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The Impact of Blockchain Technology on Trust in the Supply Chain

Master's Thesis

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I hope you will enjoy reading this survey.

Goldis Mansouribakvand

Abstract	
Title	The Impact of Blockchain Technology on Trust in the Supply Chain
Background	Trust is a main issue in supply chain collaboration. Since the Blockchain technology has received lots of attention, researchers and industries started to ask what the impact of BCT on supply chain collaboration is, and how they can benefit from BCT in supply chain relationships. This research is about exploring the impact of Blockchain technology on trust in supply chain relationships. Different interviews were conducted with different companies about the effects of the blockchain on the supply chain. The companies included, Arya Hakim and Nestle, Zalando, VESRES and Modum.
Purpose	The aim of this thesis is to identify the impact of private BCT applications on trust in the supply chain.
Methodology	The Methodology of this study was divided into three phases. The first phase was a literature review that provided the investigation model. The second phase was interviews for the selected cases. In this study, cross-case analysis was done using within-group similarities and intergroup differences technique to analyze the data and to understand the situation of trust. For instance, similarities between different companies were evaluated with regards to blockchain technology, motives and challenges. The third phase was the conclusion and answering the thesis questions.
Conclusion	Many researchers pointed out that trust in SC is a major issue as it needs information sharing of sensitive data and openness between the different parties. This report has discussed the importance of technology in influencing behavioral intention. It is mentioned that BCT improves the level of trust in the relationships within SC; however, one hundred percent trust in the records may not be achieved due to human errors in inputting data. As one of its main conclusions, the research especially points out the relationship between trust and information sharing among partners in SC. The degree of information sharing between partners in different industries is varied. Trust is mentioned as an important aspect of managing both positive and negative issues such as increasing profits and reducing risks. One of the drivers to shift traditional information sharing toward BCT is consumers' trust. Nowadays consumers show an increasing interest in knowing the background of products. Therefore, they need to get clear information, for instance, about production and delivery conditions. Companies try to respond to this need by being more transparent in their supply chain. By facilitating transparency and traceability, BCT is a solution for improving supply chain trust. In this thesis, trust is discussed from two different aspects, trust between SC partners and trust in the platform. The companies presented in the study are at different levels of trust and our investigation model in this thesis showed that investment in BCT can improve the level of trust.

« Trust has been described as the key building block of society »

Mazzella, Sundararajan, D'Espous, and Möhlmann, 2016, p. 27

1. Introduction

This chapter gives a background about the subject matter of this thesis. It introduces blockchain technology (BCT) and its effect on trust related to the supply chain. It goes on to offer a problem description, stating the need for this study and presents the purpose and research questions. Finally, it outlines the focus and delimitations of this study.

1.1 Background

Over the last two decades of increasing global competitiveness, the supply chain has become more complex, and the concept of the world-class logistic has expanded beyond the boundaries of companies. Many companies started to work on their relationships with their partners to gain superior performance (Hofer, 2014). In this fast-changing environment, collaboration is rapidly becoming an important part of supply chain management (Soosay and Hyland, 2015). However, research revealS that supply chains have difficulties in the aspect of information sharing and trust. Supply chain transformation toward a complex chain is shown in Figure 1, which compares the traditional supply chain with complex value webs (Kelly and Marchese, 2015).

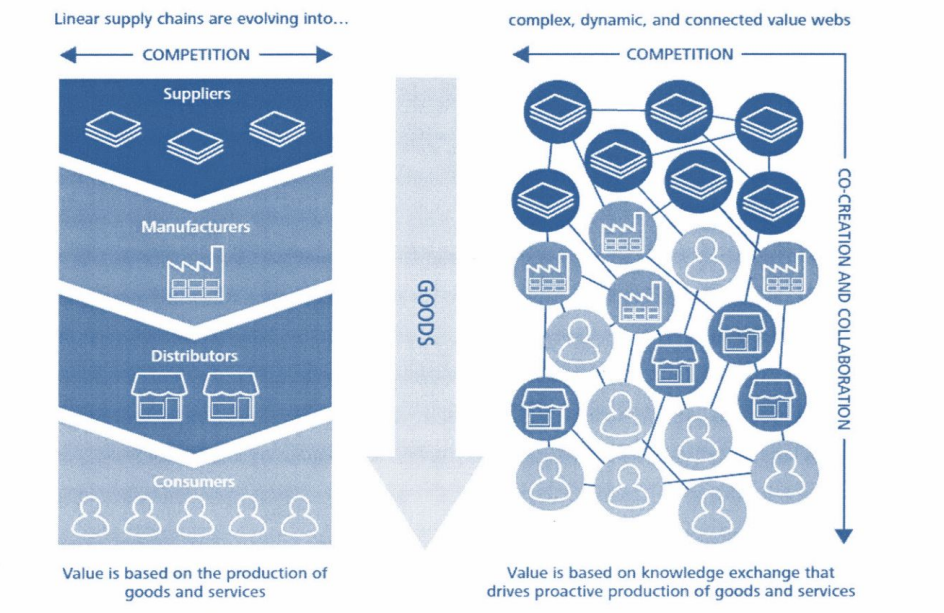


Figure1: Supply chains evolve into complex value webs (Kelly and Marchese, 2015)

In general, supply chain management (SCM) and supply chain collaboration are well-researched and are proven strategies that have positive impacts on a chain performance (Horvath, 2001). For example, Whipple et al. (2010) discuss the value of long-term collaboration in the supply chain to increase the overall performance.
Strategically, when collaboration is needed, the demand for trust will increase since partners in an SC try to know more about their capabilities, needs, and weaknesses (Ralston et al., 2017). Companies in a chain make an effort to increase transparency and trust by investing in the new technologies of information sharing and communication (Ramanathan and Gunasekaran, 2014). In parallel with challenges throughout the supply chain for improving performance, the demand for transparency by consumers and end users has also grown.

Frentrup and Theuvsen (2006) discussed how buyers and sellers have to make a reliable system for verifying and validating the real value of a product or service. This is currently developing into the global demand for improved access to information in order to regain consumer trust in the products. Olorunniwo and Li (2010) explain how trust and openness have an impact on inter-organizational collaboration in the supply chain. The illustrated lack-of-trust problem can be tackled with new technologies, and in this thesis, the focus will be on the blockchain technology.

1.1.1 Blockchain Technology

Blockchain technology (BCT), which is the technology underlying Bitcoin, refers to a distributed database that manages and keeps a continuously-growing list of data records that are secured from revision and tampering. Blockchain technology (BCT) is defined as a "*distributed, shared, encrypted database that assists as an immutable and incorruptible repository of information*" (Wright, 2015).
As the term implies, a blockchain is basically a chain of blocks (Figure 2). The primary function of a blockchain is that all the transactions are stored in so-called blocks which form a chain. Each one of these blocks includes a set of transaction records and their characteristics. A key attribute of each transaction (and each block) is its timestamp. The blockchain functions not only as a distributed ledger, but also as an immutable audit trail. The log of past transactions is typically known for the users. All transactions and each of the blocks in the network can be identified as an encrypted piece of information.

Figure 2. Visualization of blockchain (Catalini et al., 2017)

1.1.2 Blockchain Characteristics

Beck et al. (2016) described blockchain as a "*trust-free technology*". BCT as an application takes care of trust issues, thereby frees the users from the necessity of implementing mechanisms to signal or convey trust (Economist, 2015). IBM, as one of the first service providers by BCT, stated that a blockchain has the potential to create a "*sharing economy*" by the trust-free systems (Lundy, 2016). Botsman (2016), one of the pioneers of collaborative consumption, explained that the pace of building trust among people gets accelerated by blockchain technology. Casy and Vigna (2018) described the blockchain as a Truth Machine in an organizational relationship.
Based on the theoretical underpinnings of blockchain technology, a summary of the features can be formalised into a list of six core characteristics:
1- Decentralized: Blockchain technology does not use and rely on the central node, which is the main feature of the blockchain.
2- Transparent: Each node is capable of seeing the data recorded in the network. The data is updatable by each node. It is transparent, traceable and trustworthy.
3- Open Source: In a public blockchain, everyone can see and monitor a transaction. Even in a private blockchain, network members have access to the sources openly.
4- Autonomy: Because of the general agreement which is a feature of the technology, every node in the network can update or transfer data independently. The idea behind it is the trust between each member and the whole system. No one can interfere with it.
5- Immutable: The records are invariable and will be reserved forever unless a node has the control on more than 51% of the other nodes.
6- Secrecy: BTC in public mode is an innovative way to solve trust issues for node-to-node transactions since it can use operations anonymously.

1.1.3 Different Types of Blockchain

BCT has already been made for digital transactions and acts as a tool to resolve trust issues. Without monitoring from one trusted party, all the members can equally and securely share transactional data across a shared ledger. (Casey and Wong, 2017).

Satoshi Nakamoto (2008) introduced the original blockchain which was completely public, having 100% distributed control. However, this construction is not appropriate to all potential ledger applications. Different applications need various degrees of control. Therefore, a division of the various blockchain forms can be created based on two dimensions: public/private and permissioned/permissionless.

The difference between public and private blockchain is at the level of accessibility. In the public blockchain, everyone without any approval from the third party can join and perform a

transaction (e.g. Bitcoin). On the other hand, a "*private*" blockchain has a limited number of users who can observe and access the data as trusted parties.

The difference between permissionless and permissioned blockchains is based on the power to decide and write on the platform. In a 'permissioned' platform, only a limited number of approved members can submit updates of a record and engage in a confirmation which has contradiction with the permissionless platform. Examples of this are 'Bitcoin Blockchain' where anyone has the same power to execute updates and verification of data. Figure 3 shows the different types of blockchain technology.

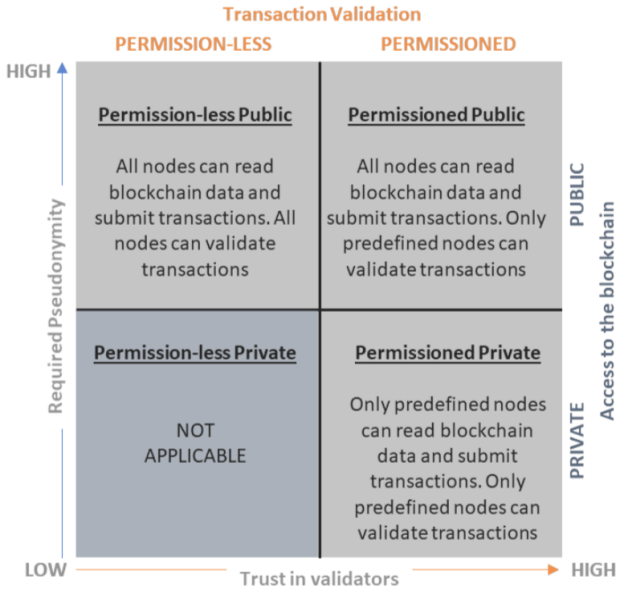


Figure 3. Types of BCT based on Kravchenko (2016), Peters and Panayi (2015) and Nærland et al. (2017)

The potential benefits of BCT include surpassing governmental and hierarchical power structures that impose demanding regulations within industries, elimination of weaknesses in the global financial market, reduction of trade costs, elimination of factors which decrease the risk of human error by electronic processing and making a protected platform for global connection, cooperation, and trade (Manuel et al., 2016).

Brennan and Lunn (2016) explained that BCT and related applications are in the early stages, and there is no common standard to categorize BCT and applications. Figure 4 below shows some of these applications. Deloitte (2017) discussed the main features of the blockchain as a platform to maintain information such as costs, date, certifications, etc. One can argue that this information is already recorded in any coordinated supply chain, but something that makes the difference in this case, is the particular characteristics of the BCT which implies that the collected information can be trusted.

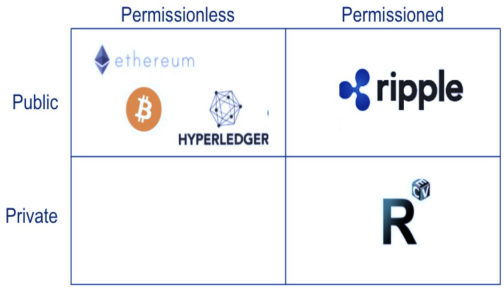


Figure 4. Different types of the blockchain and applications

Lehmacher (2017) argued that the BCT platform reduces the risk of security breaches, just like in a centralized system. Every recorded transaction in BCT could represent any exchangeable like actual money or properties such as digital certificates. They could have algorithms for instructions, such as orders to buy or sell a stock. They could include a conditional contract or so-called smart contracts, which are computerized structures to do something (e.g., sell a stock) if the condition holds (the value of the stock has increased over $12).

Trust has great importance when talking about the blockchain mainly because the blockchain is regarded as an innovation in building trust in digital environments (Leibowitz, 2016). However, it seems that one of the main misconceptions around the blockchain which has to be dealt with is the lack of knowledge about the role of trust in the blockchain context.

In social sciences, various definitions of trust exist (Chen and Dhillon 2003; Jøsang, 2005). In typical, conversational use, trust means confident reliance on another person or object when the situation is not under control (Chen and Dhillon 2003).

Jøsang (2005) argued that "*Trust is the extent to which one party is willing to depend on something or somebody in a given situation with a feeling of relative security, even though negative consequences are possible*".

1.2 Definition of the problem

In the past two decades, much research has been carried out about the role of collaboration for effective supply chain management Collaborative supply chain has also been recognized as a significant approach to improve the overall performance and achieve competitive advantages for the whole chain (Simatupang and Sridharan, 2002). Collaboration has been referred to as a driving strategy toward achieving a successful supply chain when two or more firms share the responsibility of planning, control and performance management (Anthony, 2000).
Efficient collaborations facilitate supply chain partners to develop their strength to fulfil customer needs and to increase the company's capability to immediately respond to market opportunities (Simatupang and Sridharan, 2005). For instance, joint problem-solving improves

the pace at which products are brought to the market by quicker problem resolving. Collaboration between supply chain partners leads to new product ideas (Kalwani and Narayandas, 1995). Companies such as Procter and Gamble, Hewlett-Packard, IBM, and Dell, have enhanced collaboration as a source of competitive advantage. External collaboration among supply chain partners leads to the reduction of costs, stock-outs and lead-time (Barratt and Oliveira, 2001; Callioni and Billington, 2001). Simatupang and Sridharan (2005) suggested that for obtaining all the advantages of the supply chain, the focus should be on different drivers to achieve the highest grade of integration. Information sharing, as a basic driver, improves the current situation within the supply chain (Lee et al., 1997), for example, to reduce the bullwhip effect by the vendor management inventory (VMI) (Yu et al., 2001).
As one of the crucial issues, surveys are notably pointing out a lack of trust and transparency in information sharing among companies in the SC. These problems are partly an outcome of a large number of partners being involved (Casey and Wong, 2017). Having independent entities, there is always a risk of conflict between businesses' goals.

In order to collaborate, different companies are seeking a standard governance or structure that will develop relationships and reduce the threat in their transactions (Heide, 1994).
Blockchain technology is a ground-breaking innovation to improve trust through transparency and traceability within any transaction (Nakamoto, 2008).
Although currently there is much hype around blockchain technology as a novel solution to the age-old human problem of trust, the relation between the blockchain and trust in supply chain relationships is still poorly understood. Crosby et al. (2016) argued the blockchain is a verifiable, immutable and distributed database or ledger for transactions based on a consensus mechanism. Thus, the blockchain takes the place of law, intermediaries, and personal relationships as a trusted instrument. On the other hand, some scholars argue that a lack of trust can quickly become a barrier for partners for information sharing throughout the supply chains (Kembro et al., 2017). Hence, the relation between trust and information sharing in the blockchain is double-sided. The principal objective of this study is to explore how blockchain technology impacts trust in supply chain relationships. Figure 5 presents a visual summary of the concepts used in this study.

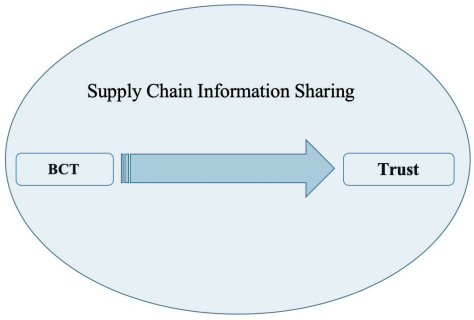


Figure 5. Visual relationships between BCT and trust in supply chain

1.3 Purpose of Research

The aim of this thesis is to identify the impact of private BCT applications on trust in the supply chain.

1.4 Research Questions

The research questions are the vehicles for understanding the importance of blockchain technology in supply chain collaboration. Moreover, they investigate the definition of trust in the supply chain context. Accordingly, the purpose of this research can be broken down into the following Research Questions (RQs).

RQ1: What is the nature of trust in the supply chain?

RQ2: How does the private blockchain impact trust within the supply chains?

1.5 Limitations

The scope of the research is defined in the area of the blockchain, technology, trust, and supply chain. This research area will be approached by exploring the private blockchains' potential ability to fulfill the trust requirement in the supply chain.

There is no emphasis on the technicality and real data processing that is related to blockchain technology or hash-functions, and hence there will be no detailed explanation of the systems processing functions.

1.6 Thesis Structure

This study is structured as follows: First, a relevant literature about the blockchain is presented, then SCM and trust are introduced to provide comprehensive knowledge about these topics. Later, the relationships between blockchain technology and trust in SCM are shown. After that, the research methodology is described, including the research theory, research design, data collection, analysis process as well as research reliability and validity. The following two chapters will address the interviews in terms of empirical data and analysis in the single case and then cross cases analysis. Finally, chapter 6 will discuss the findings and will propose the conclusion, limitations, and further research opportunities.

1.7 Contribution

The contribution of the thesis will be how the private blockchain can help to reinforce trust in today's complex and globalized world and bring confidence to the global supply chain.

2. Frame of Reference

The aim of this chapter is to present a frame of reference for the topics of blockchain technology, SCM and trust. First, the literature about blockchain technology is presented. Then, the technology, its fields of application, its role for supply chains as well as limitations are explained. In the second part, the terms of SC and SCM will be discussed. In the third part trust, its different types, and characteristics, as well as a different approach, are defined. Finally, the connection between trust, SCM and blockchain technology is discussed.

2.1 Blockchain

The application of blockchain was first developed in the financial field in 2008 as the cryptocurrency Bitcoin (Swanson, 2015). Blockchain technology is described as "the computers of separately owned entities that follow a cryptographic protocol to constantly validate updates to a commonly distributed and shared ledger" (Casey and Wong, 2017).

The transactional data is immutably collected in the distributed database in the form of a chain of sequentially related blocks, presenting a comprehensive and visible history of past interactions. The technology can be used for tracing, tracking and controlling assets, information and communication. It facilitates executing long term relationships through smart contracts (Swan, 2015).
The terms of the decentralized and distributed ledger are often used when referring to the blockchain. The difference between various types of the blockchain is based on the different network structure and level of the control.

2.1.1 Network Structure

Several modes of the network system, including centralized, decentralized and distributed are illustrated in Figure 6. The modes show where data and sources are divided on multiple hardware in the network. Based on the different structures and level of access, the blockchain takes different forms.

Centralized Network: This is used for the traditional ledger, when a central owner in the network has the power to control every transaction and to verify the information. Information sharing happens in the single point of contact.

Decentralized Network: Multiple central owners have the history and record of the transactions. The permissioned blockchain, no matter public or private, normally uses this network mode.

Distributed Network: The distributed network is the decentralized network taken to the extreme. The public permissionless blockchain uses this structure (Figure 6). The main point for the distributed network rests in the idea that every activator actor gets equal access to do transactions and activities in the network**.** Each node keeps a database of historical, actual and valid transactions, which are transmitted within the nodes in that system. These digital ledger entries are then distributed among several computers/servers each of which acts as a node. (Swan, 2015).

The relation between the different network structures and types of the blockchain is illustrated in Figure 6.

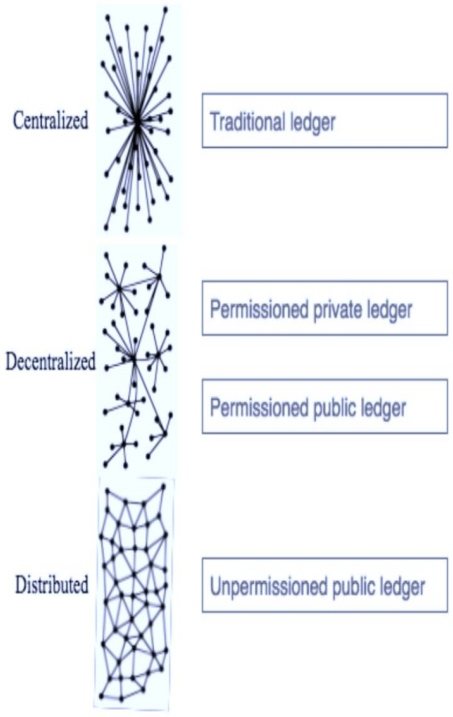


Figure 6. The relationships between different structure of the network and blockchain type

2.1.2 Technology Overview

The general view of the technology is developed based on the structure provided by Brenig et al. (2016), who defines the technology into the platform, services, and applications (Figure 7). In this thesis, two types of cases will be analyzed. The first type is the companies which are using the blockchain application and blockchain platform. The second type is the companies that act as the service providers which develop the application of BCT for different industries.

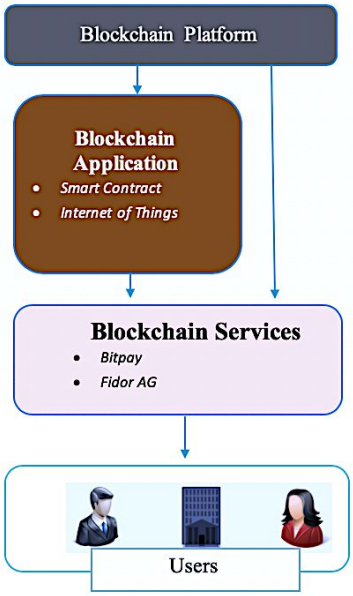


Figure 7. Framework for blockchain analysis (Brening,2016)

2.1.3 The blockchain platform

Brenig (2016) described the blockchain platform as a "*distributed decentralized consensus system*". Mougayar (2016) discussed that the blockchain platform can be classified as the protocol of the technology which provides the base for the other two layers (applications and services). It consists of the foundation that serves as the technical backbone of applications such as smart contracts and services like Bitpay. Based on the definition provided by Glaser (2017), this research identifies the blockchain platform as a transactional database, which is shared between nodes connected in a peer-to-peer (P2P) information system. Access to the network is based on a recognition and permission mechanism, which allows the nodes to execute transactions that contain validity based on an agreement mechanism. (Glaser, 2017).

All transactions in each system are recorded in a digital ledger at a distributed network, and various transaction activities are collectively forming a block (Swan, 2015). After adding the 'block' to the general ledger, a predetermined value of transactions is recorded. Each new block includes labeled addresses to receive the exchange value and also holds the digital address (hash) of the earlier block (White, 2017). Network members can reach all historical activities and transaction and specific details, e.g. value and time of the creation of the block (Catalini et al., 2017). The visualization of the process of the blockchain is shown below (Figure 8).

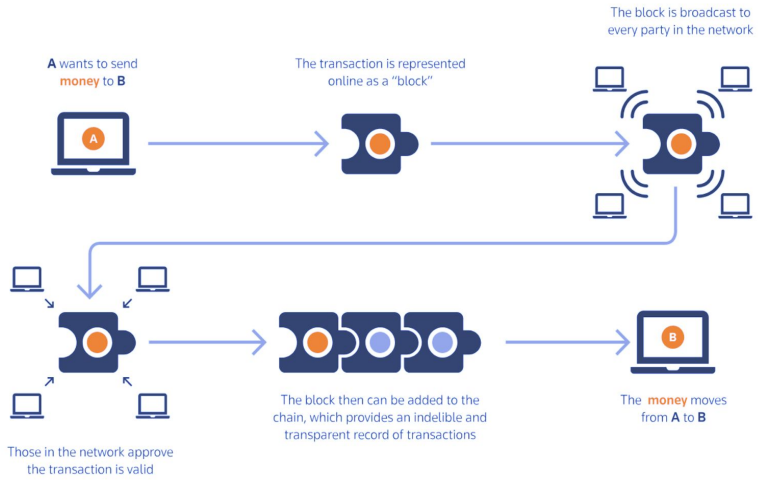


Figure 8. Blockchain process source (Value Coders, 2017)

A set of keys (Figure 9) has been held by each node in the private or public mode. The private key could be used to encrypt the data before each transaction. Each sender needs its private key and the public key of the receiver. In addition, before recording each transaction, two different phases need to take place: signing and verification. Senders use a private key as the singing phase. in the second phase, verification needs to be done which is the solution of the computational problem and facilitates a unique transaction (Morabito, 2017).

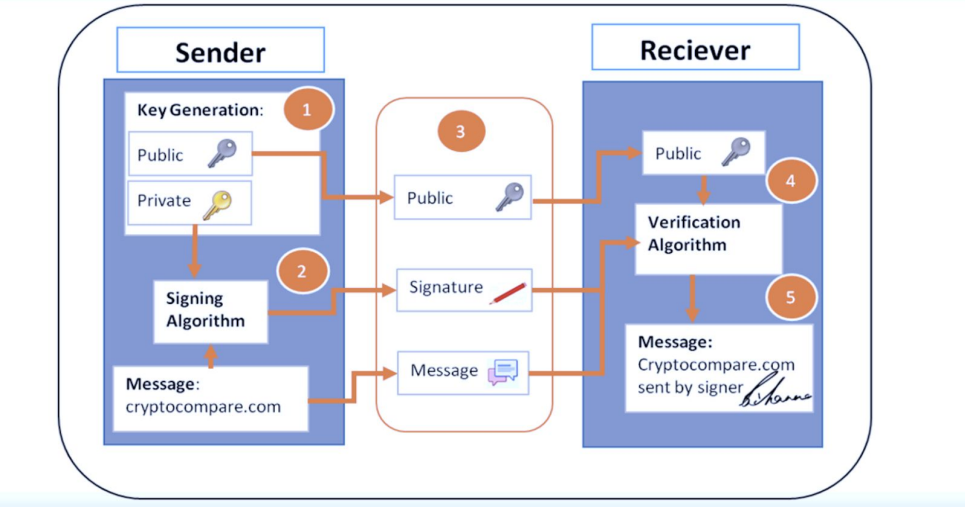


Figure 9. Digital signature mechanism adapted from (Wright et al.,2018).

2.1.4 Blockchain Applications

The blockchain applications, are executed on top of a presented platform (Figure 7), which is linked to a particular blockchain, to provide further functionalities.

Since the fundamental use-case for blockchain technology is to obtain more transparency, accuracy, and truth of transactions that cross the platform, possible applications of such technology are nearly limitless. Mougayar (2016) illustrates the importance of the blockchain application system and identifies the value proposition of blockchains to address one or more of six elements denoted by the mnemonic ATOMIC (Assets, Trust, Ownership, Money, Identity, and Contracts).

These characteristics facilitate and improve the creation, transfer, and controlling of digital assets through automatic validation laws. Hence, blockchains can promote new services to come to market with lower transaction charges and accelerated execution. Different types of application is shown in Table 1.

Application	Goal
Property rights management	To fight corruption and to protect people's rights to e.g. land
Financial services	To enable micropayments, access to financial services
IP rights management	To track and control the use of IP
Voting	To enable transparent voting, online voting
IoT	To enable machine-to-machine transactions
Sharing economy	To offer decentralized platforms for sharing
Smart contract platforms	To offer decentralized platforms for smart contracts
Decentralized organizations	To enable smart optimization of resources

Table 1. Different application of blockchain (Nofer et al., 2017,187)

There are lots of applications and services based on the BCT. The selected cases in this thesis are implementing BCT as a platform for two applications: Internet of things (IOT) and smart contract. In this regard, the following content will be dedicated to these two applications.

2.1.4.1 Smart Contract (using BCT)

Sultan et al. (2018) describes the blockchain application as a programmatic interface which is called a smart contract. A smart contract is described as "*being able to perform useful functions to create, maintain or augment the value of digital assets*" (Sorin et al., 2016).

Smart contracts can simplify the complicated multi-party supply chain by facilitating the tracking of the product origin and history. The smart contract is a "*pieces of software that represent a business arrangement and execute themselves automatically under pre-determined circumstances*" (The Economist Staff, 2016).

Sultan et al. (2018) explained how the specific functionality of BCT such as the smart contract can be as a facilitator in buyer-seller relationships in the example of Visa and DocuSign, who have cooperated to ease the experience of vehicle leasing for customers by simplifying the transaction management among multiple parties including sellers, buyers and insurance companies (Hirson, 2015).

The difference between the traditional transaction model and the smart contract transaction is shown below (Figure 10). In the traditional model, there is always an intermediary as a trusted party (e.g. bank) to approve the trustworthiness of the interaction. In the smart contract interaction with the blockchain, the requirements are stored in "*contracts*" that have to be achieved by the users to enable the creation of a new block, thus there is no need for an intermediary partner as a controller.

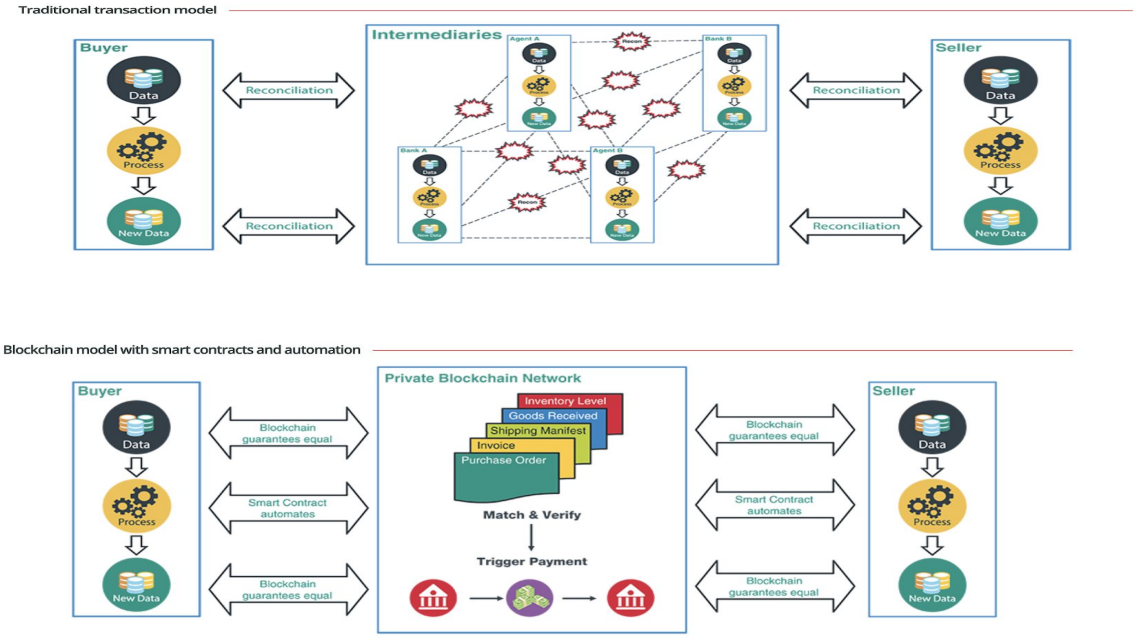


Figure 10. Difference between traditional transaction and smart contract transaction

2.1.4.2 Internet of Things (IoT) using BCT

BCT can empower the Internet of Things related devices to be intelligent. Independent companies can cooperate with each other by using IOT based on the blockchain technology, for example for tracking the inventory location and ownership in almost real time. IOT based on the blockchain can be linked to the smart contract, e.g. the payment can be automatically proven between multiple companies if the delivery reaches the conditions defined in the contract. It would enhance the confidence of consumers in the origin of the product and reduce the risk of deception (Francisco and Swanson 2018).

2.1.5 Blockchain Services

Blockchain services do not need a special link to the application of the blockchain (Figure 7). Service providers use the existing functionality of the blockchain platform to provide a new way of serving, but they do not add new functionalities. For instance, BitPay provides payment processing as a service for companies who desire to accept payments with bitcoin. Another example of services is the IBM product, which is a flexible software-as-a-service and is delivered through the IBM Cloud. This service is an enterprise-ready blockchain platform designed to accelerate the development, governance and operation of a multi-institution business network (IBM, 2019).

These are the fundamental services for developing programmable ownership, trust, and identity, and also for facilitating the transactions and providing a governance mechanism (Sultan and Ruhi 2018).

As a trusted service application, blockchain technology highly impacts the supply chain management. The aspects of what parts of the supply chain are associated with the blockchain and who is affected are relatively poorly covered in the literature.

2.2 Supply Chain

The academic literature has discussed the critical role of the supply chain, its border, scope, and characteristics. The terminology is complicated as some scholars describe the supply chain as an operational term concerning the flow of goods and materials. Some recognize it as a management theory, and others understand it as process management. Today, the supply chain is defined as activities such as inbound and outbound logistics, operations, marketing, sales, and services across intercorporate borders to add value through the chain.

Pienaar (2009) defines the supply chain as "*a general description of the process integration involving organizations to transform raw materials into finished goods and to transport them to the end-users*". The definition that has been used for this thesis is from Mentzer et al. (2001) that defines the supply chain as "*a set of three or more entities (organizations or individuals) directly*

involved in the upstream and downstream flows of products, services, finances, and information from a source to a customer."

2.2.1 Supply Chain Management (SCM)

Cooper et al. (1997) explain the supply chain management as "the *integration of business processes from end user through original suppliers that provides products, services, and information that add value for customers*." SCM as a management philosophy has recommended the following characteristics for viewing the supply chain as a whole. The aim of the SCM is to maximize performance by strategic cooperation. SCM creates customer value and brings customer satisfaction (Mentzer et al, 2001).

2.2.2 Supply Chain Management Activities

In choosing supply chain management as an approach, organizations need to set management practices that allow them to work or behave consistently with other partners, and some main activities are needed to enhance the capabilities within SC (Table 2).

Supply Chain Management Activities
1. Integrated Behavior
2. Mutually Sharing Information
3. Mutually Sharing Risks and Rewards
4. Cooperation
5. The Same Goal and the Same Focus on Serving Customers
6. Integration of Processes
7. Partners to Build and Maintain Long-Term Relationships

Table 2. Supply chain management activities (Mentzer et al., 2001)

Integrated Behavior

Companies in the chain need to develop integrated behavior toward customers and suppliers. Bowersox and Closs (1996) discussed how the integrated behavior, through external integration, is related to supply chain management. In this meaning, the philosophy of SCM includes a set of coordinated activities between supply chain partners to answer the needs of the end customer.

Mutually Sharing Information

For implementing SCM as a philosophy, chain entities need to establish an information sharing system mutually among chain members, especially for the planning and monitoring processes (Cooper et al., 1997). Mentzer et al. (2001) discussed the definition of information sharing as the enthusiasm to make strategic and tactical data accessible to other members of the supply chain. The ultimate goal of information sharing is to reduce the uncertainty between supply partners and to obtain enhanced performance.

Mutually Sharing Risks and Rewards

SCM enhances competitive advantages and effectiveness by mutually sharing risks and rewards over long relationships. Risk and reward sharing should happen in the long term among supply chain members (Cooper et al., 1997).

The Same Goal and the Same Focus on Serving Customers

La Londe and Masters (1994) discussed that effective and efficient supply chain needs all the members of the supply chain to have the same goal and the same focus on serving customers, which results in policy integration (Mentzer, 2001).

Integration of Processes

Integration of processes is needed for the successful implementation of SCM, though all the processes, including the manufacturing, sourcing, and distribution across the chain. By some activities like cross-functional decision making, using third-party providers and in-plant supplier personnel integration can be obtained (Cooper et al., 1997).

Partners to Build and Maintain Long-Term Relationships

Mentzer (2001) discussed that developing strategic for partnerships with supply chain members increases customer value and give a competitive advantage.

2.3 Trust

McKnight and Chervany (2001) studied the consequences of organizational "*restructuring*" crisis of 1990 when through increased complexity, trust became more crucial as a strategic asset in organizations. In 1996, scholars began to argue about the role of trust in SCM, when the concept of trust started to challenge transaction cost economics (TCE) theory's explanatory power. In 1996 in a book on partnering issues, a manager discussed trust as a key concept in each cooperation. It is quoted "*without trust, there is no basis for partnering*" (McKnight and Chervany, 2001).

Andaleeb (1996) mentioned the impact of a high level of trust between chain members which emerges the high level of buyer's satisfaction. Kumar (1996) explained about the role of trust as a fostering commitment among interactive relations and building effective relationships. Monczka et al. (1998) and Chandra and Kumar (2000) explained the tendency of the supply chains for mitigating risks and uncertainties through trustful collaboration.

In 2003, Sahay discussed that trust in a buyer-supplier relationship decreases the perception of risk related to opportunistic behavior, and at the same time reduces transaction costs. For example, in a collaborative relationship, where the buyer trusts the supplier, the tendency of using double sourcing will be decreased.

The lack of trust is commonly considered as a cause of being less effective than planned in dyadic relationships in the supply chain. On the other hand, one of the issues with developing trust in collaborative relationships is attaining the necessary balance of trust and maintenance of proprietary interests; if this balance is not maintained appropriately, then the partnership is likely to fail (Bstiler, 2006).

According to the definition and characteristics of the supply chain management, the strategic collaboration in the supply chain is a key aspect to gain competitive advantages (Yeung, 2008) and a lack of trust has been pointed out as a barrier to long-term partnerships in the supply chain (Cannon, Doney, Mullen, and Petersen, 2010). This thesis focuses on the effect of BCT on trust in the supply chain, especially in dyadic (Buyer-Supplier) relationships (Figure 11).

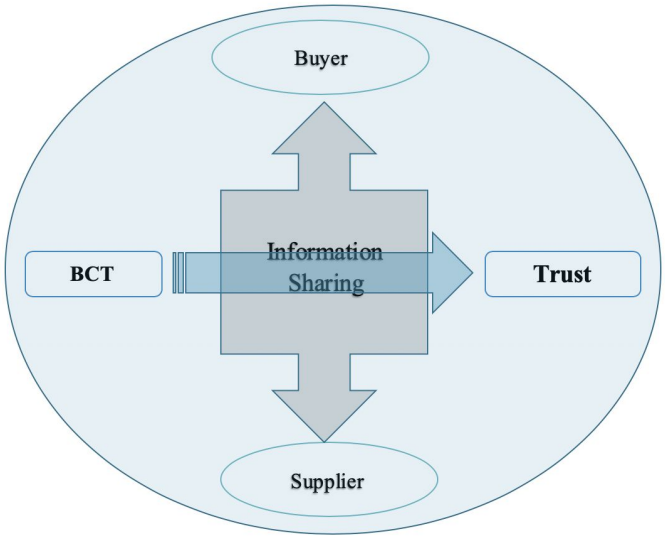


Figure 11. Conceptual model of relationships between BTC and trust within supply chain

2.4 Unpacking Trust

The awareness of trust's role in organizational behavior already appeared in 1958 when Strickland discussed the dilemma of the supervisor. The criticism described the negative feeling as a consequence of controlling by supervisors, which can harm the feelings of both the controller and the controlee. The empirical data (delivered by Enlz and Anderson (1993)), proved that controlling threatens the controlee's autonomy and reduces intrinsic motivation and trust.

In 1967, Giffin mentioned the mystical and intangible factors within trust which create the challenges for precise definition.

Lewis and Weigert (1985) discussed "*conceptual confusion*" about trust terminology. Shapiro in (1987) mentioned trust as a "*confusing potpourri*". Carnevale and Wechsler (1992) described trust as a "*conceptual morass*" (McKnight Chervany, 2001). Even though lots of research has been done on trust, there is still a lack of agreement about what constitutes trust. Furthermore, there is no generally accepted definition of trust. Even though lots of research has been done on trust, there is still a lack of agreement about what constitutes trust, and there is no generally accepted definition of trust.

Research on trust is complicated as there are many different ways in which trust is described. For instance, trust has been described as both a noun and a verb. It can also refer to a personality characteristic and a feeling, or social construction and behavioral intention (Barber,1983).

Seppänen et al. (2005) conducted a study on the theoretical approach, operationalization and conceptualization of trust in inter-organizational relationships from 1990-2003. They analyzed different definitions and aspects of trust, that were used in literature (Figure 12). For instance, credibility as a form of trust has been defined by Ganesan (1994) as "*the willingness to rely on an exchange partner in whom one has confidence.*"

Reliability and truth and honesty were delivered by Chow and Holden (1997) as "*The level of expectation or degree of certainty in the reliability and truth/honesty of a person or thing*".
Sako and Helper (1998) defined goodwill trust as "*an expectation held by an agent that trading partner will behave in a mutually acceptable manner*".

Figure 12. Trust conceptualization by Seppänen et al. (2005)

Seppänen et al. (2005) discussed in their extensive study how trust could impact communication and information sharing and help to manage conflicts (Adam et al., 2010). They examined the differences between countries in inter-organizational trust. As a case in point, the conceptualization of trust was more complicated in Japanese firms as compared to U.S. firms, and the examined factors influenced trust somewhat differently. For example, the duration of contracts had no meaningful impact on opportunism in Japan; however, this might be explained by the fact that contracts are typically being renewed annually in Japan. Contract duration did have a significant effect on opportunism in the U.S (Adam et al., 2010).

The other main reason for the ambiguity and confusion in defining trust could be the causality. Seppänen discussed trust as a two-sided concept which is potentially a cause and an effect in inter-organizational relationships.

2.4.1 Different Forms of Trust

McKnight and Chervany (2001) discussed different ways of defining trust in research, articles or books. They illustrated five major categories that are defined in various definitions of trust.

Different classifications of trust influence each other in different ways (Figure 13). The arrows indicate how these types of trust influence one another.

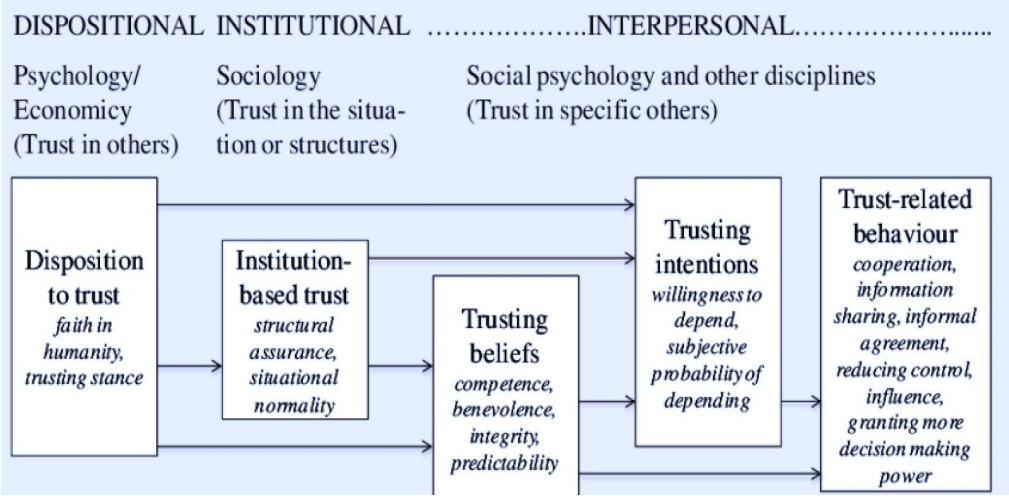


Figure 13. Interdisciplinary model of trust constructs (McKnight and Chervany, 2001)

Dispositional Trust: exists mainly because of the personality characteristics of the trusting partner. That is, the trustor generally has the willingness to trust others, which has two sub-constructs: faith in humanity and trusting stance (Rotter, 1967).

Structural Institutional Trust: means that trust is established upon social or institutional structures in the condition and situation, not on the person, or personal characteristics of the trusted parties (Lewis and Weigert, 1985b). Garfinkel (1967) argued that trust is a function of reliability and described such natural phenomena as the law of gravity. Shapiro (1987a) defined trust as function assurances given by such social arrangements and structures like banking regulations.

Belief of Trust: is a psychological willingness to accept vulnerability (Li, 2007). This would show the faith whereby the online shop will deliver the product through promises, or some service providers keep private information secure (McKnight and Chervany, 2001).

Intention Trust: is the extent to which one party is ready and willing to rely on the other party in a given situation with a perception of applicable safety and security despite the probable negative consequences. The probability of negative consequences is mentioned as the risk and uncertainty associated with trust, which makes it more problematic and important.

Behavior Trust: is the extent to which one person likely depends on another person in a special situation with a perception of dependent security, even though negative consequences are possible (Lewis and Weigert, 1985). 'Dependance' is particularised as a behavioral terminology, distinguishing trust-related behavior from trusting intentions, which essentially means a willingness to be dependent.

It is beneficial to recognize the difference between behavioral trust, "*the enthusiasm to increase one's vulnerability to another side whose performance is not under authority*", and the intentional trust, or the mental probability that one acknowledges to benevolent action by another agency or group of agencies.

Behavioral trust can be based on intentional trust, but can also be based on other circumstances (such as a failure to understand unilateral dependence or structural regulations), and the existence of intentional trust cannot be inferred from the presence of behavioral trust alone. There is a willingness to accept and even appreciate vulnerability which is called trust-as-choice (Li, 2007). Various characteristics of trust have been mentioned in the literature (Table 3).

Author	Dispositional Trust	Structural Institutional Trust	Belief and Intention Trust	Behavior Trust
Shapiro, 1987		X		
Anderson and Narus, 1990			X	
Luhmann, 1991	X	X		
Kasperson et al., 1992			X	
Ring and Van de Ven, 1994			X	
McKnight and Chervany 2001	X	X	X	X
Seppänen et al., 2005	X	X	X	X
Six 2007			X	X
Lee 2007			X	X

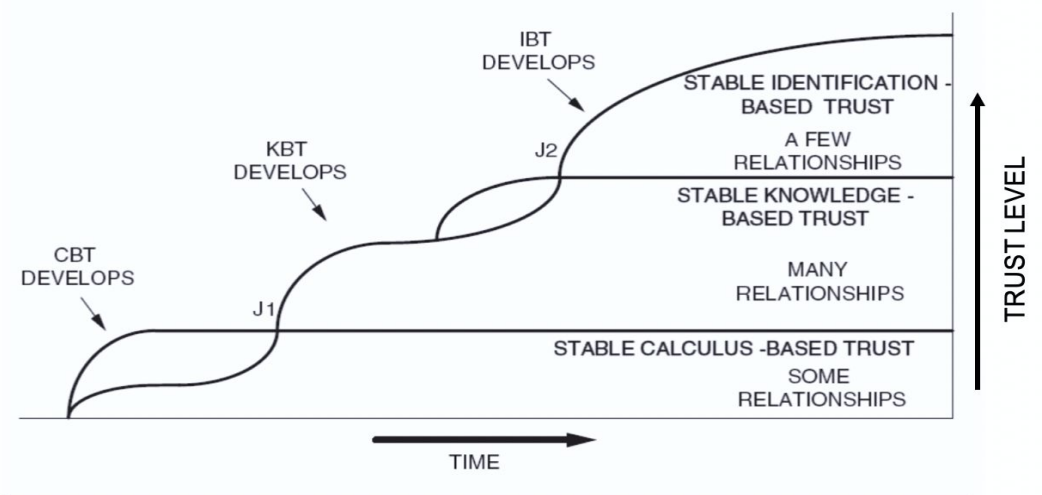
Table 3. Various approach to trust in literature

2.4.2 Trust Development Model

Researchers found out that the dynamics of trust are varied at each stage of partnership. As the partnership "*moves from one stage to another during the time, the parties' interest in different behaviors is necessary, both to change and sustain the relationship*" (Lewicki and Bunker, 1995). Since this research aims to understand the impact of the blockchain on trust in the supply chain, it is critical to focus on the model which traces the changes and can be adapted to reflect the change process.

Trust development, which in a professional business relationship, was first proposed by Shapiro et al. (1992) who rgued that three types of trust can be instrumental in developing a business relationship: deterrence-based trust, knowledge-based trust, and identification-based trust.

Lewicki and Bunker (1995) developed this idea and proposed three distinct dimensions of trust: calculus-based (CBT), knowledge-based (KBT), and identification-based trust (IBT) (Figure 14). Lewicki and Bunker (1995) mixed deterrence and calculus into one stage. In the following sections, first the characteristics of deterrence-based trust by Shapiro (1992) will be described to clarify the first stage of trust in professional relationships. Then, the three-stage model by Lewicki and Bunker (1995) will be explained.



Source: Adapted from Lewicki and Bunker (1995).
Note: J1 = At this juncture, some calculus-based trust relationships become knowledge-based trust relationships; J2 = at this juncture, a few knowledge-based trust relationships where positive affect is present go on to become identification-based trust relationships.

Figure 14. The stages of trust development by (Lewicki and Bunker, 1995)

Deterrence-Based Trust: This is the first kind of trust and was introduced as the most primary form of trust, which especially exists in the initial stages of any cooperation. One will do

whatever he/she promises to, since they are afraid of the consequences of violating their obligations. In deterrence-based trust, parties assume that the other side will not violate the agreement because it knows breaching trust will be costlier than keeping it. For trust at the deterrence level to be effective, monitoring is a must. (Shapiro et al., 1992).

Calculus-Based Trust (CBT): It takes deterrence trust one step further. This form is grounded not only in the fear of punishment for violating trust, but also in the rewards for preserving it. Trust based on a calculatioń compares the costs and benefits of creating and sustaining a relationship versus the costs and benefits of severing it. Reputation is trust's hostage in this stage. If trust is violated, the professional reputation of the parties serves as a hostage.

Knowledge-based Trust (KBT): This form of trust is grounded in predictability. Partners continuously attempt to learn about the other side. As this knowledge increases, one gets to know the other party better. At this level, gained information leads to the anticipation of the action which the other side contributes to trust. Constant communication allows understanding of actions of the others.

Identification-Based Trust (IBT): After repeated interactions, partners may become aware of shared values and goals. At this stage, trust has been built to the point that the parties have internalized each other's desires and intentions. At this level of trust, a party can be seen as the representative, substituting the other in interpersonal transactions (Lewicki and Bunker, 1995). The development of trust in three stages is illustrated in Figure 14. Trust evolves and changes during the partnership. Trust in a relationship could go through all stages to mature from CBT into KBT and finally into the IBT level. However, there is no constant development as some relationships cannot be fully developed.

2.4.3 Trust and Contract

Effective coordination among supply chain entities causes a significant impact on supply chain performance (Lee et al., 1997). Collaboration and coordination are needed to ensure both the timely and quality flow of information. To be successful in managing a whole chain, each chain member needs to agree on common governance mechanisms. These governance mechanisms define the processes and structure of the relationships that exist between chain members.

Lee et al. (1999) mentioned that the coordination of transactions should be maintained in the supply chain in order to reduce costs, risks and to improve overall competitive advantages. A

fundamental approach is the contractual relations between the different partners. (Narayanan et al., 2004).
Lewicki and Bunker (1995), in defining development trust during a relationship, claimed that there is a certain amount of trust when peers decide to join the contract or have the willingness to rely on the other parties. Several types of research on the modeling of supply chain contracting have pointed out that revenue-sharing contracts improve coordination and increase profitability and that the incentive for collaboration depends mostly on the condition of payment and timing.

Scholars described contract design as an essential element of managing mechanism between trading partners. At the same time, researchers have discussed the importance of relational mechanisms, especially trust, to enhance the value of partnership. While there is broad agreement on the point that both contractual and relational factors are crucial elements to strengthen cooperation, interaction between the two dimensions remains unclear (Puranam and Vanneste, 2009).

Some scholars have discussed that trust and contract are usually the opposite. The presence of contracts would "*crowd out*" trust- related motives and actions. Others recommend that contracts and trust are not only cooperative, but mutually strengthening. In this regard, contracts, by encouraging primary association, would expedite trust (Puranam and Vanneste, 2009).

Earlier surveys describe both trust and contracts as crucial success factors for partnerships. They are assumed as 'making or breaking' partnerships factors, influencing the collaboration both positively and negatively. They are usually listed under governance mechanism factors in the relevant literature, and among the most frequently mentioned factors are goals, equality, mutual trust, and ground rules.

Trust from the transaction economic cost point of view is a governance mechanism, which is aimed at bringing about effective coordination of activities while safeguarding the risk of opportunist decisions. Opportunism is "*a self-interest seeking assumption that makes allowance for guile*".
Collaboration is seen as investments that can make profits in the future with regard to available resources. For this to be realized, trust is required in the coordination, which in some cases is identified as the contract (Camén et al., 2011). In general, contracts need some form of relationship management, which requires an amount of trust between the concerned parties.

(Camén et al., 2011). Contracts boost the ability to bind actors to each other, specify the conditions of the transaction and provide evidence and enforcement for execution of the set terms. (Blomqvist et al., 2005).

As discussed, contracts and trust seem to be two sides of the same coin. Trust complements flexible contracts. The contract is simply a framework, and trust is an essential complementary mechanism. Trust and contracts are perceived as complementary, not alternative, modes of governance, which enhance each other. Collaboration requires trust and the parties should attempt to build it up from the very early stages. Starting contracting and cooperation is not feasible without the presence of some trust.

2.4.4 Trust Categorization Model

Steppänen (2005) collected all the antecedents, dimensions, components, and consequences of trust by various authors, and categorized a range of perspectives on trust dimension and consequences (Figure 15).

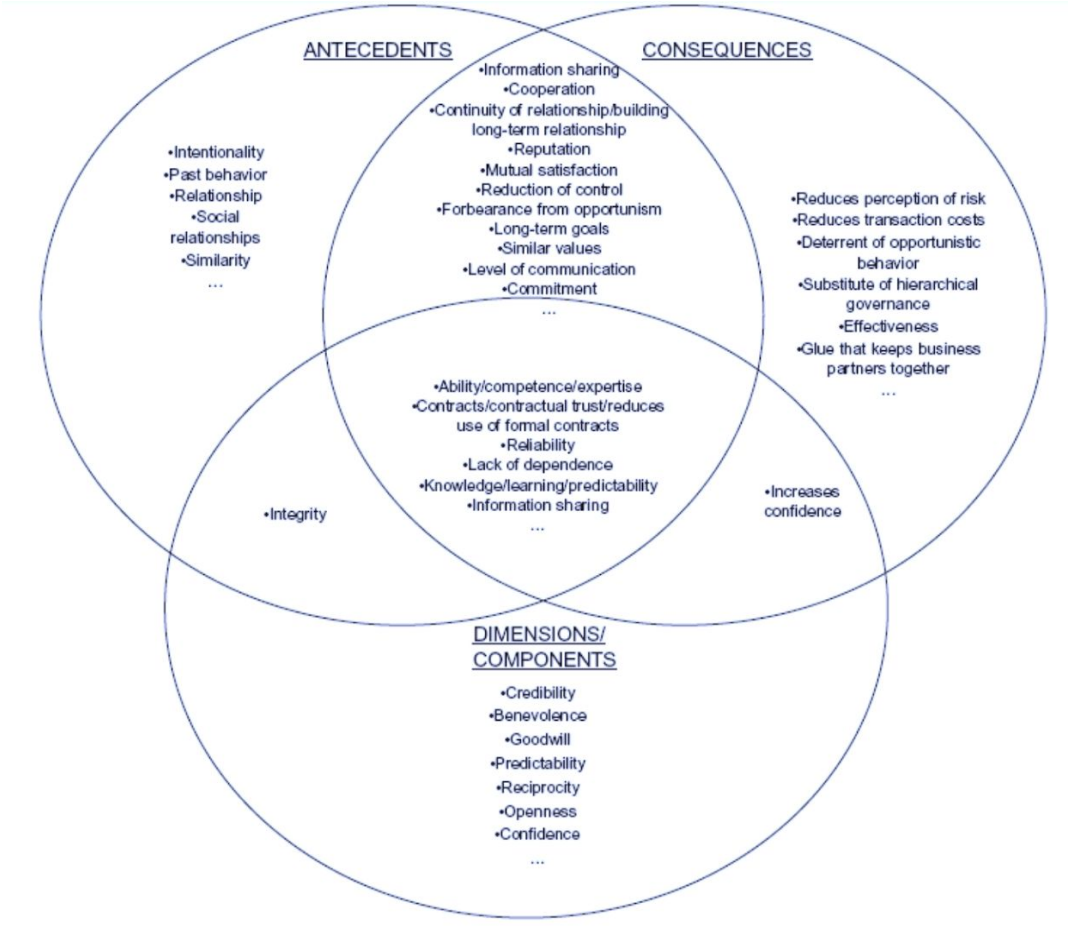


Figure 15. Antecedents, dimensions/components, and consequences of trust (Steppänen et al, 2007).

Earlier surveys have illustrated insights into different types of organizational-level trust, which display significant overlap in meaning. They are defined as expertise, competence, integrated, calculative trust, trust in predictability, trust in the integrity, trust in credibility, trust in goodwill, and contractual trust (Ghosh,2008).

2.4.5 Operationalized Trust in Supply chain

Interorganizational trust is multidimensional and difficult to operationalize and measure. However, some previous researchers have tried to measure trust. Steppänen et al. (2007) have renewed (Table 4) and summarized it into conceptualization, dimension and operationalization.

Author	Conceptualization of Trust	Dimensions of Trust	Operationalization of Trust Dimensions
Ganesan (1994)	‘‘Trust is the willingness to rely on an exchange partner in whom one has confidence’’.	Credibility and benevolence	Four measurements of retailer's long-term orientation: 1. We believe that over the long run our relationship with this resource will be profitable. 2. Maintaining a long-term relationship with this resource is important to us. 3. We focus on long-term goals in this relationship. 4. We are willing to make sacrifices to help this resource from time to time All items were measured on a scale of 1– 7 (strongly disagree–strongly agree).
Aulakh et al. (1996)	‘‘Degree of confidence the individual partners have in the reliability and integrity of each other’’.	Confidence, reliability and integrity	Four items for measuring continuity expectations, 1-Our firm and our partner firm are very committed to each other. 2- If our firm could find another partner in this country, we are likely to switch to a new partner 3-There is a high level of uncertainty in this partnership. 4-We and our partner firm are not sure how long our relationship will last. All items were measured on a scale of 1– 5 (strongly disagree–strongly agree).
Doney and Cannon (1997)	‘‘Perceived credibility and benevolence of a target of trust’’.	Credibility and benevolence	Trust of the salesperson on seven items. The first item is sales expertise which was measured by: 1-This salesperson is very knowledgeable. 2-This salesperson knows his/her product line very well. 3-This salesperson is not an expert.

Table 4. Conceptualizing Trust and measurement adapted from Steppänen et al. (2007).

2.5 Key Aspects of Trust in Supply Chain

The results of the literature search and classification indicate both broad and ambiguous definitions. As far as the objectives of the thesis are concerned, the author focuses on the trust dimension as it is perceived by chain members concerning their direct business partners. To that end, three dimensions of trust which are associated with BCT characteristics will be analyzed. The reason for selecting these three dimensions is to access the relevant literature about the signals in the context of the supply chain and BCT and the characteristics of trust as a behavior in these three forms. Benevolence, openness and credibility are trusting behavior that can be operationalized based on different indicators. Thus, trust can be broken into three main dimensions which are illustrated in Figure 16. The following section tries to highlight the core constituents of trust which can be operationalised in the supply chain.

The manifestation of each form of trust is presented in the below Figure 16. In fact, by this manifestation, one can analyze the form of trust in relationships. In that operationalization, trust includes sub-dimensional constructs such as openness, credibility and benevolence. These levels are also developed or adapted from existing literature to assess factors that could help to understand the form and level of trust in supply chain relationships.

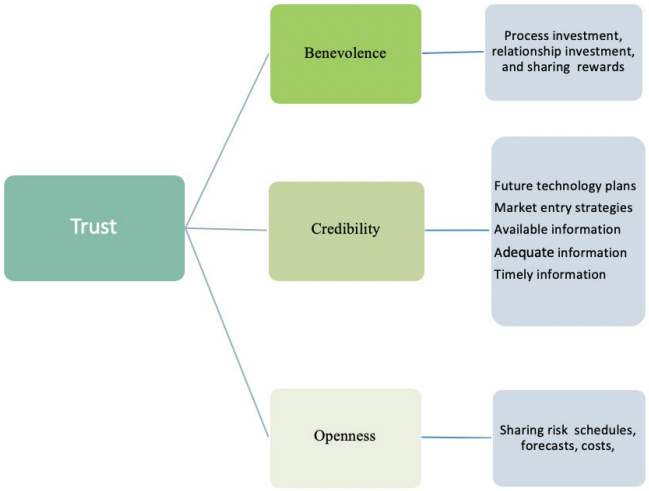


Figure 16. Different dimension of trust and trust manifestation

2.5.1 Benevolence

The way partners treat each other in their relationships shows benevolence. Avoidance of opportunistic behavior and making investments to improve mutual performance increase the level of trust and present evidence that the partner's motives are trustworthy. Mayer et al. (1995)

explains benevolence as the mutual confidence whereby no party will exploit the others' vulnerability.

2.5.2 Credibility

Credibility means a partner's intention and ability to keep promises and deal with the others' standards. Credibility includes reliability and predictability signals. According to So and Schill (2002), a partner trusts the reliable partner when the other partner's activities are accurate, consistent and predictable over an extended period of time. By credibility, chain members share plans toward the future and try to be consistent in their relationships. They have adequate, accurate and timely information about other sides.

2.5.3 Openness

Kwon and Suh (2005) described openness as a significant effort to develop trust. By openness, chain members share operational information (e.g. schedules, forecast, costs, etc.) after making the contract, and reduce uncertainties by sharing risk. Thereby, openness conveys the strong intention of partners to perform as expected.

2.6 Trust in BCT

In the blockchain literature research, some authors differentiate between trust in partners and platform. In the following content, trust in the platform will be discussed. Trust in a platform, or the corresponding platform provider, can be interpreted as the beliefs regarding the performance of an institution or organization rather than that of an individual (Lu et al., 2010).

Trust creates the basis for allowing a trustee to use or plan available sources by the trustor or may affect a trustor's decision to use a service provided by a trustee (Grandison and Sloman, 2000).

2.6.1 Trust in Platform

Specifying and managing trust in the web-based application is an essential aspect of decision making and there are no admitted techniques or mechanisms for specification and rationalising of trust. Grandison and Sloman (2000) conducted a study about trust in the context of networked and distributed computing systems and the trustworthiness of internet-based services and applications. Trust is characterised into four different classes: provision trust, resource access trust, delegation trust, certification trust and infrastructure trust (Figure 17).

Provision Trust

The trustor trusts the trustee to implement a service that does not require access to the trustor's resources. For example, the user trusts a system only to indicate the items that are having specific properties or not having any offensive information.

Certification of Trustees

The set of certificates presented by the trustee to the trustor works as the authenticated identity. "*Describes the belief that the trustees' identity is as claimed"*.

Delegation Trust

"*A trustor trusts a trustee to make decisions on its behalf, with respect to a resource or service that the trustor owns or controls*".

Infrastructure Trust

This applies to the base infrastructure that the trustor must trust, and it is recognized in early computing as trust in applications, e.g. the administrative procedures that keeps the monitor working.

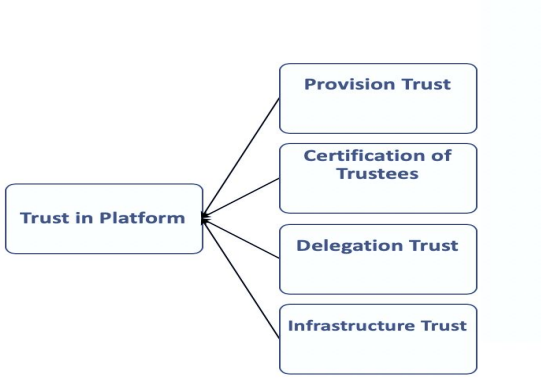


Figure 17. Adapted from Grandison and Sloman, (2000).

BCT service providers must fulfill these requirements to have an effect on users beliefs and trust in the platform.

2.6.2 Trust in Records

The vulnerability of the blockchain technology could be illustrated as a technological problem in the whole of the technology since there is always a risk of having tempered transactions and mistakes and malicious incentives in data entering, e.g. registering false products in the

blockchain. If the registering is not done correctly, the blockchain cannot detect the deception (Crosby et al., 2016). The result of the research indicates that trust in sharing platform is rather new and the discussion about trusted records mainly leads to the two interlinking concepts of reliability and authenticity of the records (Mak, 2014). Reliability in records is defined as how records originate and who created them. The capability of the author is also important in this context (Duranti and Rogers 2012). The authenticity of a record depends on the establishing process and maintaining the identity of the records from its creation on thereafter (Rogers 2015).

2.7 Investigation Model

The main issue in the current thesis is how the technological shift toward BCT will affect partners' trust in each other. The problem is the ambiguous use of trust as a central term. The author had to choose between the different definitions of trust and provide a clearer understanding of how the private blockchain characteristic can affect trust.

The investigation model (Figure 18) of this study will be divided into two parts. The first part analyzes the trust building mechanism in the supply chain by using BCT, and the second part shows the interpersonal trust in the BCT which is divided in two parts: trust in the platform and trust in records.

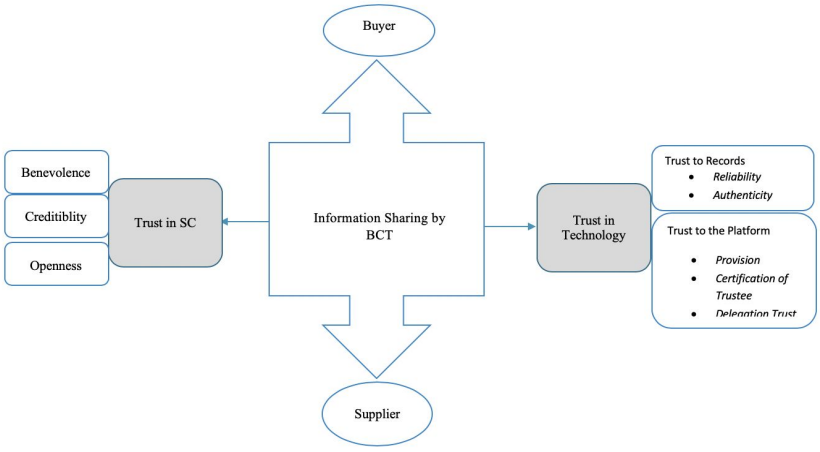


Figure 18. Investigation model for analyzing the impact of private BCT on trust within a supply chain

2.7.1 Trust between Supply Chain Partners

As the starting point in the trust building mechanism between SC partners, the fundamental attributes of the private blockchain are mentioned to clarify understanding of how private BCT can affect trust between SC partners. There are many different BCT characteristics offered, ranging from application characteristics to excessively technical characteristics. From a technical

perspective, private BCT rests on the idea that BCT automatically creates a transparent, decentralized, immutable and traceable information sharing platform. In order to find the meaningful impact of the private blockchain, selected features and characteristics of the private BCT are described below briefly.

Distributed: Information is saved on multiple servers and is transparent to all involved participants.

Immutable: The platform protects the data against changes and deletions.
Traceable: All verified members know the transaction history and authenticity of each item.
Security: Encrypted data, so that only authorized participants can decrypt it.
Restricted: Protocol-governed rules in private BCT that restrict the kind of data allowed, etc. These rules are defined based on the agreement between the partners.

Building on the BCT foundation, the consequences of BCT on trust in the supply chain will be analyzed based on two promises. These promises are addressed (Figure 19) as information availability and information quality. These may impact the notion and formation of trust in the supply chain

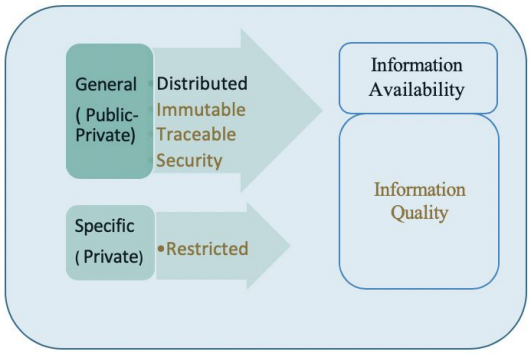


Figure 19. BCT effects on the information sharing platform

2.7.1.1 Information Availability

The decentralized information platform is an essential component of private BCT. BCT ensures high availability of information related to transactions that are registered inside the network. It means all authorised members maintain their identical copy of the transaction and they can control and monitor interactions. Chen et al. (2011) mentioned that in supply chain relationships, information sharing helps to build up trust over time. Indeed, trust in the transaction can be increased by sharing, monitoring, and controlling information. For instance, when the chain members share delivery schedules and performance metrics, they increase understanding of both parties and reduce the perceived risk. In the supply chain, the lack of information availability, as well as information asymmetries, make more operational inefficiencies, transaction risks, and

coordination expenses. It is reasonable to assume that this situation leads to imperfect forms of interaction and would reduce the level of trust (Chen et al., 2011).

2.7.1.2 Information Quality

BCT is an encrypted database that is immutable and thus cannot be corrupted. Moreover, information is traceable and verified and secured. Moberg et al. 1999 pointed out the importance of reliability and validity of the information in the supply chain. They mentioned that information availability can facilitate flexibility in the supply chain, but this information should be accurate and valid. Distorted information reduces the benefits of information sharing. With misleading information, chain members would not be able to trust the information to make decisions.

2.7.2 Trust in Technology

The second part of the investigation model analyze the trust between users and platform and trust in the record (Figure 18). Trust in the platform and records will cause users to be more willing to believe or accept transformation toward blockchain technology.

2.8 Developed Investigation Model

Figure 20 shows the investigation model in two parts with regards to BCT's impact on trust. The first part is adapted from trust classes in internet services by Jøsang et al. (2007) which presents trust factors in records and platform. The second part provides an integrated, holistic view of interconnected and pivotal elements of blockchain-based platforms and trust indicators. The investigation model for trust within the supply chain is developed based on the two effects of the blockchain on the information characteristics which are information quality and information availability. The updated model is shown in Figure 20.

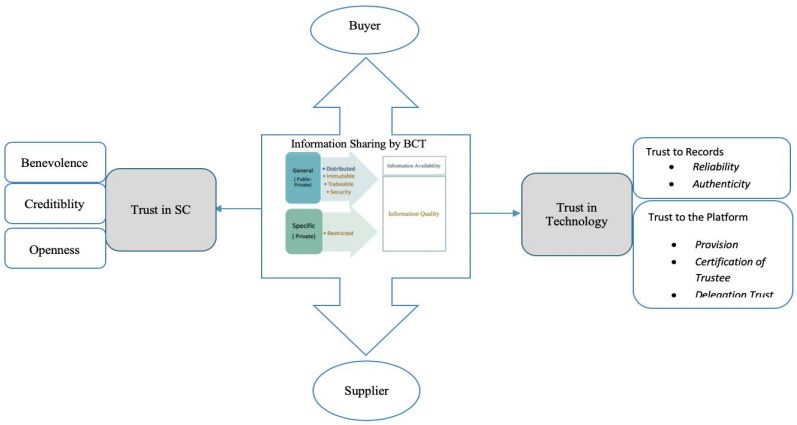


Figure 20. Developed investigation framework

2.9 Linkage Between Investigation Model and Trust development Model

This thesis aims to understand the impact of BCT on the trust level in the supply chain. For understanding the changes, the author decided to make a linkage between the investigation model and the trust development model by Lewicki and Bunker, to analyze the trust level and situation.

Firstly, three different levels of trust in the development model (TDM) will be discussed. The framework presented (Table 5) by Lewicki and Bunker is defined based on the view of the trust as "*confident positive expectations about another's motives with respect to oneself in situations entailing risk*" (Lewicki and Bunker, 1995). They proposed that the three stages of trust are connected and consecutive in development, rather than being three separate types of trust. Lewicki and Bunker argued that CBT would emerge in many relationships, KBT in some relationships, and IBT in only a few relationships.

Identification-based Trust (KBT)	Confidence based upon the understanding that full internalization of each other's desires and intentions has been achieved—the parties understand each other, agree with each other goal.
Knowledge-based Trust (KBT)	Confidence in partners' predictability, dependability, and reliability (good information regarding a trustee that comes from the experience of working together and regular communication)
Calculus-Based Trust (CBT)	Founded on the understanding that both potent rewards for preserving that confidence and punishments for violating it are in place. Ensuring consistency of behaviors; Keeping promises because of the fear of the consequences of (losing contract). Trusting the party's capacity and commitment to impose penalties for defection. Trust at this level does not have the capability of developing the relationship to going to the deeper level of relationships.

Table 5. Trust development level adapted from (Lewicki and Bunker, 1995)

The development model can be compared by the trust determinants in the investigation model. Lewicki and Bunker (1995) argued that calculus-based trust means companies try to keep promises based on the mutual agreement and shared risks. Trust at this level is minimum if companies have no intention of developing trust, so they will not continue their relationships for a long time. At the same time, it seems that openness, as a form of trust, presents the same level of trust, which decreases the risks and shows the partner's intention to perform as expected (Kwon and Suh, 2005).At the KBT level, increased information improves the predictability of the other party. KBT includes confidence in partners' predictability, dependability, and

reliability (good information regarding a trustee that comes from the experience of working together and regular communication). It seems this level of trust has the same characteristics of trust transparency in credibility form when the reliable partner's performance is accurate, consistent and predictable

In IBT, after repeated interactions, partners may become aware of shared values and goals. At this stage, trust has been built to the point that the parties have internalized each other's desires and intentions. At this level, the partner can be as the representative and substitute for the other in interpersonal transactions.

At the IBT level, trust has similar characteristics as benevolence trust (Lewicki and Bunker, 1995). In benevolence trust, partners make investments in their relationships in order to facilitate the improvement of performance. For example, a vendor can always help in training the retailer on the way of merchandising and a supplier can always help a buyer with technical assistance on the new equipment (Sahay, 2003). The conceptual model that presents the linkages between the two models is shown in Table 6 and Figure 21. The author has chosen the same color to show similarities at each level.

	The linkage between Investigation Model and TDM		
	Determinant related to the trust	Trust Manifestation	Trust Development Model
Trust between SC Partners	Benevolence	Sharing reward	Identification-Based Trust (IBT)
		Process investment	
		Relationship investment	
	Credibility	Future planning (New Market Strategies, Future Technologies)	Knowledge-Based Trust (KBT)
		Real time information	
		Adequate information	
		Available information	
	Openness	Sharing risks	Calculus-Based Trust (CBT)
		Sharing operational information (forecasts, costs)	

Table 6. Trust development level adapted from (Lewicki and Bunker, 1995) and trust level in investigation model

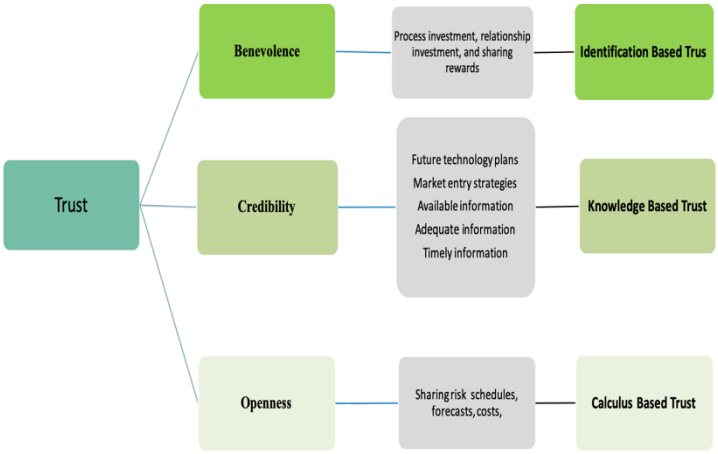


Figure 21. Linkage between TDM and IM

Later in analysis chapter the case companies will be analyzed based on the relationship between Investigation Model and TDM.

3. Methodology

This chapter describes the selected methods of this thesis. First, the general purpose of the study will be explained. Then, the design of specific methodology will be presented. After that, each of the project's particular phases will be discussed in a separate part. Finally, the chapter will conclude with a discussion on the quality of the study.

3.1. Research Purpose

Taking previous research into account, this thesis increases present knowledge through exploratory research and, to some extent, theory-building. As mentioned, the role of trust in the supply chain has been studied by previous researchers. However, there is little research on how BCT impacts trust in the supply chain. Therefore, this thesis builds upon existing research and, thus, functions as an extension to previous findings. Moreover, a link between literature on trust and blockchain technology, and trust in the context of the platform is established through the development of an investigation model. The aim of this study is to explore the nature of trust in the supply chain and the impact of BCT on trust in the supply chain.

3.2 Research Approach and Strategy

Bryman and Bell (2015) explained the difference between Qualitative and Quantitative research strategies. The main differences between the two are that qualitative research uses words rather than numbers, as quantitative does. For this thesis, the qualitative approach was chosen mainly because it supports studying multi-sided aspects of the research topic. It is a proper approach to examine the depth of phenomena more than the quantitative approach. Author is aware of the risk to influence the study through her own interpretations and bias (Pandey and Patnaik, 2014). Thus, that risk is decreased by implementing tools for trustworthiness (further explained in subchapter Trustworthiness).

The goal of this thesis is to outline how blockchain technology impacts trust in the supply chain. Thus, the data that has been collected in this study, need to have the interpretative character; therefore, the report uses a qualitative research strategy.

One of the first types of research to be used in the field of qualitative methodology is case studies since it is favored to be used in conditions where one requires to create a deeper understanding of a situation or problem (Björklund and Paulsson, 2014). The main barrier in this thesis was the lack of respondents, therefore the author used multiple sources to increase the depth of evidence. In this thesis, 5 interviews were conducted with different industries and multiple data sourcing was used to increase the depth of the study.

After considering the aim of the thesis and the research questions it seems the main purpose of the research is building theory based on the main variables and linkage between them. However, because of the immaturity of BCT in literature, it explores the nature of trust and the impact of BCT in the trust supply chain. Ketokivi and Choi (2014) suggested that field research is essential for creating a theory if there is a lack of empirical data from the literature.

In this study, multiple interviews have been conducted to understand the fields of relevance and impacts of blockchain technology in trust of different companies. A multiple interview is the chosen strategy to analyze different top managers' experiences about blockchain technology to find out a common relationship based on findings from different interviews and other sources (Gummesson, 2003).

3.3 Research Design

Yin (2014) proposed that research design should present reasonable steps on how questions of the research will be clarified through empirical data and conclusions. The main elements of research are the research question(s), propositions, unit(s) of analysis, a decision of how the data are connected to the propositions and criteria to explain the findings (Yin, 2014). Therefore, this thesis is designed based on three phases. The output s of each phase helps to go further toward next steps (Figure 22).

This research has an exploratory nature and it follows a qualitative approach, using both primary and secondary data. Figure 22 elaborates on the methodological approaches taken in this research and it identifies the main steps that need to be taken into account to answer the research questions.

First, to gather the available knowledge on practical issues, the reviews and analyses of the literature of the blockchain and the impact of that on trust have been provided. Second, specific literature reviews, the nature of trust in inter-organizational relationships and then the supply chain management were discussed and identified as part of the objective of the study. In the beginning, the first question will be answered, which is, "What is the nature of trust in the supply chain?" The output of the literature review will give insights into defining the unit of analysis and participants' study selection which are critical for being determined before starting the case research.

Once the theoretical framework is defined, then the interview guide can be structured in order to pursue the phase. In the second phase, the interview with companies will be conducted, and the empirical data will be gathered. The interview analysis will be within each company by considering the current situation of the business and supply chain characteristics before

conducting a comparison analysis to find patterns, similarities and differences. The author is aware of the insufficiency of empirical data from interviews (each company one person) and has tried to gather more data from secondary sources. The second phase will answer the second RQ. The result of the second phase will be an input for conclusion.

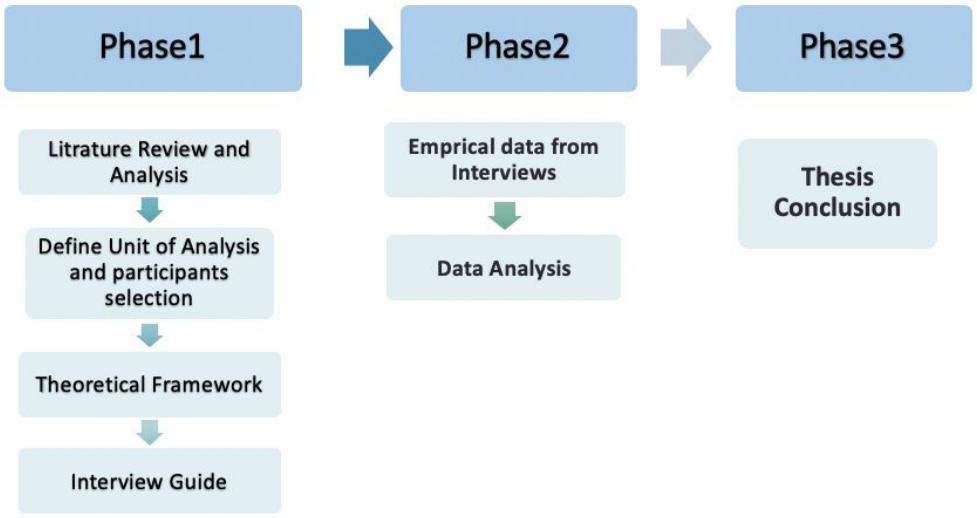


Figure 22. Research process

3.3.1 Literature Review and Analysis

To be able to provide knowledge about trust, SC and BCT, the frame of reference was presented in chapter 2 of the study. Firstly, to introduce the reader to the topics, SCM, blockchain technology and trust were defined and explained separately. In order to find out the relation between the three topics, findings from the literature were presented to give initial insights into the potential impacts of blockchain technology on trust in SC on which the empirical study will further elaborate.

Literature reviews in an academic study can either be done as a systematic or traditional approach. The body of literature in this thesis was conducted through a snowballing literature review which is recommended by Webster and Watson (2002) as a different approach to the systematic literature review. They investigated more efficient approaches to searching related literature. Snowballing considers the reference list of a paper or the citations to a paper to recognize further articles. Snowballing can take advantage of not only attending at the reference lists and citation, but also where papers are cited.

This kind of review allowed to find the most relevant sources about SCM, trust and blockchain technology in the first step and include studies about the connection between the topics in the second step. However, a systematic literature review is claimed to be more objective because it

covers all relevant research about a specific topic and offers higher transparency and replicability (Easterby-Smith et al., 2015).
Also, as there is a high number of surveys about SCM and trust, a snowball review allowed us to concentrate on references most related to the study. In comparison, there are fewer studies about the impact of blockchain technology in the supply chain. Therefore, it was of high importance for me to concentrate less on studies about the characteristics of the BCT and more on studies about the impact of BCT on supply chain relationships.
Due to the fact that two main topics, as well as the connection between them, are presented, the snowball approach enabled us to inform the reader about the most relevant aspects which are further elaborated in the empirical study. The literature selection procedure is shown in Figure 23.
As a result, 34 articles were selected for further review. After carefully reading all 18 articles were chosen for the first selection. This step resulted in a list of 11 for trust and seven blockchain-related items, which were included for a forward and backward search (Snowball) to extend the coverage of the review. The result for this step were 17 new articles, so in total 35 articles were studied.

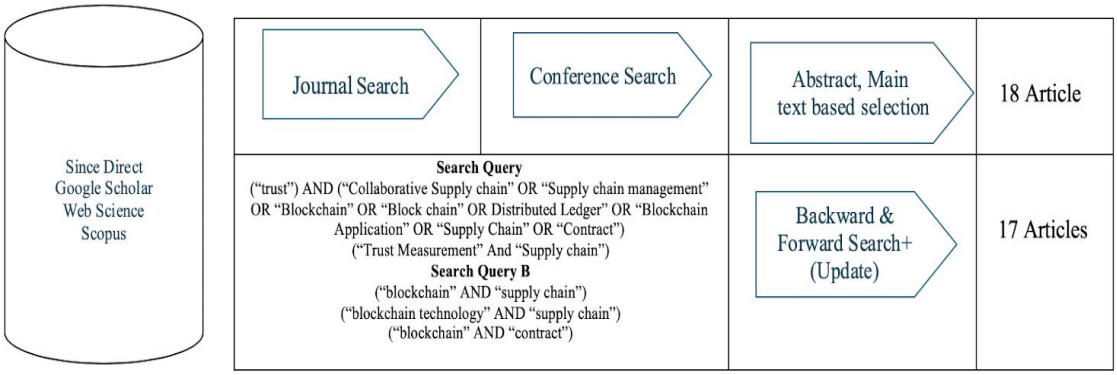


Figure 23. Steps in the literature search and classification process.

3.3.2 Unit of Analysis

Within theory building research, selection of the cases is an essential step toward building theory from case studies (Eisenhardt, 1989). Moreover, the concept of a population is essential because the population represents the set of entities from which the research sample is to be extracted from. Also, the selection of an appropriate population manages external variation and it is helpful to define the limitation for generalising theory (Eisenhardt, 1989). The simple way to determine the sampling is to get a proper population and then choose an appropriate sample to present the whole population. A sample of cases could be built by selecting cases according to different

criteria (Eisenhardt, 1989; Yin, 2014). Scholars like Rowley and Slack (2004) stated that "*before searching for cases, the researcher should determine the unit of analysis that is most appropriate for the project*". Unit of analysis can be defined as individuals, groups (e.g., a business task, profit core) or an entire system. Moreover, the unit of analysis might be defined as a particular project or choice. In making this decision, the researcher should thoughtfully consider the questions to be attempted. These usually show a relevant unit of analysis (Benbasat et al., 1987).

As a comprehensive guide, the description of the unit of analysis is explained to the way the initial research questions have been defined (Yin,2009). The unit of analysis in this thesis is the level of trust within the supply chain.

3.3.3 Participants Selection

By indicating different understandings of trust and conceptual model of trust and BCT, some characteristics are taken into account to select the companies' participants. These are 1) the information sharing activities by BCT in the supply chain 2) the existence of a trustor-trustee relationship (buyer-seller) 3) the willingness for vulnerability in the relationship, and 4) the critical aspect of trusting and trust. For increasing accuracy in case selection, the author relied on the previous study by Gideon Greenspan (2015) which is published as a post on his blog by the title "*Avoiding the Pointless Blockchain Project - How to determine if you've found a real blockchain use case*". The title tells the story: Greenspan set rules that should be investigated to determine whether the blockchain is an appropriate solution for a business or not. For this project, some of these rules were used for selecting company cases based on the purpose of the thesis. These rules are listed below in Table 8.

Rules	***Explanation***
The data base	*"Blockchains are a technology for shared databases."*
Multiple writer	*If there is a need for generating transactions by multiple writers*
Absence of trust	*"If multiple entities are writing to the database, there also needs to be some degree of mistrust between those entities.*
Disintermediation	*"To prefer a blockchain-based database over a trusted intermediary might include lower costs, faster transactions, automatic reconciliation, new regulation or a simple inability to find a suitable intermediary."e.g. in a private blockchain provides a mechanism where you can define the parameters of an agreement within a self-executing contract, called a "smart contract",*

Table 8. Case selection rules

Participants in the Study

Table 9 gives an overview about the companies, and industrial categories. The companies are chosen based on their interest and experience in BCT. They are collaborating with other companies in chain and investing in shared database to improve performance, trust and transparency.

Company name	Role	Type of industry	Country
Arya Hakim	Chairman of the Board	Medical Industry	Iran
Nestlé	Demand and Supply Planning Manager	Food Industry	Canada
Zalando	Lean Manager	European electronic commerce company	Germany
VERSES(Provider)	Senior Software Architect	Tech and Innovation	United States
Modum (Provider)	Communications and Marketing in BCT projects	Tech and Innovation	Germany

Table 9 Different case companies and type of industries

3.4 Data Collection Method

To answer the overall goal of the thesis, qualitative interviews are the main chosen method in the data collection. Moreover, additional materials are used. The relationships between the research question and data collection method is shown in Table 10. The study involves two types of companies: first the service providers of BCT which deliver different applications of BCT and platform (IOT; Smart Contract), secondly, the companies which have claimed that they are going to be implementing BCT in near future.

Research Question	Aim	Input	Result
How is the nature of trust in supply chain?	Provide general understanding on the topic and inspecting available knowledge for evaluation tools	Available Literature Desk Research	Theoretical Background
How blockchain impacts on the trust in supply chains?	Evaluation of the technology impact on trust in supply chain	Semi Structured Interviews/ Secondary Data	Finding and Result

Table 10. Research questions associated data collection method

An interview is a discussion that gives interactive reflection, knowledge and information sharing among the interviewee and the interviewer (Tracy, 2010). Interviews are therefore a suitable method to investigate experiences and opinions of trust and blockchain within chain structures. Although interviews are often described as the most suitable way of collecting information, the author is aware of the possible disadvantages of the chosen approach. Problems such as interview bias, meaning that the interviewer might influence the respondents' answers in the interviews based on their own reference frame, were considered (Easterby-Smith et al., 2015).
Moreover, additional supporting information was collected through the use of secondary data from blockchain seminars and webinars. This extended source of information was gathered to follow the chosen data collection strategy that involves collecting information from multiple sources of information (Creswell, 2013).

To understand the respondents' experience about the impact of BCT on trust in SC, we performed semi-structured interviews with developed questions to get a more flexible structure in answering the thesis purpose (Easterby-Smith et al., 2015). Semi-structured interviews find the balance between an open conversation and a closed questionnaire with the aim of finding evidence for the research purpose (Kvale, 2007).
Brinkmann and Kvale (2015) present semi-structured interviews to be effective and flexible while gathering empirical data which contributes to the fact that it is one of the most popular qualitative research methods. The technique was therefore chosen to create an environment that allows the interviewer to have room to follow up the authenticity and validity of research data. This will be improved by a well-designed research protocol (Yin, 1994). Voss et al., (2012) stated that a protocol includes the procedures and the overall rules that should be used, from which different sets of information are to be sought. The core of the protocol is the questions to be used. (Interview Guide can be found in Appendix).

Company name	Interview Code	Role	Duration
Arya Hakim	A.C.	Chairman of the Board	An Interview in person for two hours by Skype
Nestle	D.M	Demand and Supply Planning Manager	An Interview in person for one and a half hours by Skype
Zalando	L.M	Lean Manager	An Interview in person for one hour by Phone
VERSES (Provider)	V.A	Senior Software Architect	An Interview in person for one and a half hours by Phone
Modum (Provider)	M.O	Communications and Marketing in BCT projects	The skype or phone interview was not possible. The interview was by sending questions by e-mail.

Table 11. Interview Information

The author used various sources of data. Most of the information came from interviews. That information is used in a few ways in this work: First of all, it is used to explore the motives and capabilities of the companies using blockchain technology. Secondly, it is used to explore the challenges for industries. Finally, the impact of BCT will be analyzed based on trust theories to see whether blockchain would be able to change the level of trust. In addition to interviews, the author used other sources such as company web pages, videos and other publicly available data. An overview of all sources used can be found in the following Table 12.

Company	References for Secondary Data
Nestle	1. COINDESK. 2019. *Nestle, Carrefour Team Up to Feed Consumers Data With IBM Blockchain*.[Online]. https://www.coindesk.com/nestle-carrefour-team-up-to-feed-consumers-data-with-ibm-blockchain 2. COINTELEGRAPH. 2019. *Nestle: IBM Food Trust Blockchain Set to Expand to New Suppliers, Consumers in 2019*. [Online]. https://cointelegraph.com/news/nestle-ibm-food-trust-blockchain-set-to-expand-to-new-suppliers-consumers-in-2019 3. FOODNAVIGATOR. 2019. *Nestlé unveils blockchain initiative with Carrefour to improve transparency.*[Online].https://www.foodnavigator.com/Article/2019/04/16/Nestle-Carrefour-unveil-blockchain-initiative-to-improve-transparency 4. NESTLE. 2019. *Nestlé and Carrefour give consumers access to blockchain platform for Mousline purée*. [Online]. https://www.nestle.com/media/news/carrefour-consumers-blockchain-mousline-puree-france 5. SUPPLYCHAINMOVEMENT. 2018. *Nestlé trials blockchain to improve food-ingredient supply chain transparency*.[Online]. https://www.supplychainmovement.com/nestle-trials-blockchain-to-improve-food-ingredient-supply-chain-transparency/ 6. NESTLE. 2018. *Annual Report 2018*.[Online].https://www.nestle.com/investors/annual-report 7. IBM. 2019. *IBM Food Trust: trust and transparency in our food.*[Online]. https://www.ibm.com/downloads/cas/EX1MA1OX **Videos**: CNBC. 2017. *IBM partners with Nestle, Unilever and other food giants to trace food contamination with blockchain*.[Online]. https://www.cnbc.com/2017/08/22/ibm-nestle-unilever-walmart-blockchain-food-contamination.html 8. MDIACENTER. 2017. *Walmart's food safety solution using IBM Food Trust built on the IBM Blockchain Platform.* [Online]. https://mediacenter.ibm.com/media/Walmart%27s+food+safety+solution+using+IBM+Food+Trust+built+on+the+IBM+Blockchain+Platform/1_b3n798xc/98867192 9. NESTLE. 2019. *Nestlé Responsible Standard Sourcing.* [Online]. https://www.nestle.com/asset-library/documents/library/documents/suppliers/nestle-responsible-sourcing-standard-english.pdf.
Zalando	1. FORBES. 2019. *This Blockchain Startup Is Partnering With Fashion Giants(Zalando)To Make Organic Cotton Traceable.* [Online]. https://www.forbes.com/sites/alexknapp/2019/03/04/this-blockchain-startup-is-partnering-with-fashion-giants-to-make-organic-cotton-traceable/#663bb8c11fd2 2. ZALANDO. 2018. *Digitizing Supply Chain Transparency.* [Online]. https://corporate.zalando.com/en/newsroom/en/stories/digitizing-supply-chain-transparency

	3. ZALANDO. 2018. *Transparent: Sustainable Fashion in Digital ERA.* [Online]. https://corporate.zalando.com/sites/default/files/media-download/TRANSPARENT_mag_2018.pdf. 4. ZALANDO. 2018. *Annual Report.* [Online]. https://corporate.zalando.com/en/investor-relations/publications/annual-report-2018 5. ZALANDO. 2018. do.Know – Supply Chain.[Online]. https://corporate.zalando.com/en/corporate-responsibility/doknow-supply-chain JUSTSTYLE. **Video**: 6. YOUTUBE.2018. *The Evolution of the Fashion Retail Industry in the Age of AI - Kshitij Kumar (Zalando)* .[Online]. https://www.youtube.com/watch?v=I4CRYq4O-KA 7. YOUTUBE.2019. *Ethereum and Lukso - How Blockchain will change the Fashion Industry.* [Online]. https://www.youtube.com/watch?v=iOMoNzBTa9Y 8. YOUTUBE.2019. *Zalando - Gigantic growth, meager profits, copious criticism* | Made in Germany. [Online]. https://www.youtube.com/watch?v=3SDUZzpOIE0. YOUTUBE.2019.*Improving Supply Chain at Zalando.*[Online]. https://www.youtube.com/watch?v=N3miB5eLdw0.
Arya Hakim	1. HEALTCAREWEEKLY. 2019. *The Global "Blockchain in Healthcare" Report: the 2019 ultimate guide for every executive*.[Online]. https://healthcareweekly.com/blockchain-in-healthcare-guide/. 2. WARC .2018. *JandJ sees healthcare benefits in blockchain.* [Online]. https://www.warc.com/newsandopinion/news/jj_sees_healthcare_benefits_in_blockchain/40480 3. DREAMIT VENTURES. 2018. *The Rise of Innovative Blockchain Products in Healthcare*.[Online]. https://www.dreamit.com/journal/2018/8/15/the-rise-of-innovative-blockchain-products-in-healthcare. 4. Market Report (Internal Report) 5. Growth of Sales(Internal Report)

Table 12. Secondary Information Sources

3.5 Data Analysis

According to Eisenhardt (1989), despite the difficulties, analyzing data is the heart of the study. In this thesis, each user's company is analyzed based on three perspectives و including a general background as a company description, business framework characteristic, and trust evaluation. Each aspect displays the actual practice of the company based on the interviewee responses and secondary sources.

To increase the reliability of the analyzed conclusions, comparison of patterns is useful. One way is to select pairs of companies to see similarities and differences. Evidence from multiple sources can generate more reliable results and increase internal validity (Voss et al, 2002). Wood (1995) suggested using the table comparison technique. The findings are analyzed based on the iterative coding method. The author has grouped motives, challenges, business context issues, and SC strategies in different companies. In this thesis, the comparison analysis is divided into three parts. The first part compares service providers with information regarding the BCT impact on the supply chain and trust. The second part analyzes the business context, supply chain characteristics and BCT-related issues of the three companies. The last part compares the trust situation before and after using blockchain technologies.

3.6 Research Quality

Trustworthiness is important for evaluating the quality of a survey. Lincoln and Guba (1985) suggested creating reliability, transferability, dependability, and confirmability to establish trustworthiness in the research process. Reliability is reached by considering if the research findings are accurate in comparison with actual reality. Triangulation is one tool to establish the credibility of the research. A comparison of results from more than one method - in this thesis, interviews, seminars and additional secondary materials increase the possibility of accurate findings which are close to reality (Pandey and Patnaik, 2014). To approve the qualifications of transferability, the findings need to be general in order to apply them to multiple settings and supply chains. Transferability is created through a detailed explanation of how the findings can be adapted to similar business contexts. Due to the fact that the research sample is based on multiple business fields and countries, transferability can be approved. In this chapter, by concentrating on the overall methodology, every step and decision in the research process is described further in detail to the reader, which contributes to the third criteria of trustworthiness: dependability. Dependability means that results would be comparable if the study was replicated by another researcher.

4. Description and Analysis

This chapter will discuss description of the companies and comparison analysis. First, based on the interviews, close-ended questions and secondary data of each company will be presented, i.e. Arya Hakim, Nestle, Zalando VERSES and Modum. Each of these companies will be analyzed based on the empirical data.

4.1 Company Description (Arya Hakim)

Arya Hakim is an exclusive distributor of medical equipment in Iran. The company sells and distributes different products such as Cardiovascular, Endovascular, Neurovascular, and Neurosurgery which need various strategies for marketing, sales and distribution. In Figure 24, the relationship between the brand owner and Arya Hakim in an SC network is presented.

Figure 24: Supply chain network for Arya Hakim

The main brand owner of the product is interested to implement two types of blockchain. Firstly, the private BCT platform which enables them to keep track of all the information about their products, and secondly the public BCT to track the patient's information history which will be available for end consumers. The aim for Arya Hakim as a distributor is to have a transparent retailer chain and to perform inventory management more effectively by private BCT. The planning started in 2018, and the company has performed a feasibility study and resource planning. The quick facts related to the Arya Hakim company are shown in Table 13.

Industry	Healthcare
Foundation Date	2002
Product	Pharmaceutical (700 different Product)
Retailer	44 Located in different cities in Iran
Type of BCT	Private platform between downstream chain

Table 13. Arya Hakim quick fact

Arya Hakim's chairman (A.C) first explained that trust is a very important factor for the company in terms of trustworthiness and reliability of the information: "*Our mission is defined*

based on saving lives. In daily work, our decisions impact people's life, so having accurate and real time data means everything." A.C stated how the data through the downstream and upstream had been gathered as a report and mentioned that "*Blockchain is exactly what healthcare needs*". A.C cited the Global Blockchain Healthcare report stating: "*The most prominent beneficiaries of the technology will be the pharmaceutical companies, which lose approximately $200 billion to counterfeit drugs each year. By enabling complete visibility and transparency throughout the drug supply chain, blockchain will allow tracking of drugs to their point of origin and thus, help to eliminate falsified medication, reduce revenue loss by up to $43 billion annually for pharma companies*" (Global Blockchain for health care, 2019).

Arya Hakim has two types of reports, qualitative reports and quantitative reports (e.g., marketing report, sales report, transportation report). They take the information from downstream partners (e.g. retailers, representatives and seller) by these two reports.

Retailers register data after each transaction and send it to the higher managers in Arya Hakim as daily or weekly reports. Arya Hakim improves the relationships with retailers by collaborative planning and keeps them tuned with new technologies and skills.

Due to the gap between what they do and what they are interested in, Arya Hakim is hoping to use BCT technology to store and share data between different stakeholders (Retailers, Arya Hakim, and Hospitals). Now, they are using an ERP which generates the structured reports as daily, weekly and monthly documents. Due to their privacy and security concerns, there is no real time-shared database with downstream partners yet, but they are interested in having real-time data which helps to keep them informed about the status of critical key factors like inventory level, deliveries schedule or maintenance condition.

One of the main characteristics of the medical industries is the demand for transparency and origins of products, which is associated with Corporate Social Responsibility (CSR). Arya Hakim has some challenges related to product characteristics which are the limited shelf life and require specific maintenance condition. Another issue in the healthcare industry that can be resolved by implementing BCT is "*Black Market*" or "*Fraud Medicine*". As A.C explains according to HRFO (Health Research Funding Organization), approximately 10 to 30 percent of medicines in developing countries are not original and customer's demand for original product is growing.

Due to geographic expansion, the unstable situation in Iran, and the competitive market, some of the managers in Arya Hakim have recognized the worth of establishing collaborative relationships. They have to share critical information with downstream chain partners and pursue long-term relationships with them. A precise selection process is required with restricted rules and tasks that are clearly described. Furthermore, Arya Hakim has training workshops to align

downstream partners more with organizational values of Arya Hakim which is delivering the best service in minimum time in the best way.

Availability of information, in this case, plays a significant role in managing the business. Openness in terms of sharing forecast and future planning and risks is critical, making them capable of managing the bullwhip effect and demand fluctuation.
By available and accurate information, collaborative relationships will enhance the values obtained from each partner. According to the chairman, by collaboration, the net value delivered in the whole supply chain is higher than the other competitors in the same industry. He explained that in this case, the private blockchain can solve the current barriers of availability and reliability of the information, for example by product tracking and reverse logistics.

BCT increases the level of communication, by using the shared database and sharing of available resources. "*BCT increases knowledge and decreases opportunistic behavior*". For making the willingness for collaboration, they see trust as a necessary binding force in their business "*we first trust in their competence and after that in their (retailers) benevolence"*.
A.C explained that if the blockchain were implemented only internally, the technology would not be very beneficial because current technologies and ERP already offer reasonable internal solutions. In contrast, when downstream partners are involved, the blockchain technology enables the possibility to share data selectively in a safe way. Moreover, for their chain as a large one, with several retailers, the technology facilitates monitoring (e.g. delivery time, maintenance situation). When a problem occurs, with the help of the saved history in the blockchain, the root cause can be tracked.

In general, through secure transactions, A.C thinks the technology will enhance trust and stated that "*Everyone taking care of the reputation, in this specific (healthcare) market one mistake for a company has a huge cost*". The corporation will not be unsure about the accuracy of data since the registered data is directly saved into the blockchain, and even if there is a mistake, it cannot occur repetitively based on the previous experience. In other words, trust in technology will drive trust between parties. If they have the willingness to have a shared database and avoid opportunistic behavior, BCT can be a solution.

A.C mentioned that the company's managers are aware of the openness and honesty as essential elements in communication and negotiation: "*Openness and honesty are everything in our communication. Sometimes we do not have time to do check before doing transaction, so we should have truthful information to take decision. In this case shared database and accuracy within their information act as a vital key to survive in this competitive market*."

A.C believes that investing in BCT in the current chain exhibits trusting behavior in their relationship based upon the perceptions, and long-term mutual interests. He explained there is a concern of losing the current flexibility due to joining restricted rules, which sometimes increases the complexity and ignores the past experiences with a certain partner.

A.C argued about some cases, for example an emergency situation where they ignored the lack of evidence for payment and because of a life emergency situation they delivered the product before payment. "*If we want to work by applications of blockchain like a smart contract we should think about these situations*" .

He thinks that in the healthcare industry, keeping moral preferences has high importance and obeying strict rules can be harmful. The challenges for implementing BCT were discussed. The chairman considers regulations and international law as potential challenges that shared databases might encounter, such as privacy law. He explained that due to Iran's sanctions, the numbers of BCT service providers are limited and there is a lack of skill and knowledge in this area. They select service providers based on their reputation and insurance. Trust in the platform and algorithm was discussed and he points out the importance of the familiarity of the BCT platform for users and similarity of the processes with existing ERP which can facilitate the transformation.

4.1.1 Business Context of Arya Hakim

In business framework (Table 14) the main information regarding Arya Hakim business is summarized. All the critical factors in implementing BCT motives and challenges are extracted from answers given in interviews as well as secondary sources.

Product	Limited shelf life Special maintenance requirements High technology High cost
Business	Geographic expansion Different product with different strategies, Long term relationship with partners CSR (Corporate Social Responsibility) Flexibility payment with retailers ERP oriented.
Motives for BCT	Privacy law International law Information security Connecting the BCT database to the BCT of upstream partners when needed trust in the platform Insurance of service provider Reputation of service provider
Challenges	**INTERNAL** Improve performance **EXTERNAL** Answering customer demand
Type of BCT	Private blockchain (Platform) in downstream chain including retailers and hospitals

Table 14. Business framework, Motives and Challenges for BCT of the Arya Hakim

4.1.2 Trust Analysis in Arya Hakim

Trust has been discussed in two different sections: one is trustin the platform and records, the other one is trust in the SC partners in the current situation when they do not use BCT as a daily application yet.

Trust in the Platform and records

Trust in the records was discussed as a concern. Interviewee mentioned about skills and knowledge of the users to reduce the mistakes in data entry. trust in the platform was one of the main concerns of the company. *"How much skill is required, what should we do to train all the users*", and more serious than other concerns "*what should we do if something goes wrong in the platform. How the service provider guarantees the reliability of the platform*".

Trust in the Downstream SC

The objective of this thesis is exploring the impact of BCT on the supply chain's trust. This thesis argues openness, credibility, and benevolence as the three forms of trust. The analysis of current situation of Arya Hakim in each aspect is shown in Table 16. In the current situation, Arya Hakim shares all the operational information with retailers (e.g. forecast cost); however, the information sharing is not real-time. Arya Hakim conducts workshops and training courses about new products and investigates new market strategies collaboratively. Arya Hakim shares the risk in their contract and invests in new technologies for improving retailer's staff.

The AS_IS analysis of trust is based on empirical data and the author's perception is shown in Table 16. The dark green cell means that the company has completed this level, a green light cell means that the criteria have not been fully reached and a yellow cell means that company has not reached this level yet and the BCT can facilitate the improvement. Arya Hakim by improving the retailers' knowledge and skills to invest in their relationships. They collaborate in future planning and market entrance strategies. The availability of the information is high but the data is not in real time. By investing in implementing BCT the level of benevolence will be achieved.

	Determinant related to the trust	**Trust Manifestation**	**Trust Maturity**
Trust	Benevolence	Sharing rewards	
		Process investment	
		Relationship investment	
	Credibility	Future planning and new market strategies, future technologies)	
		Real-time information	
		Available information	
		Adequate information	
	Openness	Sharing risks	
		Shared forecast and delivery time	

Table 16. Trust in Arya Hakim supply chain before using BCT.

4.2 Company Description (Nestle)

Nestle is a Swiss multinational food company which was formed in 1905 by the merger of Anglo-Swiss Condensed Milk Company and Farine Lactée Henri Nestlé. Nestle is the largest food company in the world since 2014. The Nestle's SC is shown in Figure 25.

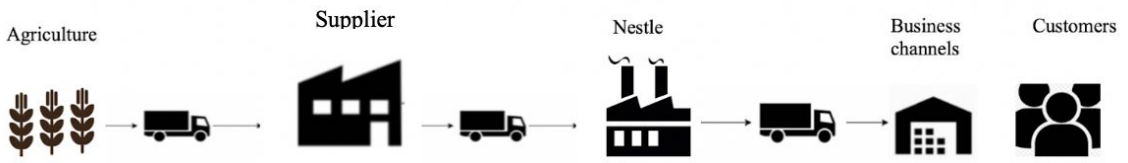


Figure 25. Nestle SC

Nestle has a vast range of different brand categories (e.g baby food, bottled water, etc,) and have more than 339000 employees in 150 countries. "*We recognize that our growth is built on excellent relationships – from farm to shop. In so doing, we also ensure the best results for our shareholders and, most important of all, our consumers*" (The world of Nestle, 2018). A quick overview of Nestle company is shown in Table 17.

Industry	Food
Foundation Date	1905
Product	2000 Different food product
Geographic expansion	442 factories in 86 countries
Type of BCT	Private Platform

Table 17.Nestle quick fact

Project's leader of Blockchain in Nestle argues that it is the customer demand for transparency that motivates Nestle to implement the blockchain-based application. IBM Food Trust initiative involves major global retailers such as Walmart and Unilever as members, and they are interested to onboard new suppliers and retailers this year. In IBM Food Trust (IFT) chain participants view their permissioned data similarly in a trusted network (Figure 26).

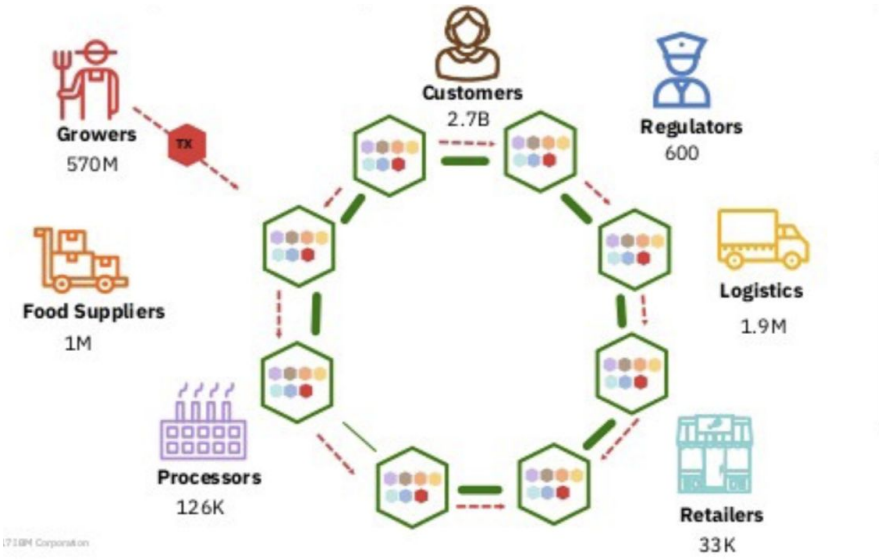


Figure 26. IBM trust food chain by BCT

Benjamin Dubois, digital transformation manager of global supply chain explains the development of the blockchain project in Nestle since fall 2016, with the first product trials spearheaded by Walmart in China in December 2016. Nestle, for its part, has been engaged in testing the product as of August 2017 (Dubois, 2019). IBM as a service provider uses BCT to create unprecedented visibility and accountability in the food supply chain. It is the only network of its kind, connecting growers, processors, distributors, and retailers through a permissioned, private and shared records of the food data system. By using IFT retailers are able to provide fresher options (with increased shelf life) to their consumers leading to reduced product loss and increased margins. The project is in its first initial test phase and it is widely using QR code according to Dubois.

This platform is a powerful tool for retailers and suppliers to generate digital trust and manage data in a secure and decentralized manner, with visibility in real time (Dubois, 2019). Dubois mentioned these important characteristics for food production: "*Using IBM Trust Food BCT specifies not only the origin and composition of the product, but also the farmer who participated in the harvest , the date on which the food was processed, the identity of the factory that took care of it, even how many employees the agricultural enterprise has and which ethical certificates the producers hold."* Dubois mentioned some remaining technical challenges that should be tackled in 2019, such as managing the interoperability of data platforms, therefore the exact date that the initiative would be operative at a large scale is not specified yet.

Demand and Supply planning manager (D.M), mentioned the critical role of availability of information in demand and supply planning, mainly because of difficulties of demand estimation, planning for demands of different products, geographical expansion of the suppliers, distributors, retailers and third parties in different countries (e.g. Germany, New zealand). Moreover, due to specific characteristics of the product, which is freshness and having the expiry date, the planning would become even more complex. For smooth supply chain and lower level of the bullwhip effect, real-time and accurate data is necessary. D.M explained the structure of reporting between different parties and discussed how the data availability and accuracy can increase the performance. BCT can solve issues related to the availability of information and facilitates cooperative arrangements within the chain for responding to fast-changing demand and reducing the risks and cost. IFT enables the supply chain to track how fresh the food really is and how long it has been traveling in a real-time manner to confidently understand the remaining shelf life. BCT does have a great deal of potential to provide additional transparency, accountability, and security to the realm of corporate social responsibility.

The lack of data availability makes managers feel insecure when they try to do accurate forecasting with minimum mismatches between supply and demand. That is why they have the willingness to monitor and obtain data in real time. Predictability of a partner's behavior even for delivering a report within the agreed time can contribute to reducing the uncertainty. Joining the network by BCT warrants maximum efforts at maintaining the relationship by credibility, availability, and reliability. Inefficiency in the food system is a pervasive problem worldwide. With so many participants, there are endless possibilities to lose efficiency and profits. Inefficiencies adversely affect consumer pricing, carbon footprint, food waste, and expected freshness. With the absence of consistent and well-designed certification processing, inefficiencies between producers and suppliers are estimated to be $60 billion annually (Hegnsholt et al., 2018). Blockchain as a strategy has an impact on reducing costs and achieving efficiency through the transparency that the technology offers. IBM Food Trust consists of several modules designed to support participants in the food system. Using the Data **Entry** and **Access** module, participants can securely upload, manage and access transactional data. With the **Trace** module, food system members can securely and transparently trace the location and status of food products on the supply chain. Additionally, with the **Certifications** module, users can prove sustainability and provenance with ease by securely managing certificates throughout the entire supply chain (IBM,2019).

To develop into a JIT company D.M mentioned the influence that BCT has, on time and traceable by being transparent (e.g. IoT and Smart Contract). BCT by monitoring performance can increase the willingness to rely on external partners by enhancing integrity, and benevolence. Nestle focuses on inter-organizational collaboration. D.M believes that BCT facilitates production monitoring and helps to establish a preventive mechanism. They are determined to

keep relationships: "*We firmly believe in creating long-term relationships, it is beneficial for both sides to be truthful and loyal*".

All parties involved in the chain need to agree on using the BCT platform. If only one party, e.g. the distributor or supplier, decides not to use the platform, the finished product would not offer any benefits for the customers because transferring all the way from the exporter to the final receiver must be covered.

4.2.1 Business Context of Nestle

In business framework (Table 18) the main information regarding Nestle business is summarized. Motives and challenges of implementing BCT in Nestle are recognised during the research.

Product	Limited shelf life Special maintenance requirements High cost
Business	Geographic expansion Different product with different strategies, long term relationship with partners
Motives	Improve performance (Cost, Quality) Improve supply chain transparency CSR (Corporate Social Responsibility) Customer requirement for originality
Challenges	Privacy law International law Information security Connecting the BCT database to the new retailers and suppliers Making agreement between current partners Change management
Type of BCT	IBM trust food (Private blockchain Application)

Table 18. Business framework,Motives and Challenges for BCT in Nestle

4.2.2 Trust Analysis in Nestle

Trust in Platform

There are concerns about the security of the system as a whole and leakage of information. The interviewee mentioned "*while we discussed about BCT even in private blockchain we cannot claim that we have a closed ecosystem.*" There is also a risk perception due to companies which are providing BCT services. The interviewee mentioned the critical role of providers in this transformation." *they not only deliver technical infrastructure and platform but also provide an interface and that change user's communication way*". The organizational behavior will rely on BCT heavily, and probably will be affected by that.

Trust in Upstream SC

For understanding trust in this case three different determinations of trust that are openness, credibility and benevolence and the manifestations of each are presented in Table 19.

The AS_IS analysis of trust is based on empirical data and the author's perception.The dark green cell means that the company has completed this level, a green light cell means that not all criteria has been reached and a yellow cell means that company has not reached this level yet where the BCT can facilitate the improvement.

	Determinant related to the trust	Trust Manifestation	Trust Maturity
Trust	Benevolence	Sharing rewards	
		Process investment	
		Relationship investment	
	Credibility	Future planning and new market strategies, future technologies)	
		Real-time information	
		Available information	
		Adequate information	
	Openness	Sharing risks	
		Shared forecast and delivery time	

Table 19. Trust in Nestle supply chain before using BCT

4.3 Company Description (Zalando)

Zalando is a huge retail corporate in Europe. It is especially prominent in Germany, where they boast 95% brand recognition amongst the market, but it has also been extending into other countries in recent years and opened fulfillment centers in many countries e.g. Sweden and Belgium in 2017. The SC network of Zalando is shown in Figure 27.

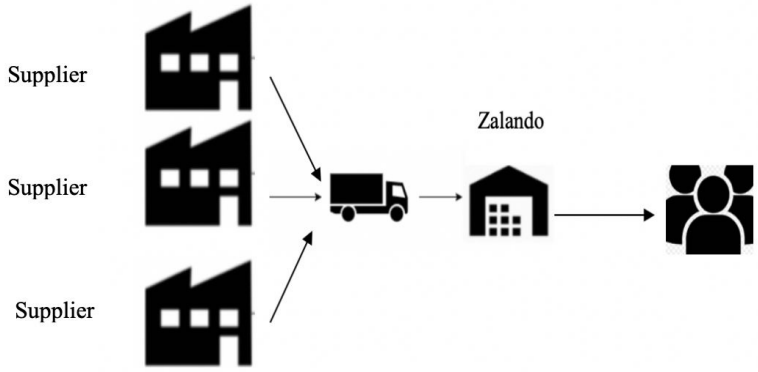


Figure 27. SC network of Zalando

Zalando has been quickly transformed from what started as a Berlin-based online shoe shop into Europe's leading online fashion platform. Zalando concentrates on the fashion industry. From online retail, private labels, and shopping club to style information, they provide customers with multiple touchpoints to join the fashion world. In doing so, Zalando presents its strengths in the digital arena, and today, they work with customers, brands, and partners in 17 countries (Zalando, 2019). The quick facts related to the Zalando company is shown in Table 20.

Industry	Fashion and lifestyle online shop
Foundation Date	2008
Product	2000 brand 300000 assortment
Geographic expansion of Market	15 500 employees 17 countries
Type of BCT	Private BCT platform

Table 20. Zalando quick fact

Zalando is growing quickly, the growth in the sale is aimed to get 5% of the market share in the fashion industry (Figure 28).

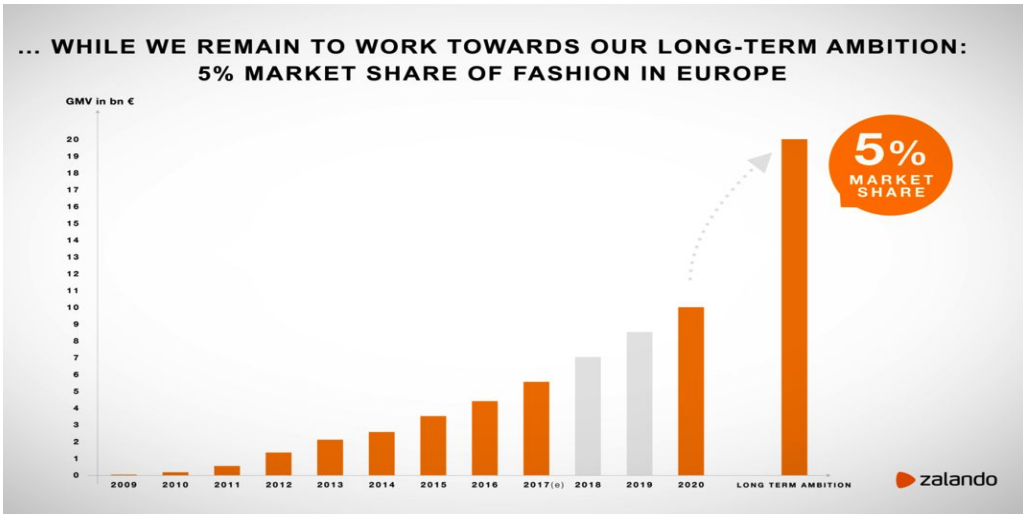


Figure 28. Zalando growing market value

One of the main development projects in Zalando is going toward transparency, and one solution which they are concentrated on is using BCT in the supply chain (Zalando, 2019). By 2020, Zalando aims to be one of Europe's leading transparent fashion platforms. They have conducted an event called "*TRANSPARENT*" where the challenges of transparency and BCT were explained. Dennis Ohnsorg, the team leader of the project of transformation toward transparent supply chain at Zalando, explained: "*We want to be a global enabler and bring players together. BCT can help us to collect data more efficiently, transform it into valuable information, and thus enable more qualified decisions for all parties involved"* (Zalando,"2018).

Bext360, an agricultural blockchain startup, is partnering with Zalando for a pilot test to see if blockchain can be utilized to ensure the integrity and authenticity of the organic cotton supply chain. The initiative began in December 2018 and is currently being used to trace organic cotton from farms to the gin where it is processed to produce textile. The second phase of the pilot will be to ensure that cotton can be traced from gin to consumers, and finally, the initiative is aimed at implementing the project on an industrial scale, so it can be used for organic cotton farmers, textile producers and fashion companies (Knapp, 2019).

Amy Mason, sustainability consultant and researcher in the fields of supply chain transparency with Zalando states "*The key*" for not only the problems of the fashion supply chain, but also many inspiring examples of possible solutions "*is technology*". "*Many brands and suppliers still think and act analogously. Digital technologies such as Blockchain, AI and Big Data can help us*

to collect data more efficiently, transform it into valuable information, and thus enable more qualified decisions for all parties involved" (Zalando, 2019).

The Lean Manager(L.M), stated: "*with transparency projects in Zalando's chain, a lot of projects toward being lean have been conducted during these years to improve performance*" (L.M,2019). Zalando internally has a great and integrated information platform, "we are *highly digitalized, but it is not for all the chain*".

L.M (2019), explained how they share a lot of information between different partners and consider their interests.

According to L.M (2019) for an online shop like Zalando which is active in the stock exchange, there are always concerns for leakage of information: "*We are growing, and information sharing is important and sensitive*". Moreover, some concerns were expressed about the value of the information which will be shared in the blockchain.

BCT platform can bring new concerns about how the information should be shared, for example, chain partners (downstream and upstream) must have an agreement to join the platform which is difficult since they have different levels of power in the chain. As the interviewee said, "*Some parts of the chain e.g raw material suppliers) have more competitors and information sharing can have a negative impact on their own privacy*". For such a supply chain which has different regulations and ownership, joining to the BCT platform can be more difficult for some partners than the others (L.M, 2019).

In Zalando Tech Event, it is mentioned that "*The challenges for the implementation of sustainable and transparent supply chains are. a strong fragmentation of the chain into many individual parts. In addition, this area is hardly digitalised*". Immaturity of the innovative technology and being inexperienced role playing in cross-industry and cross-brand cooperation are the main barriers. Greater cooperation is mentioned as a solution between all those involved worldwide in order to push the topic forward to a transparent supply chain(zalando,2019).

4.3.1 Business Context of Zalando

In Business framework (Table 21) the main information regarded to the Zalando's business is summarized. All factors related to the implementation of BCT and the impacts addressing the critical factors as well as additional impacts are shown.

Product	Limited shelf life
Business	Geographic expansion Growing fastly
Motives for BCT	Answering customer demand for transparency
Challenges for BCT	Privacy law Information security Connecting the BCT database to the new retailers and suppliers Making agreement between current partners Incentive alignment
Type of BCT	BCT platform between all the chain

Table 21. Business framework,Motives and Challenges for BCT in Zalando

4.3.2 Trust Analysis in Zalando

trust in the platform

trust in the records discussed in terms of the reliability of data. They think the familiarity of BCT platform influence the user's ability to make reliable data. If the process of data entry is complicated the mistake is unavoidable

There is also mentioned about trust in the platform in terms of the belief regarding the performance of the platform which is still doubtable. However, interviewee thinks everything is depends on the future if the companies see a positive impact of blockchain in their process the users will trust in the platform.

trust in the partners

For understanding trustin Zalando the AS_IS analysis of trust is shown in Table 22 based on the empirical data and the author's perception. Three determinants of trust and their signals are shown in the following table and the manifestation of each form are presented. In Zalando's chain operational information is available, however it is not in real-time. Zalando is internally highly digitalized but in the information flow, the chain is fragmented and not integrated with

partners who are not in the same level of digitalization. The contracts between partners cover risks and they plan to work more closely with their suppliers and persuading lean projects in their processes. The dark green cell means that the company has achieved this level, a green light cell means that not all criteria have been achieved and a yellow cell means that company has not reached this level yet where the BCT can facilitate the improvement.

	Determinant related to the trust	**Trust Manifestation**	**Trust Maturity**
Trust	Benevolence	Sharing rewards	
		Process investment	
		Relationship investment	
	Credibility	Future planning and new market strategies, future technologies)	
		Real Time information	
		Available information	
		Adequate information	
	Openness	Sharing risks	
		Shared forecast and delivery time	

Table 22. Trust in Zalando supply chain before using BCT.

4.4 VERSES (Blockchain Provider)

VERSES is a non-profit foundation, developing and governing open protocols, standards, and specifications for the next generation of the web. VERSES aim is to provide a single, worldwide network for linking people, places and things – both virtual and physical – to enable seamless interactions, transactions, and navigation between them.

VERSES Labs

VERSES Labs is a for-profit company providing enterprises, organizations, and governments with an extensive suite of integrated technologies built on open spatial protocol specifications and standards developed and governed by VERSES Foundation.

The VERSES services respond to the need for multi-party privacy, security, and interoperability by design. In 2018 they launched augmented reality blockchain to connect physical and virtual spaces.

With protocol, developers and users can share VR and AR experiences and objects across all types of devices as well as trade virtual objects between physical locations. It means that a company or individual can place AR objects in the world, visible to people using AR glasses such as HoloLens or Magic Leap One and allow them to interact with those objects based on where they are standing.

To do that, VERSES overlays distributed ledger blockchain technology over real and virtual world locations and objects, allowing each to receive their own unique identifier. That creates what the company calls "*smart spaces*" and "*spatial domains*" – a proposal whereby real places can possess a virtual layer and enable programmable rules that apply to that space in virtual reality (Dotson,2019).

4.4.1 Smart Contract and IOT

VERSES present a layer of management that makes BCT attractive to the company, looking to track virtual assets, such as real estate, gift cards, stocks and other virtual items and smart warehouses. The VERSES protocol adds a spatial or location-based element to these tracked digital assets via augmented reality. Senior software architect (V.A) explained how IOT and smart contract offers different ways to resolve the issues related to the availability and accuracy of the data to increase trust in industries. "The *BCT increases accuracy and decreases risk*". V.A stated that some industries are more interested in the BCT for example the logistics service providers (e.g distribution center of online shopping) with a high rate of the workload are more interested in the platform. The concept of blockchain is captured by cryptocurrency, and it

affects the willingness of industries to go further with blockchain. BCT is still an unfamiliar concept; although, the technology is young, but they assume the usage rate is growing and, in a few years, there will be more awareness and users.

Trust in the capability and the security of the platform in the user's point of view is the main challenge for BCT service providers. Users of the platform have concerns about the security and level of accessibility of the information in a shared platform. Blockchain offers many solutions in this regard; for instance, smart contracts define many preconditions to giving someone access to the shared platform. Leveraging information sharing in his point of view is a critical situation in this process and the primary trust between partners is as a necessary binding force in the implementation process. "*When the companies decide to implement BCT they already have the certain level of trust in their partners*". The characteristics of the blockchain facilitate worldwide trades and increase the level of trust between them.

The main purpose of VERSES from the standardization of the application is to attract the interest of the customers. V.A explained for supporting the transformation process from the current situation toward BCT, they will provide a high standard protocol for different industries.

4.4.2 Business Context of VERSES

VERSES deliver platforms that the data can be tracked through time and space. Partners in chain by using VERSES application can record details of their ownership, manage their own transactions and interface with a whole related of devices. Summarized information related to the VERSES company as a service provider and the capabilities of their application is shown in Table 23.

Business	Blockchain Service Provider
Industry field	Logistic service providers (e.g. Distribution Centers, Warehouses)
Product	Smart Contract, IOT based on the BCT
VERSES Application Capabilities (Service Provider's Point of View)	Transparency of process Increase Efficiency Trust Improvement Risk Reduction Intermediary Reduct Paperwork Reduction
Challenges for Implementing BCT	Immaturity of technology Customer concerns for information and platform security

Table 23. VERSES' Business, Applications, Challenges

4.5 Modum (Blockchain Provider)

Modum AG is a Zurich-based company founded in 2016 by a group of entrepreneurs with backgrounds in technology and pharmaceutical manufacturing. Modum offers next generation solutions for chain monitoring, automation, and optimization. The company, thus, creates digital ecosystems, powered by IoT sensing, AI and Blockchain technology, for a wide range of applications related to sensitive goods in various industries.

Modum not only collaborates with global technology partners such as SAP and AWS, but also joins up with business partners such as Swiss Post to ensure that their solutions are fit-for-purpose and meet market needs. Communications and Marketing manager (M.O) stated that the company is focusing on logistics companies and the pharma industry because of the rigid standards of the industries. "*Good Distribution Practice of medicinal products for human use regulation (GDP 2013/C 343/01)*", for all actors such as distributors and logistics providers, is a regulation that forces them to maintain a record of the temperature of the medical product while the goods are in transportation. Modum in 2016 conducted the first use case for blockchain and sensor technology which was an application in pharma logistics. The BCT platform allowed users to more efficiently and cost-effectively adhere to the current EU regulations. They sent the first 50 shipments under the first project (Modum,2019).

The lack of transparency among the numerous different actors in the supply chain is a well-known problem. M.O stated that the blockchain is a reasonable solution for every industry which is interested to bring transparency as an advantage for the involved stakeholders (food, pharma, electronics, medical supplies, art and valuables). The Supply Chain Resilience Report shows that 69% of companies do not have full visibility into their supply chain, which leads to the fact that they have lots of uncertainties and no control over the state which their product is delivered in. On the other end of the supply chain, in many cases the end customer has no way to check the status of the product during the shipment. In supply chain management, blockchain technology has been proven to be of great value, by tracing the authentication of products and accuracy of the transactions. The data on the blockchain is accessible to authorized users and the actors are allowed to share the data without disclosing any information which should stay private. They think trust between the actors is built by the fact that the data is immutable and verified by each user. M.O explains this level of transparency and provenance together can build trust through the chain. As the individual actors in the supply chain have very limited access to shipment data before implementing blockchain technology, they are forced to simply trust that the other actors will handle the product properly. The BCT projects are still at an early stage, and it is hard to analysis the changes in trust between different parties' relationships (M.O,2019).

Smart Contract as an application of blockchain

Encrypted and immutable link to recorded sensor data based on Smart Contracts. The temperature monitoring device MODsense, records the temperature during the shipment and the monitored data is then uploaded and verified on the blockchain at readout. The temperature parameters create a unique record to the smart contract for each shipment, which ensures data authenticity. Storing data sets on the blockchain ensures that they have data integrity throughout their useful life which cannot be altered. Moreover, they are accessible to all actors in the supply chain at all times and can be shared easily and safely.

4.5.1 Business Context of Modum

Modum is delivering combining IoT sensors with blockchain technology to provide data integrity for transactions of physical products. Summarized information related to the Modum company as a service provider is shown in Table24.

Business	Blockchain Service Provider
Industry Field	Pharma
Foundation	2016
Product	Smart contract based on the BCT
Modum Application Capabilities (Service Provider's Point of View)	Safety in Information Sharing Trust Improvement Transparency of Process Process Controlling Increase Efficiency Risk Reduction Intermediary Reduction Provenance of Product Collaborative Planning
Challenges for Implementing BCT	Immaturity of Technology

Table 24. Modum Business, Applications, Challenges

5. Comparison Analysis

After describing the companies and analyzing trust-related factors, the author will present the Comparison analysis. The interviews' findings will be analysed in two parts. The first part is related to the service providers and the factors that they assume that are impacting trust. The second part is related to the companies which have willingness to use BCT. These companies will be analyzed based on the basic data, supply chain characteristics and their motives and challenges to using BCT. The last part discusses the current level of trust in these three companies and the impact of private BCT on trust.

5.1 Service Providers Analysis

This section summarizes all impacts of blockchain technology on supply chain from the service providers point of view. All the factors that any interviewee mentioned as a catalyst for trust improvement are presented in the following table (Table 25).

BCT Capabilities	Modum	VERSES
Safety of sharing information	×	×
Confidentiality integrity and availability and reliability of data	×	×
Data is secured, tamper proof and cannot be changed over the time	×	×
Information sharing is increased toward the customer	×	×
Direct information sharing without intermediary	×	×
Transparency of information	×	×
Integration internally and externally improve the speed and safety	×	
Improve performance	×	×
Decrease uncertainty	×	×
Improve collaboration		×
Detect bottleneck		×
Through high degree of information sharing partner can do better decision making	×	×
Balance power differences		×
Transparency of information	×	×
Having incentives for mutual goals brings loyalty and honesty		×

Table 25. Impact of BCT on supply chain

Findings show despite all the differences between the industries, the security of data sharing and access level is a main concern. Trust highlighted as a factor which can be improved by BCT. Although blockchain is a novel solution for trust issues, there are also other incentives for their customers to implement blockchain, such as information asymmetry, speed, increasing control or cost reduction. It seems the main reason for using BCT is increasing the control, as in their current situation they do not have enough visibility to their own flows. Users of BCT already have a certain level of trust when they decide to implement BCT, which is a safe way to increase or maintain trust.
Previously, I touched upon the relationship between the contract and trust in surveys. It seems BCT has the same characteristics as the contract. If the application capable of having full control over the transactions, then there would be no need for more trust. In that case, trust and control are interchangeable; however, complete control is not possible since there is always some interaction between the human and the system and the reliability of data cannot be guaranteed hundred percent.
It can be said that the main reason for companies to do BCT from the service provider's point of view is increasing control for performance management and reducing the cost and the loss in their collaboration. For aiming this in first steps they need to have trust in partners' promises and competence.

5.2 Business Context (Arya Hakim, Nestle, Zalando)

The comparison of companies' characteristics (Table 26) shows that the core business of the three companies are totally different, which means that they have different requirements when they request for BCT. Furthermore, the companies are in a different position in their life cycle, so the maturities of processes are different as well.

Arya Hakim is representative and distributor, Nestle is manufacturing and Zalando is Online shop. Supplier and retailer selection processes are different between them because of different levels of regulations and standards in each industry. Healthcare and food industries have rigid standards for their processes, consequently, they have long term supplier selection. So, they try to keep their partnership, which is crucial for building collaborative planning and creating trust.

	Characteristics	Arya Hakim (Distributor)	Nestle (Manufacturer)	Zalando (E- Commerce)
Business Characteristic	**Industry**	Medical equipment	Food	Fashion and lifestyle
	Type of the company	Representative and distributor	Manufacture	Online shop
	Industry Rigid Regulation	High	High	Low
	Geographic Expansion	40 retailers in Iran (sale)	442 factories in 86 countries	17 countries fulfilment center
	Founded Date	2002	1867	2008
	ERP Orientation (internal)	High	High	High
Product Characteristic	**Shelf life**	Limited	Limited	Medium
	Maintenance Requirements	Special	Special	----
	Cost of Products	High	Low	Medium

Table 26. Business context Comparison

The situation of each company is different based on the firm's life cycle stage. Life cycle of each firm is categorized in four stages with different requirements and characteristics (Start Up-Growth-Maturity-Decline) (Miller & Friesen, 1984). By considering the foundation date, the market share and sales reports, It is concluded that Arya Hakim and Nestle are in the maturity level of their business and Zalando is still in growth stage. In each stages company seeking different strategies to take competitive advantages. Arya Hakim and Nestle try to growth their opportunities by using new strategies or innovation. In maturity level the maturity of process which is needed for transition toward new technology and innovation also is higher than growth level. Arya Hakim and Nestle in maturity level for implementing BCT have more tendency to improve efficiency and reduce cost.

5.3 Supply Chain Characteristics (Arya Hakim, Nestle, Zalando)

Partners in the supply chain share their information for managing the different processes and developing the quality of the final product or service. The comparison between different supply chains is shown in Table 27. In terms of supply chain characteristics, Arya Hakim and Nestle are in the same situation. The interviewees talked about strategies for long-term relationships, and ranked the current situation as high, medium or low with regards to supply chain characteristics. Some other situation like having a long-term supplier/retailer process with restricted rules and

prerequisites. The current level of digitization in the chain for both Arya Hakim(A.C,2019) and Nestle is medium (D.M,2019), but Zalando has a fragmented chain (Digitizing Supply Chain Transparency, 2018) with less level of digitization, which is surprising as they work with e-commerce. Findings shows the high tech industries (Nestle, Arya Hakim) have more tendency to improve alignment in their chain. This alignment leads to having more investment in their mutual goals and values that can bring trust in their relationships. Future planning gets more facilitated due to continuous relationships and transferred information, it can affect the current level of trust.

Supply Chain Characteristics	Arya Hakim	Nestle	Zalando
Level of collaborative planning	Medium	Medium	Low
Level of information sharing	Medium	Medium	Low
Relationships orientation	Long term	Long term	Medium
Level of digitalization	High	High	Low

Table 27. Supply chain characteristics

High-tech companies need to achieve faster speed-to-reaction to reduce losses, in order to balance the tradeoffs, risks, and constraints and to be prepared for the future. BCT facilitates process performance for having well-developed and integrated supply chains. An appropriate combination of technology and processes are observed in Arya Hakim and Nestle. These are to optimize their supply chains to achieve prioritized objectives. The collaborative process such as collaborative forecasting and planning with customers and suppliers were more structured in comparison with Zalando.

5.4 BCT Motives and Challenges

Three main motives and challenges for implementing the blockchain technology were investigated in the interviews (Table 28).

Information sharing is considered as one of the main challenges in SCC (Min et al, 2005). Main security matters which were discussed in the interviews were the fear of cyber-attacks and data breach which can be limited to a minimum with the blockchain technology.

BCT can develop trust in a new way by BCT characteristics which lead to increasing information availability and information quality. However, without effective governance, this approach may not promote trust at all. The importance of governance and rules are crucial issues within the chain. The main concern was how blockchain regulates the business.

	BCT Motives and Challenges	Arya Hakim	Nestle	Zalando
Interna Motives	Improve efficiency	×	×	
External Motives	Answering customer demand for transparency	×	×	×
	CSR (corporate social responsibility)	×	×	×
Challenges	Privacy law	×	×	×
	International law	×	×	×
	Information security	×	×	×
	Database to the new retailers and suppliers	×	×	×
	Connecting the BCT database to the BCT of brand owner when needed	×		
	Making agreement between current partners		×	×
	New governance method	×		
	Incentives alignments			×

Table 28. BCT motives and challenges comparison

Similar to states, large corporations such as Nestle, have a centralized authority, rules and governance. In a centralized infrastructure, rules and regulations are implemented by the company or other trusted parties. In a decentralized system based on BCT, the missing link is the third trusted party to verify the reliability of the transactions. In BCT the official rules and regulations can be replaced by integrating the set of rules in a protocol. A customized governance system is needed for each situation. BCT needs to be able to adapt to business environments, law and regulations.

5.5 Trust Analysis (Arya Hakim, Nestle, Zalando)

One of the most critical requirements for supply chain management is trust. Trust in the concept of the shared ledger is a new area which brings new challenges. In the traditional form of trust, there was a dyadic relationship between trustor and trustee. By shared ledger, this relationship has given a new dimension which is trust in the platform competence. Thus, the new relationship is extended to a triad. In this thesis, trust was regarded in two different levels. The first one is the disposition of trust in the platform and records (Figure 29), and the second one is trust between different partners in the chain when the information is shared based on the private BCT.

5.5.1 Trust in the Records and Platform

The receiver of trust should not necessarily be a person, it can be a process, an algorithm or a structure. If the service provider can fulfil the trust requirements for trustee (eg. delegation trust, infrastructure trust) the user can trust the platform (Jøsang et al, 2007).

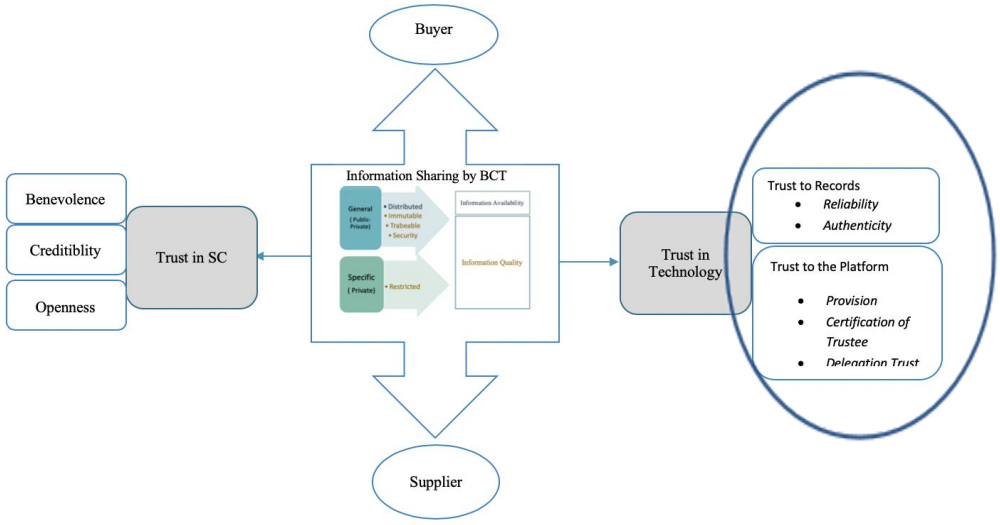


Figure 29. Trust investigation model (Platform and Records)

Previously, institution-based trust was mentioned as comprehensive security by the adjusted rules, legal structure, regulation, safety nets and guarantees. This means that an external agent provides trusted tools and mechanism which can promote trust between partners (Zucker, 1986). McKnight and Chervany (2014) explained in their study that in the online shopping, the objective of trust can be an institutional trust in the service provider (e.g., to trust in the Airbnb platform that they keep personal information securely). The author believes that trust in the BCT platform can be described as institutional trust. For trusting to the platform, the users can have trusting intention if the other requirements (e.g. provision trust, certification of trustee, etc.) are satisfied. Then the user can have trust-related behavior as we can see in Figure 30. The result of trust behavior can lead to cooperation and information sharing.

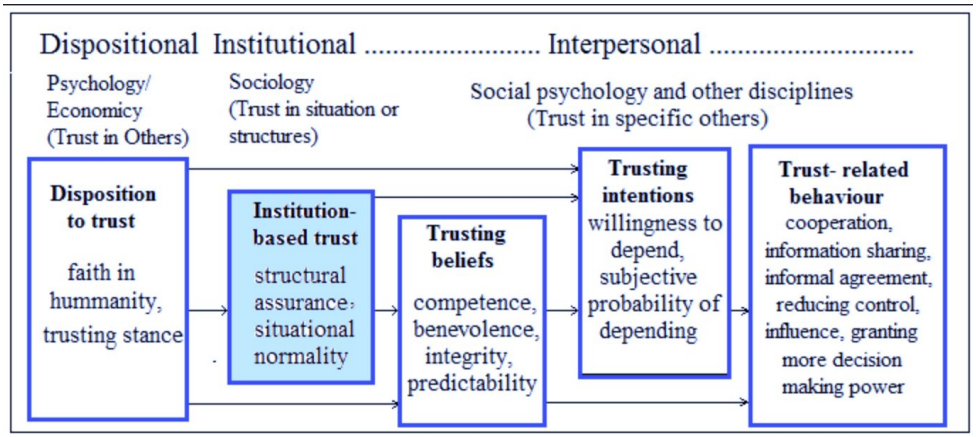


Figure 30. Different form of trust (McKnight and Chervany, 2014)

Institutional trust in BCT‘s capabilities plays an essential role in the formation of interactions and relationships in the context of the supply chain. This arrangement is between the end-user and the blockchain system. BCT enable verified and transparent recording and value exchange mechanisms without the need for a central authority or institution. The main reason is to reduce the intermediary level, and consequently, cost. BCT platform provides a strong control mechanism for opportunistic behaviour. BCT change the shape of the corporation the scope of the responsibilities and communication. Users of the BCT are impacted by not only the technical infrastructure, interfaces, and process guidance but also by the services such as smart contract which is the revolution in the contracting. The smart contract facilitates the cost-efficient transaction and reduce the complexity of writing and governing contracts, and enable financial transactions in different situations.

BCT in the cross-disciplinary review of the literature is mentioned as the technology for transparency. On the other hand, BCT seems to be more than just tracking and tracing technology; it affects some other factors like orientation in the chain, level of participation and communication.

Since the BCT projects are still in the pilot stage, it is important to consider how a technological shift toward BCT will affect the user’s behavior in a still-developing platform.

Whether the BCT platform is capable of maintaining trust in a business cooperation or enhances complexities is unknown. If trust in the platform considered as an institutional trust; in the author's opinion this can also affect the dispositional trust within SC. It means if the platform in user’s mind is reliable they can rely on that for doing the transaction and concentrate on improving their performance. The author finds that despite all the interviewees are in different industries with different organizational needs, they all have the same concerns regarding the reliability of their data. Therefore, the challenge is to ensure that all entries are correct and reliable. Thus the reliability of data is BCT's Achilles heel.

My study shows that the technology has evolved from its role as a verification mechanism for cryptocurrencies, and led to a broader field of industrial and commercial applications. Despite the vulnerability in guaranteeing of reliability, BCT as a highly institutionalized structure has the capability of attaining the trust of the users and transferring power in their interaction.

5.5.2 Trust between Partners in the Supply Chain (Arya Hakim, Nestle, Zalando)

The literature mainly stated that the blockchain technology is an efficient way to achieve successful Supply Chain Collaboration and a high level of trust (Wang et al., 2017; Weber et al., 2016). For the thesis purposes, the author focuses on the trust dimension as it is perceived by chain members concerning their direct business partners. Trust between SC partners is defined in three parts, which is shown in Figure 31.

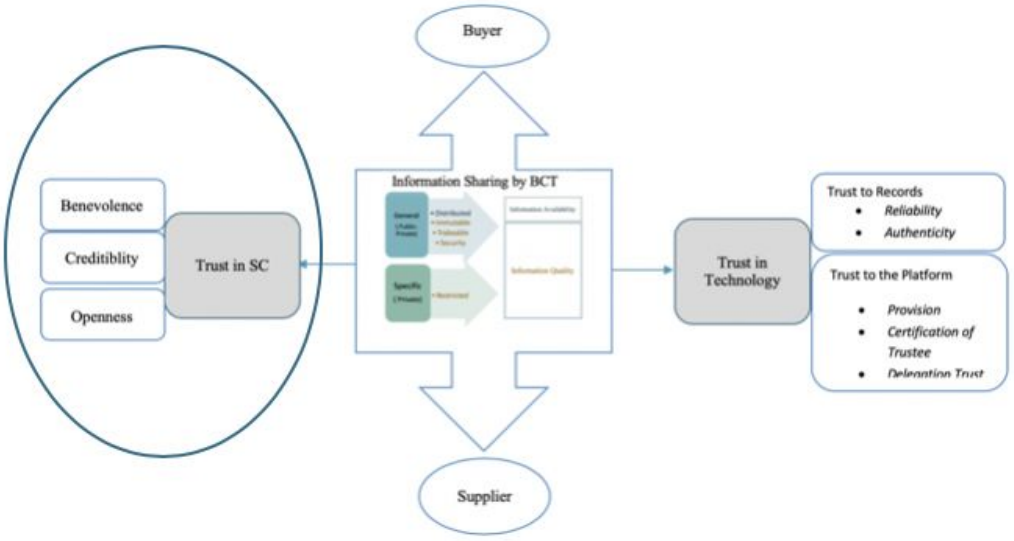


Figure 31. Trust investigation model (between SC partners)

The AS_IS analysis of trust based on the empirical data and the author's perception about the level of trust in three companies is shown in Table 29. A dark green cell means that the company has completed this level, a green light cell means that the criteria have not been fully reached, and a yellow cell means that the company has not reached this level yet. The yellow area shows the possibility of improvement by BCT.

	The Maturity Level of Trust in Investigation Model				
	Determinant related to the trust	Trust Manifestation	Arya Hakim	Nestle	Zalando
Trust	Benevolence	Sharing reward			
		Process investment			
		Relationship investment			
	Credibility	Future planning (New market strategies, future technologies)			
		Real Time information			
		Adequate information			
		Available information			
	Openness	Sharing risks			
		Sharing operational information (forecasts, costs)			

Table 29. Trust situation before using BCT

Information sharing level has a positive impact on the supply chain collaboration. In the investigation model, trust is operationalized based on the level of the information sharing and quality of information. Information access level in the chain shows the extent to which participants share information that is necessary for the creation of value.

By considering the result of Table 30 it seems the degree of information sharing between partners in the chain is varied. Lamming et al, (2001) indicate that there are different levels of supply chain information sharing (also referred to as "visibility") within the supply chain.

Level of Information Sharing	Opaque	Translucent	Transparent
Business Case (information sharing between two organization	For any reason, no information is shared between the parties, even operational day-to day information is obscured	Only partial data is shared Based s strategies'on the company	Information is shared in a selective and justified basis

Table30. Information Transparency by Lamming et al. (2001)

The level of information sharing reveals the level of involvement and dependence in the chain for collaboration. It is notable that the type of information is also important as well as amount of information. The type of the transferred information matters whether it is in the operation level or in strategic level. The mentioned information types affects the level and type of dependence in the supply chain. Figure 32 displays a schematic description of information sharing level for these three companies.

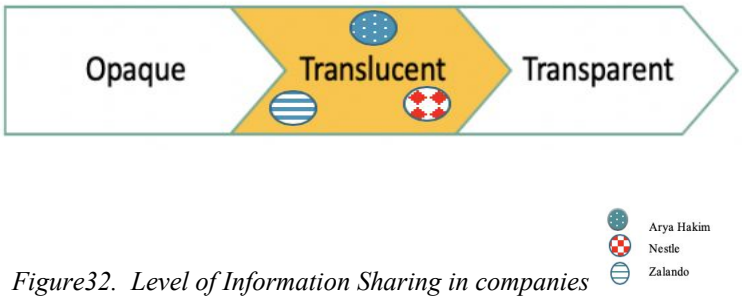


Figure32. Level of Information Sharing in companies

BCT provides real-time connectivity, synchronization of data, and improved efficiency. The author believes the level of information sharing between chains in three companies is in the translucent level and BCT can improve both quality and availability of information toward the transparent level.

The difference between three companies in maturity level of trust can be related to the industry and supply chain characteristics (Figure 33).

The maturity level of trust in the healthcare and food industry is high. Mainly because of having more dependency on their partners and the long-term orientation in supply chain relationships. The interviewees of these two companies mentioned about the limited number of

supplier/retailers who can meet their standards, the partnerships need a high level of technology, skills, and knowledge. The reason can be the consequences of having rigid standards for the products. These two industries try to maintain their partnership and invest heavily in their relationships.

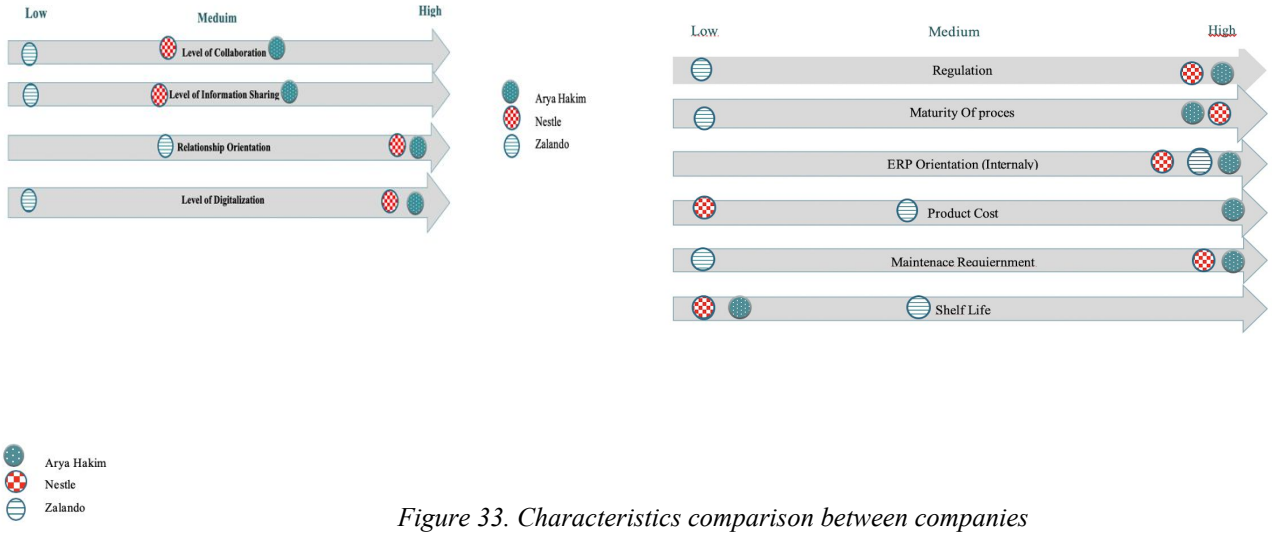


Figure 33. Characteristics comparison between companies

The importance of trust even seems higher in the healthcare industry to protect the customer's privacy. So, this means that trust in the healthcare industry is even more complex, as the chain should have trust in each other, and customers should also trust in share their personal information and history of the disease with the service provider.

The yellow area shows the space for improvement in trust by BCT. The author's analysis shows that trust in technology can be enabled but trust between the supply chain actors is hard to verify. Modum and VERSES's interviewees, for instance, did not want to make any assumptions if the relationship between supply chain partners can positively change over time because the blockchain technology is still at an early stage.

Zalando's interviewee thinks that it is hard to validate the relationship and the level of trust between the supply chain parties. Arya Hakim and Nestle stated that they try to improve their performance by BCT which also leads to a higher level of trust.
The finding shows that building trust in the supply chain area is the first thing which is needed before making a contract for BCT. Partnering in implementing BCT requires belief and faith that partners will always fulfill their obligations which will then lead to efficient cooperation.

Author thinks companies involved in consistent and long-term transactions are more interested in avoiding opportunistic behaviors, which leads to creating trust over time.

It seems regional and cultural differences can also influence supply chain partnerships and the kind of role that trust assumes. According to author perception, relationships were more supportive and trust oriented in Arya Hakim, but it is not obvious if they perform better than the others according to customer perception. SC's relationship involves companies of different sizes or different powers. Power asymmetry is important in BCT implementation in the supply chain. The author thinks a supplier may be pressured by a buyer with high bargaining power to participate in processes to join the BTC network. The role of trust and relationship with BCT in asymmetric relationships is required to be more investigated.

The author believes that the issues such as trust in relationships, in general, should be followed over a period of time and analyzed again when the blockchain product has been implemented for a while.

5.6 Relationships Between Trust and Information Sharing Technology

In many articles, researchers argue that trust is an emotion based on past experience and they argue if trust is low in a relationship, it should be raised first, then the relationship can perform well.

From this point of view, trust is a cause of something else, i.e. high trust causes high performance. On the other hand, some argue that trust is the effect rather than being the cause – the level of trust has arisen from a whole host of factors, including expectations, and the experience. Therefore, working directly on improving trust is a futile endeavor. One needs to work on other aspects of the relationship that results in increased trust

The author believes that the relationship between trust and BCT in professional relationships is not a dyadic relationship, since there is another factor which the performance is.
The relationships between BCT as a platform of information sharing, trust and performance can be seen in Figure 34.

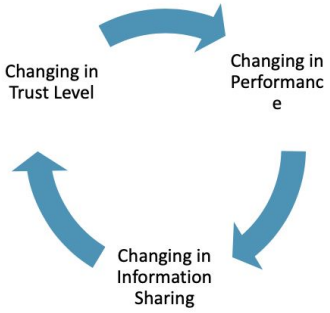


Figure 34. Relationship between trust, information sharing, and performance

5.7Impact of BCT on Trust in TDM

The BCT as a platform of information sharing ensures transparency and visibility in supply chains, by closely monitoring the processes and performing the transactions immediately. Naturally, the need for a high working capital and resources will also be decreased. The improved performance leads to having efficient collaborations. It is noticed that the primary outcome of seeking long-term relationship orientation and collaboration in a chain is to enhance efficiency. Consequently, dependency, investment in relationships, and trust between the partners will be increased.
The figure explains how trust can be a driver and also a barrier for information sharing. If the information sharing leads to different performance levels, it can be a driver for changing the level of trust between partners.

The analysis and comparison of the interviews in the level of trust is shown in Figure 34. The IBT trust level shows the highest level of trust in professional relationships. By improving information availability and quality, BCT might facilitate the progress toward this level. The role of trust in healthcare and food industry is important due to the rigid standards which demands a reliable supply chain. Therefore, BCT can act as a means of increasing the accuracy and reliability that brings more credibility and benevolence to the supply chain. It can be said that Arya Hakim and Nestle are located in the KBT (Knowledge Based Trust) level, while Zalando still is in the calculus-based level.

In the interview with Nestle and Arya Hakim they claimed that the level of trust had surpassed the threshold level of perceived risk. The author believes that the main reasons for the mentioned situation can be related to long term relationships, the maturity of their processes, and the characteristics of the product that create deep interdependencies between partners. In addition, all the companies have a tendency to improve the performance in the chain which highlights the trust role as a basic requirement for collaboration.

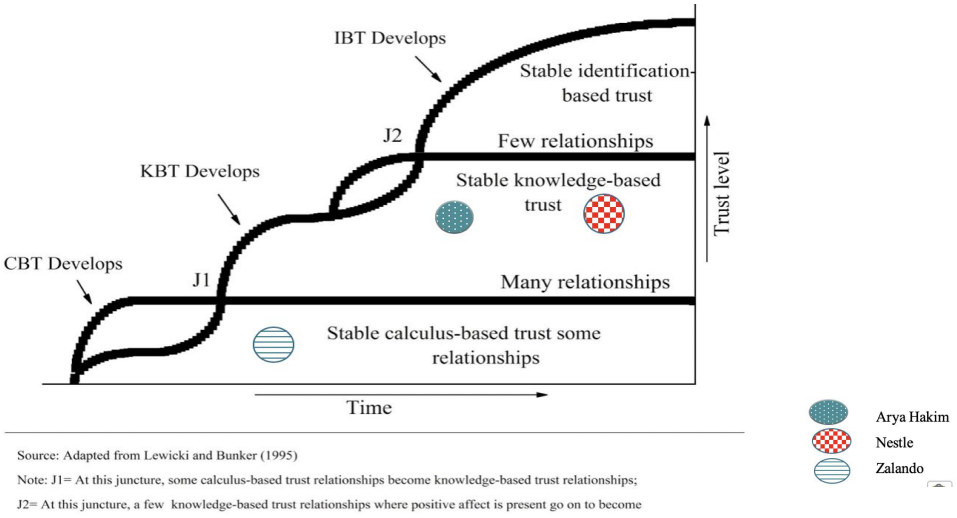


Figure 35. Case companies in TDM

By understanding the characteristics of the BCT and analyzing the impact of them, it can be seen that BCT has the capability to improve trust. However, case companies must have the willingness to go in a deep relationship. The author believes that joining BCT network is an investment in relationships since the implementation of this process is very resource demanding, so the participants try to stay in this partnership for a long time by collaborating effectively and preventing opportunistic behavior. This partnership contributes to their common interests.

The analysis shows for implementing BCT, calculus-based trust needs to be fully achieved as a requirement. After that when the relationship grows, partners can decide about going in deeper relationships with BCT. The main drivers for improving inter-organizational trust is common goals, incentives and shared values. BCT in these business contexts is considered as an opportunity to address challenges and problems in order to achieve improvements such as cost reduction and transparency.

6. Conclusion

The final chapter of this thesis reviews the key findings related to the research questions in the beginning. The answers could be seen as conclusions based on the previous analysis and discussion. Then the author explains the limitations during this research and gives suggestions for the future research direction.

The following content will answer the two research questions: a) What is the nature of trust in the supply chain? b) How is the impact of private blockchain technology on trust in the supply chain? First, the trust development model for supply chain relationships is described, and the situation of trust in the current level of the three companies will be analyzed. Then the impact of blockchain in the current situation will be discussed.

6.1 What Is the Nature of Trust in Supply Chain

The research question a) What is the nature of trust in the supply chain was answered by identifying several models and theories which defined the nature of trust in SC. This thesis describes some of the main conceptual models that have been suggested in the literature about trust in inter-organizational relationships, and it supports the idea of the multidimensional nature of trust. The main models were the Interdisciplinary model of trust by McKnight and Chervany (2001) and trust development model by Lewicki and Bunker in 1995. The investigation model for understanding the level of trust has been defined, and the linkages between the investigation model, and the trust development model have been presented. It seems that the definitions of trust in the literature tend to reflect the paradigms of the particular academic discipline of the researchers. For example, while sociologists tend to see trust as a structural nature (e.g., Lewis and Weigert, Shapiro, 1987a), some psychologists have considered trust as a personal attribute (e.g. Rotter, 1967). Social psychologists are more likely to view trust as an interpersonal phenomenon (e.g. Holmes, 1991). Economists are more inclined to view trust as a rational choice mechanism (Williamson, 1993). The importance and situation of trust vary within different industries and within different firms. In all studies, although different methods were used to operationalize trust, there is no fully satisfying and generally accepted method. The relationships between trust and information sharing were analyzed based on the relationship between trust, information sharing, and performance. In the author's opinion, information sharing and related technology (BCT) can improve trust when the partners believe that it contributes to a better performance.

6.2 What Is the Impact of BCT on Trust in Supply Chain

The second question of this thesis was to explore b) What is the impact of blockchain technology on trust in the supply chain. Despite the availability of vast literature on trust, there was no clear understanding of the concept of trust referring to the supply chain partner's relationship. A fundamental issue in the current research on blockchain technology is associated with the vague usage of central terms such as trust and the impact of BCT on trust. Trust is vital in developing a collaborative relationship among supply chain partners. It is important to understand what factors contribute to creating trustworthiness in relationships where information sharing is based on the shared ledger.

The BCT mechanism affects the nature of information sharing, as well as the availability and quality of the shared information. The level of trust in the case companies, as well as the main characteristics of BCT that can impact trust, has been investigated. The findings show the characteristics of supply chain and industries have an influence on the level of trust and BCT technology can be used as a tool to enhance the trust level.

BCT keeps the history of transaction between partners secure by using algorithms, codes and decentralized verification of the transactions. Based on the interviewee's opinions, BCT can contribute to the performance and relationships which can be a driver for increasing trust. However, at the same time, it creates new concerns due to privacy, governance and laws. Blockchain technology cannot guarantee information reliability in the recording. So, blockchain implementations will face several barriers in this case. However, there are a lot of ways to reduce the rate of misleading information by protocols and algorithms.

6.3 Contribution

The aim of the thesis was to explore the nature of trust in the supply chain and the impact of blockchain technology on trust within the supply chain. Researchers are pointing out that companies have challenges in trusting each other for collaboration and information sharing (Wang et al., 2017). The report has generated analysis and given an overview of trust nature in the supply chain by describing the trust models and proposing one investigation model. In general, the literature states that blockchain has a strong effect on trust and the ability to solve trust issues (Weber et al., 2016). The impact of BCT on trust in the supply chain has been analyzed by using the trust models. The investigation model can be used as a basic model for different studies to understand the relationships between trust in professional relationships and other technologies.

6.4 Limitation

Since this study addresses a fairly new topic, there are also some limitations due to insufficient literature and knowledge. A central issue in the current research about the relationships between trust and blockchain is the ambiguous usage of central terms such as trust. The scope of this research was limited, only three companies from three industries were studied, which is quite a small sample. Two of the industries are specific in the sense that both are heavily regulated, which could make the sample biased. The author could not reach more respondents from different levels of supply, especially since trust is a sensitive topic as it discusses the interorganizational factors. Furthermore, the blockchain projects in the selected companies are still in pilot phases which were an important barrier in this research. However, the respondents had good knowledge about and insights into trust-related issues, but still some areas might be uncovered. Only three dimensions of trust have been investigated due to time limitations and overlapping of some of the definitions.

6.5 Quality of Study

The study design should represent a set of logical statements, thus some specific logical tests may be used to determine the quality of the given design. The main practices that the author has applied to increase the quality of research are mentioned (Table 31).

Credibility	Using multiple data sources and conduct multiple interviews with five companies
Reliability	Build an interview guide with a questionnaire before interviews the use of a case study protocol, development of a case study database. Moreover, the survey instruments were applied to all cases as well. For the case study database, a record of each interview was made
Dependability	Is achieved by having the research design
Construct Validity	It has been reached by using multiple sources of evidence, interviews and documents. Important terms have been explained during the interview to each interviewee to avoid misunderstanding The results have been presented for researchers and experts familiar with the pheromone
Traceability	It has been achieved by having Interview protocol and database
Transferability	The generalizability of the findings of this study is limited due to immaturity of BCT and limited number of respondents..

Table 31. List of practice to increase research quality

6.6 Future Research

BCT can bring supply chain transparency to a new level, but presently academic and managerial adoption of blockchain technologies is limited. Many interesting research possibilities await the future, especially after more blockchain applications have been achieved. BCT brings some concerns and complexity in terms of law and regulation in the chain. The regulations about the tasks and information ownership, responsibilities, and decision-making in the supply chain need to be investigated more. This can be an interesting area to develop BCT-related standards for reducing uncertainties and risks. Due to the effect of BCT in changing trust and collaboration, the evaluation of collaboration after implementing blockchain would give some dimensions to the findings of this work, the performance of the chain can be evaluated based on the key factors of each process. Further understanding of what type of application of BCT could be viewed as the trust catalyst could be sought. Many areas are moving toward public BCT, one of them is the healthcare industry. There can be a research subject on the challenges and difficulties in public BCT and healthcare industry. Related to the logistics and supply chain, the applicability of BCT in the reverse logistics field and group purchasing is an interesting area.

6.7 Final Discussion

Many researchers pointed out that trust in SC is a major issue as it needs information sharing of sensitive data and openness between the different parties. This report has discussed the importance of technology in influencing behavioral intention. It is mentioned that BCT improves the level of trust in relationships within SC; however, one hundred percent reliance on the records may not be achieved due to human errors in inputting data. As one of the main conclusions, research is especially pointing out the relationship between trust and information sharing among partners in SC. The degree of information sharing between partners in different industries is varied. Trust is mentioned as an important aspect for managing both positive and negative issues in collaboration with such concepts as increasing profits and occurring risks. One of the drivers to shift traditional information sharing toward BCT is consumers' trust. Nowadays consumers show an increasing interest in knowing the background of products. Therefore, they need to get clear information, for instance, about production and delivery conditions. Companies try to respond to this need by being more transparent in their supply chain. BCT with facilitating transparency and traceability is a solution for improving trust in the supply chain. In this thesis, trust was discussed in two different aspects: trust between SC partners and trust in the platform. The companies presented in the study are at different levels of trust and our investigation model in this thesis showed that investment in BCT can improve the level of trust for them.

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Appendix 1

Interview Protocol

Before the start of an interview, the author proposes to record the conversation. The recorded material is explained to be only available for the researcher during the analysis process and deleted afterward. However, interview participants also get the opportunity to deny recording.

First, a short introduction about myself and the project is explained to the interview participants. Moreover, the research purpose, as well as the research questions, are presented.

In the second step, the interviewees are informed about why they are suitable candidates for our research. It is explained that I conduct interviews with companies that are having experiences with the blockchain technology through being a provider for blockchain solutions or being interested in an implementation of the technology. After the introduction to the interview, the main questions are asked. A general draft of the asked questions is prepared in advance. Nevertheless, since this is a semi-structured approach, questions can be changed depending on the situation. In general, the questions for the interview participants are organized in three main topics: blockchain in general, blockchain solutions in trust issues supply chains, and the relation between trust and blockchain.

Appendix 2

Research Question

User Questions

Before BCT

1. Who are you? What do you do?

2. Is information sharing a critical element in your job?

3. What type of information are you sharing now with your partners? How do you rank the level of long term orientation ?(Direct Partner)

4. What kind of information do they share with you?

5. How does it improve your business in terms of reducing cost and improve performance?

6. Who defines the limitation for your information sharing with your partner?

7. Who analyzes the partner's information?

8. What challenges do you have now with information sharing (Before BTC)?

9. For selecting your partner in the network do you have concerns about their reputation?

10. How do you define trustful partner?

After BCT

9. How do you see the trust changing by BTC?
10. How does BTC affect your intention for sharing information?
11. How will the technological shift toward blockchains affect your behavior with your partner?
12. How will the technological change toward blockchains impact (on) integrity with your partner for cooperative planning (sharing risk and benefit)
13. How will the effect of the quality of data be on your cooperation?
14. Do you think BCT facilitates planning for the future of your partnership?
15. How is the impact of verified and transparent records to your willingness to share more information?
16. How do you see the impact of blockchain on the insurance of your partnership?
17. Blockchain should provide timely accurate and reliable data. How do you think about the impact of that on your partnership?
18. How do you think about the level of your agreement with your partner by BTC? in terms of complexity in contracts
19. Do you think blockchain will reduce the complexity in contracts? How?
20. Do you think Perceived information quality (accuracy and completeness) will impact on your openness for information sharing? How?
21. What are your privacy concerns related to your partner?

22. How equal and timely information sharing affect your perceived risk?
23. Do you have the concern due to hidden actions(insecure transaction, misleading information) by your partner?
24. Do you inform your trading partners in advance of changing needs?
25. Do you share proprietary information with trading partners?
26. Do your trading partners share business knowledge of core business processes with you? 27. Do you keep your trading partner informed about events or changes that may affect the other partners?

Platform

23. Do you think the blockchain is the most efficient mechanisms to maintain trust and security?
24. Do you have concerns about the reputation of your service providers?
25. Do you have concerns about the security of your platform?
26. Do you have concerns about the throughput level? (Blockchains today support very low transactions per second rates, you have to live with existing constraints
27. Do you accept blockchain as a trustful platform?

Appendix 3

Service Provider Questions

Platform

1) Who are you, what do you do?

2) When did you start working with blockchain?

3) How do you work with blockchain in your company (which application)?

4) How do you work as a consultant which proposes different solutions to your clients?

5) Which types of BCT are more requested in your clients?

6) Which kind of clients do you work with? (Typical industries, company sizes etc.)

7) Do you have different approaches for different industries?

8) What are specific industries which might be especially interested in technology?

9) What experiences have you made with the opinions of clients about trust in the platform of blockchain?

10) Do you have to convince them about the security and capability of the BCT?

11) Has the client's trust in blockchain changed over time?

Platform solutions in supply chains

1) In the literature, many scholars stated that companies in collaboration often suffer problems in information sharing and information availability and information quality. What experiences do you have with blockchain applications involving these issues in the supply chain?

2) What kind of opportunities do you see for blockchain solutions to increase the level of information sharing in supply chains?

3) What are the limitations for the technology to building commitment in supply chains? 4) Do your clients already have an idea of how implementing blockchain technology changing trust intention and perceived risk?

5) How is your experience with leveraging information for your clients what are the main concerns?

6) How are the concerns about ownership of the data and information? Do your clients have concerns about terminating the contract with one partner?

7) Do you see possibilities of how blockchain could help more cooperation and integrity? 8) Have you noticed impacts on the commitment between supply chain partners during and after the implementation?

9) Have you noticed impacts on the contract between supply chain partners during and after the implementation?

10) Have you noticed impacts on the communication between supply chain partners during and after the implementation?

11) How much a product which is provided in a shared platform can be reliable in terms of information accuracy and quality?

12) In a shared platform, there is always a dominant partner, do you notice the perceived risk of opportunistic behavior in other partners?

13) Any trust needed in some sense between partners before implementing BCT (service providers vs clients; buyer vs supplier in the SC trust related to the technology/platform) ?

14) Is there any “trust-related differences” between different kind of BCT (like private vs public)

15) Do you have the experience that every potential client directly trust BCT (technology as such, and the different partners' purpose of implementing it) or is this something the service provider has to work on to increase (and then how?).

16. Have you noticed the shift of concern from the central authority to the algorithm that governs user interactions?

17. Do your clients share proprietary information with trading partners?

18. Do your clients share business knowledge of core business processes with you?

19. Do your clients inform each other about events or changes that may affect the other partners?