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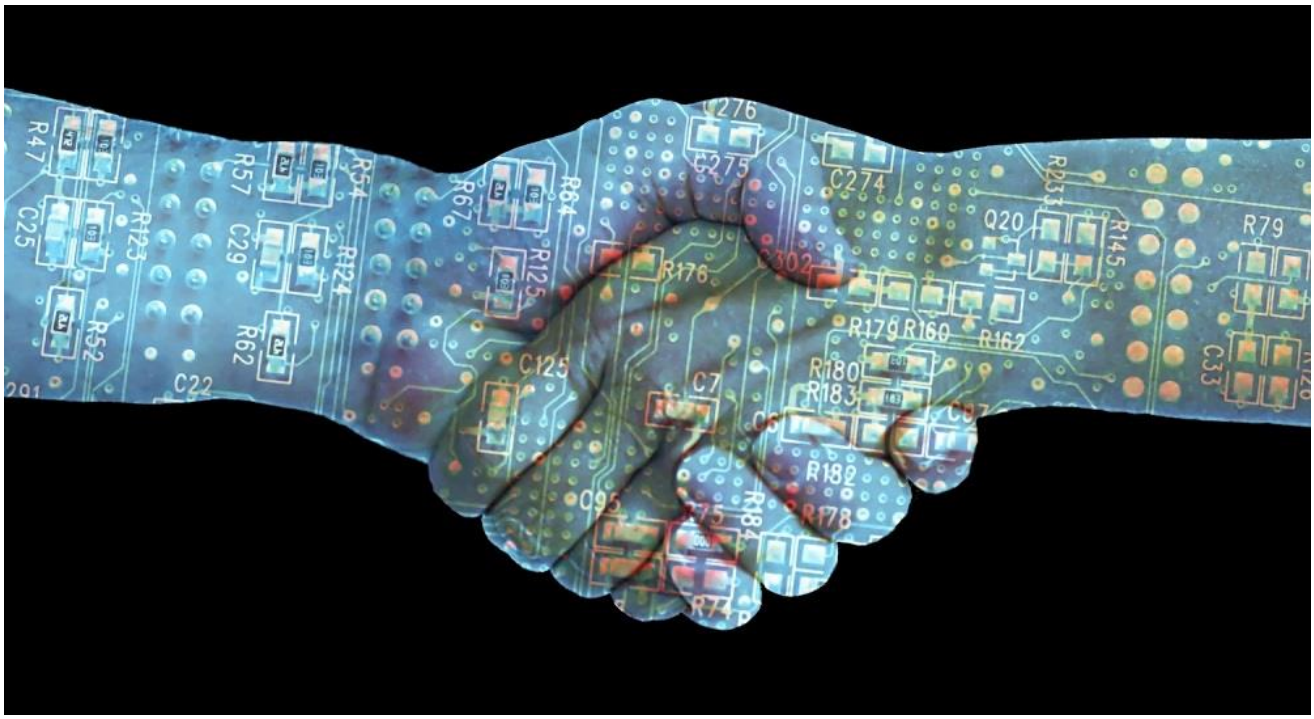

BLOCKCHAIN IN SUPPLY CHAIN

Identification of opportunities with blockchain as a platform of traceability, information and documentation sharing regarding Extra Virgin Olive Oil

Abstract

The focus of this thesis is how blockchain technology influence the role of trust and solve the challenges in tracking and tracing Extra Virgin Olive Oil throughout its supply chain. The outcome is a conceptual blockchain design for COOP Trading.

Pages: 78,8

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1 Introduction

We know surprisingly very little about most of the products we eat every day. Before even reaching the end consumer, products travel through an often-vast process flow of retailers, distributors, transporters, storage facilities, and suppliers, yet in almost every case these journeys remain unseen.

In the beginning, two centuries ago, the supply chain was a revolutionary idea. The idea would improve visibility and control of products through interorganizational exchange, as they moved from A to Z. But this old concept and the inherent technology can no longer support today's production and supply cycles of products, which have become extremely fragmented, complicated process and geographically scattered across the globe (Jensen et al. 2014). The effect is, that supply chains now is a blurred process that is extremely hard to manage for retail businesses, to effectively track and trace their products, and thereby paving the path for fraudulent behaviour (Provenance 1). This is the case for procurement businesses like COOP Trading, who procures products for retail businesses in the Nordics.

One product that COOP Trading procures, has been hit hard by fraud along its supply chain, *Extra Virgin Olive Oil* (EVOO). Reports of fraud (tampering and adulteration) with EVOO is well-known from the recent years scandals of labelling EVOO as lesser quality oils, Italian EVOO not being Italian, withholding EVOO to increase prices and retailers selling industrial olive oil not fit for human consumption classified as EVOO (Squires 2015; Høi 2013). Just this March (2017), the Danish Veterinary and Food Administration action team, found adulterated EVOO´s at Dagrofa and Dansk Supermarked (Carlsen 2017). As of now, there is no reliable way to verify and validate the true authenticity of the products from the suppliers, thus relying more on that "you" *trust* the suppliers. The common countermeasure is that suppliers and retailers make use of certifications bodies to certify and inspect the products´ supply chain process, but that seems inadequate.

This has given rise to an incipient distrust. That retailers, due to the complexity of the supply chain, rely on contracts, certifications and human oversight to reinforce trust, as the EVOO sector suffers from the scandals as a whole. But what does it mean "to trust"? The role of trust can be intangible to measure in

interorganizational exchanges, due to the ambiguity of the word (Seppänen 2005). Trust is a critical factor in interorganizational relationships, that the retailer trust suppliers to deliver the correct product, share correct information and documentation, so retailers can have somewhat of a traceability of the product.

What if a technology could influence the role of trust and improve information, documentation sharing, thereby strengthening traceability? Enter *blockchain* technology. The basic mechanism was originally proposed as part of a solution for administering the shared accounting ledger underlying bitcoin (Nakamoto 2008). This technology, according to its proponents, can revolutionize the supply chain sector. They rely on a completely different system architecture, that makes them a unique platform for applications involving multiple parties in a partnership with little trust in each other, e.g. fragmented supply chains. Numerous companies and retail corporations have already held conferences about the possibilities of this distributed ledger, and invested millions to understand this new technology and possible solutions to their challenges (Ramamurthy 2016).

Can blockchain influence the role of trust in fragmented supply chains? Or maybe, impose a form of *digital trust*? Or fall apart in the pursuit to link the physical and digital worlds? With reference to the proverb *garbage in, garbage out*, that a database is only as strong as the data feed into system. These, and other challenges needs to be depicted, to comprehend the influence of blockchain in supply chains.

1.1 Research Question

It is by the above mentioned, that I build my research question upon. The quest for a new technology to improve the tracking and tracing of EVOO. To explicit the report's approach, a research question has been generated:

How can blockchain technology influence the role of trust and solve the challenges in tracking and tracing extra virgin olive oil throughout its supply chain, and what would a conceptual blockchain design look like?

Elaboration of research question

To elaborate further on the field of the research question, the focus is identification of challenges and opportunities with blockchain as a platform of traceability, information and documentation sharing, regarding EVOO. The case will be EVOO, due to the inherent level of fraud along its supply chain, were COOP Trading is the case partner. COOP Trading grants insights from interviews on the current challenges. From COOP Trading and their suppliers' insights on the supply chain of EVOO, interviews, questionnaires and documents, the thesis will illustrate a blockchain conceptualization as the suggestion on how blockchain might solve the challenges of tracking and tracing EVOO.

The theoretical foundation is trust (Seppänen 2005), as trust is a cornerstone in interorganizational exchanges. With the application of trust, the thesis will to address the ambiguity of trust, qualify what trust is to COOP Trading employees, to how blockchain might affect certain areas of trust. This will serve to generate new theoretical insights on trust (Eisenhardt 2009: 535).

The next section serves to give account for the case partner COOP Trading, to explain the what, why and how.

1.2 Case company: COOP Trading

In relation to the research question, this section serves to inform about COOP Trading. COOP Trading is an independent company, but owned by COOP DK (Denmark), COOP NO (Norway) and SOK (Finland) and only serves these branches in the Nordics, as shown in figure 1. COOP SE is a customer.

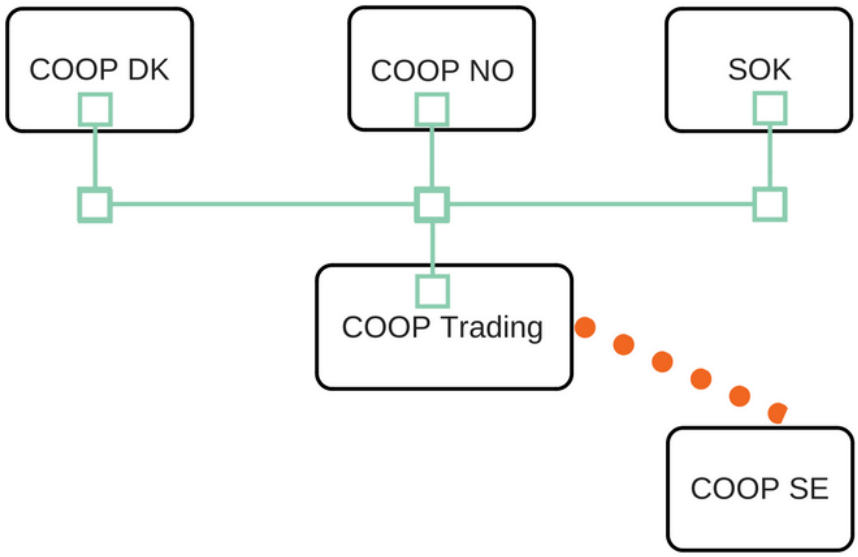


Figure 1

The WHAT

Before I explain COOP Trading, we have to start with COOP as a whole, to grasp the magnitude of their customers and certain values that route through to COOP Trading. COOP DK is the name of the cooperative association (or cooperative) where all of COOP's 1.6 million members are members, but also owners. Every member of COOP can have a say in the association's purpose and structure. The members' ability to exercise their influence is greatly appreciated and a part of the executive management.

COOP in Denmark operates the chains Kvickly, SuperBrugsen, Dagli'Brugsen and coop.dk, as well as the subsidiaries Irma A/S and Fakta A/S. Combined together, that is more than 1,200 stores across the country (COOP 1). COOP and the subsidiaries have an annual turnover of approximately 50 billion

Danish kroner, and in total more than 36.000 employees in total. Combined with Coop SOK´s 1.600 stores (S-Kanava), Coop NO´s 1.150 stores (COOP 2) and Coop SE´s 659 stores (COOP 3), COOP Trading is serving around 4600 stores in the Nordic region.

COOP Trading has its roots in COOP DK, COOP NO and SOK. Traditions and values that today underpin COOP Trading, can be dated back to the Nordic collaboration that began in 1918 when the Nordic cooperative was formed, named NAF. NAF was a trans-Scandinavian organization. Their task was to look after the interests of both buyer and seller, but at the same time exploit the economies of scale that exist in collective procurement.
COOP Trading then formed from NAF, and is now the internordic procurement company for COOP in the Nordic countries. COOP Trading´s task is to secure branded products at competitive prices, and to develop and maintain a varied assortment of *Private Label* products. Private Label is products such as Anglamärk, Xtra, Rainbow and so forth.
COOP Trading has the same roots, regarding the values that characterize the owner organizations. The conviction is that more can be accomplished collectively than individually. COOP Trading purchases for more than 13 million consumers in the Nordic countries. For COOP Trading their focus is, "*care, honesty, influence and innovative thinking in relation to the products we buy and develop are all-important*." (COOP Trading)

The WHY

I contacted Dagrofa, Dansk Supermarked, and COOP when starting this thesis as potential companies with whom I could collaborate with. COOP was my first choice, due to their inventive thinking by a consumer centric approach. Examples of this are a well-developed app for its members (COOP Medlem), and an interactive wall to celebrate their 150th birthday. It seemed logical to collaborate with COOP and COOP Trading, to investigate if blockchain can enhance traceability, so that consumers can buy products more securely, without receiving a lower quality product than entitled, or a product that is detrimental to their health.

A collaboration with COOP Trading also develops insights on case studies of blockchain in supply chain. As the use of case studies on blockchain in supply chains is scarce, the knowledge gained should expand the field of knowledge of the requirements and limitations one might encounter, when conceptualising a possible blockchain solution.
By also looking into trust in interorganizational exchanges, collaborating with COOP Trading also serves the purpose to gather knowledge and insights on trust. Trust is an ambiguous word, so COOP Trading employees will help to qualify what trust is, and examine how blockchain influences that trust.

The HOW

With COOP Trading's focus on innovative thinking, this thesis sets out to investigate blockchain as a new form of supply chain technology for more transparent traceability, improved information, and document sharing on private label EVOO products. This thesis will illuminate the identification of opportunities and limitations with a blockchain solution at COOP Trading.
To investigate the opportunities and limitations, qualitative data from different internal stakeholders at COOP Trading and external suppliers will be examined. This should in the end contribute as valuable insights for COOP Trading for a possible conceptualized blockchain solution. The thesis applies a strong academic approach, to strengthen the insights to academic literature, so it can assist as a meaningful contribution.

To grasp how blockchain might serve as a new technology for stronger traceability, improved information and document sharing, the next section serves as an introduction to blockchain and a literature review of literature on trust.

2 Literature Review

In this chapter, I will introduce *blockchain technology* and *trust in interorganizational exchanges*, which will serve as the basis for the analysis and discussion of the challenges and opportunities of blockchain later in the thesis.

First, blockchain literature will be covered with a brief explanation of the technology, and then exemplified with a case example of *Provenance - Tracking tuna on a blockchain* (Provenance 2).

The second part relays trust in interorganizational exchanges; literature is discussed to gain knowledge on what trust entails and what mechanisms establish trust in a supply chain relationship. The role of trust is chosen, due to the inherent link between blockchain being the "trust technology," and academic literature deeming trust as one of the most critical factors in interorganizational exchanges.

2.1 Blockchain

As the foundation of the thesis, I have gathered documents concerning the topic of blockchain. This was to grasp the field of blockchain and to gain an overview of what agents are talking about blockchain, and what keywords they use in their discourse. This was produced in a former assignment (Petersen 2016) that shaped my understanding and applications of blockchain. This can be read in appendix 1, as the findings don´t have a directly relation to this thesis.

2.2 Trust the code?

This section serves as an introduction to blockchain and the foundation for the next sections of the thesis. It describes and enables one to understand the possible impacts of blockchain. It should be noted that this section is largely based on a former assignment at ITU (Petersen 2016: 12).

2.2.1 How it works

The blockchain technology was invented by a person under the alias Satoshi Nakamoto, to support the cryptocurrency Bitcoin (Nakamoto 2007). For the first time it was possible for many users to trade values with each other over the Internet without the need for a third party or intermediary - typically a

bank - to verify the transaction. A blockchain is a ledger of facts, replicated across several computers assembled in a distributed peer-to-peer network. Or put simply, a chain of blocks (Beck 2017).

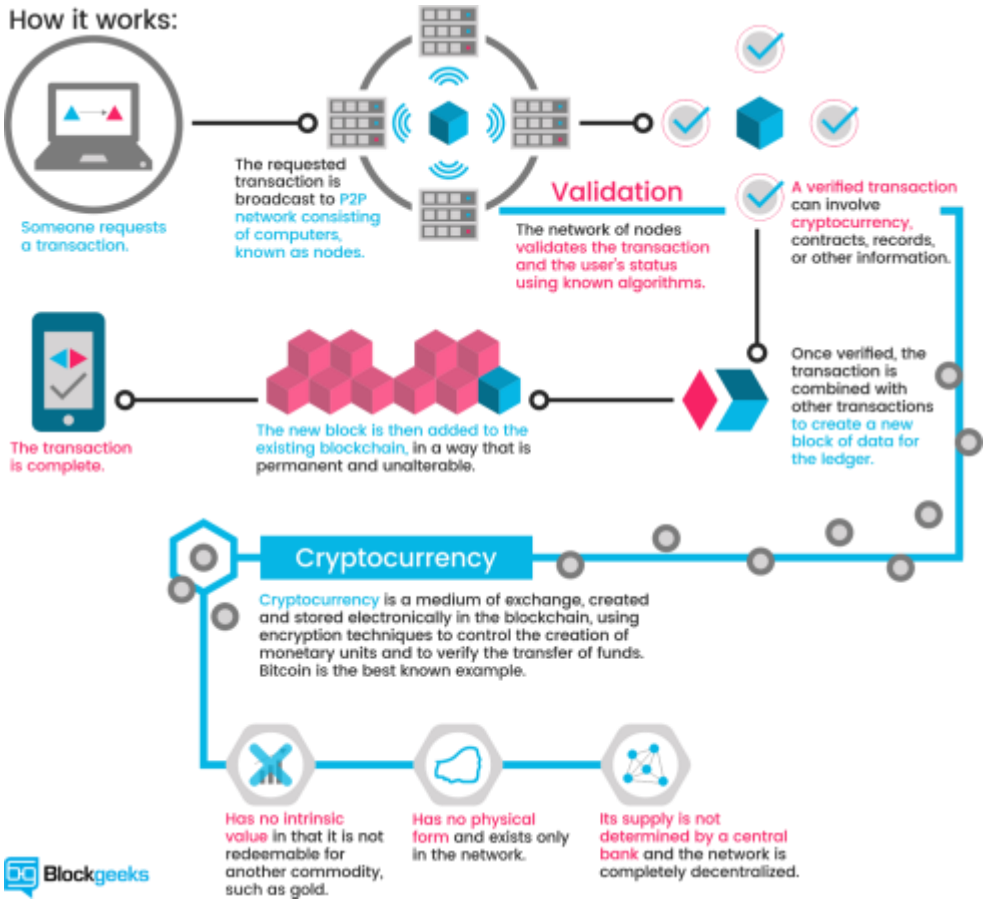


Figure 2: Blockchain illustrated (BlockGeeks)

Anyone participating in a blockchain can review the entries in it; users can update the blockchain only by consensus of a majority of participants. Once entered into a blockchain, information can never be erased (Nakamoto 2007: 2).

Blocks are an order of facts in a network of non-trusted peers, similar to how Uber's technology intermediates between suppliers and consumers of transportation. Facts are grouped in blocks, and there is only a single chain of blocks, which then is replicated in the entire network. Each block has a reference to the previous block, through the hashing cryptography that links the blocks. Some of the

nodes in the chain create a new block with pending facts. They, in the case of bitcoin miners, compete to see if their local block is going to become the next block in the chain for the entire network, called proof of work. Then this block is sent to all other nodes in the network. All nodes run a check on that to see if the block is correct, then add it to their copy of the chain, and try to build a new block with new pending facts (Nakamoto 2007: 3).

But it has gradually become clear that the technique has much broader applications than just acting as the backbone of Bitcoin. One of the key elements is the ledger, which is a database of the content of the blockchain - whether it is bitcoin transactions, intelligent contracts, or something else (Boye 2016).

"We're arguing that it should succeed, because it could help us usher in a new era of prosperity. We believe that the economy works best when it works for everyone, and this new platform is an engine of inclusion" Don & Alex Tapscott (Tapscott 2016: 25)

But there are many ways of applying a blockchain technology, in short, either as a public blockchain, a private blockchain, or as a consortium blockchain. A public blockchain is a blockchain that anyone in the world can read, through which anyone in the world can send transactions, and include transactions if they are valid. Public blockchains are open and are therefore likely to be used by many entities and gain some network effects through that, i.e. Bitcoin. Another major factor of a public blockchain is transparency. As Vitalik Buterin states, public blockchains can: *"(...) protect the users of an application from the developers, establishing that there are certain things that even the developers of an application have no authority to do."* (Buterin 2015).

A fully private blockchain is a blockchain where write permissions are kept "centralized" to one or few institutions, i.e. banks. One of the advantages is that the transaction speed with a privately-run blockchain can be faster than any other blockchain solution, approaching even the speeds of a normal database that is not a blockchain (Buterin 2015).

A consortium blockchain is a blockchain where the consensus process is controlled by a pre-selected set of nodes. An example, is a consortium of 15 financial institutions, each of which operates a node and of which 10 must sign every block in order for the block to be valid. The right to read the blockchain may be public, or restricted to the participants. A consortium blockchain can be altered to fit the need of the one using it. As e.g. the R3 consortium want different "rules", than the Hyperledger consortium or Ethereum Alliance (Buterin 2015 and R3 and Hyperledger).

Public blockchains can offer advantages that a private blockchain simply cannot, and vice versa. This also applies to consortium blockchains. The take-away with the different ways of adopting blockchain technology, in relation to COOP Trading, is what they want to gain from a blockchain solution, who should be a part of it, who should have read and write permissions and what data can't be shared. As blockchains can be altered to fit specific circumstances, one must have a high due diligence in order to research the possibilities and challenges with a blockchain solution.

Factbox:

"A block is the 'current' part of a blockchain which records some or all of the recent transactions, and once completed goes into the blockchain as permanent database. Each time a block gets completed, a new block is generated. There is a countless number of such blocks in the blockchain. The blocks are linked to each other (like a chain) in proper linear, chronological order with every block containing a hash of the previous block."

(Investopedia)

2.2.1.1 Ethereum - A decentralized platform

One of the leading blockchain developers is the Ethereum Foundation. Ethereum was initially described by Vitalik Buterin in late 2013 as a result of his research and work in the Bitcoin community. Shortly thereafter, Vitalik published the Ethereum whitepaper (Github) where he describes in detail the

technical design and rationale for the Ethereum protocol and smart contract architecture. The Ethereum Foundation was crowdfunded during August 2014 by fans all around the world, and now is a Swiss nonprofit with contributions from experts and enthusiasts from across the globe. Ethereum has a mission to promote and support research, development, and education of decentralized protocols with a focus on blockchains. Situated on the Internet, anyone may pay a small fee to its open group of maintainers in order to use Ethereum. Secured and authenticated through cryptography, they argue that it provides an unprecedented opportunity for application as the cornerstones of IoT, Internet-law, smart contracts, and the next digital economy (Ibid).

Ethereum already has numerous companies/projects running their platform based application on its blockchain technology. Many of them are still in the prototype stage, but the vast opportunities with blockchain span from lotteries to supply chains (Ibid).

Due to the vast rise of blockchain technology, Ethereum now has a focus on the enterprise sector. Many enterprises who have implemented private Ethereum networks have either "tweaked" their implementations, or have relied on proprietary vendor extensions to meet their deployment requirements. To respond to the demand, Ethereum formed the Enterprise Ethereum Alliance (EEA) in February 2017 (Weare 2017). The alliance includes large established organizations like Microsoft, J.P. Morgan, Intel, Thomson Reuters and blockchain startups like BlockApps, String Labs and ConsenSys. This is to accommodate the need for *Pluggable Consensus*, *governance* and *interoperability* between blockchains. It is needed to find mutual ground, so the different sorts of blockchains can communicate across sectors and countries, otherwise known as blockchain interoperability. EEA is seeking to provide a platform not only for the technology, but also to provide the governance and tools to create a standard for enterprise blockchain adaptation (Weare 2017).

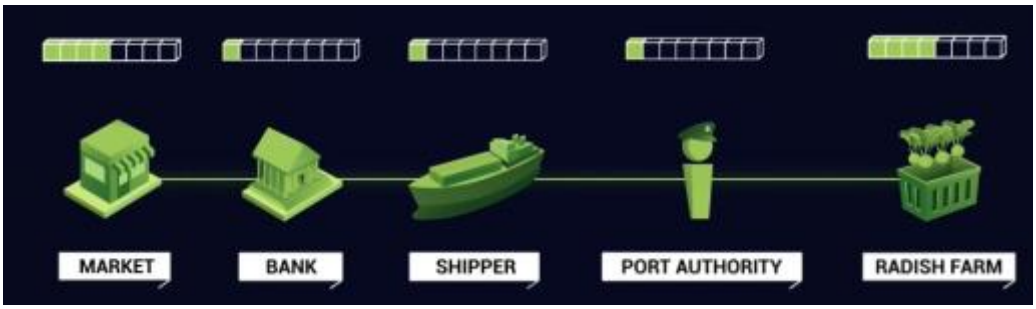
2.2.1.2 IBM - Hyperledger Fabric

One of the first agents looking to profit from blockchain technology is IBM. By partnering up with the Linux Foundation, IBM is a part of the Hyperledger Project. Their aim as an open source collaborative platform is to create cross-industry blockchain technologies including finance, banking, IoT, supply chains and manufacturing (Hyperledger).

Hyperledger Fabric work started last year (2016) with a simple framework to test the interaction between applications and secure blockchain networks, which then allowed them to test use cases in supply chain, capital markets, manufacturing and healthcare (Ibid).

IBM is aiming to deliver BaaS (Blockchain as a Service) to companies worldwide, but also know that there is business-critical information that needs to be linked between parties. They learned that permissioned blockchain networks that require every peer to execute every transaction, maintain a ledger, and run consensus cannot scale very well and cannot support true private transactions and confidential contracts. To combat this, the Hyperledger community designed Fabric ver. 1 to deliver; *a truly modular, scalable, and secure foundation for industrial blockchain solutions* (Ibid).

Hyperledger Fabric is handling the cloud solution, with IBM believing they can make it even safer by offering an additional set of security services inside the IBM cloud (Miller 2017). As pictured below, a products' supply chain is handled by many participants along the journey, but not all need to “see” the price of the product, so only those who need the specific information will receive it, as displayed by the green boxes. The farm and the market exchange more information with each other, and less with authorities and banks (Powers 2016).



(Powers 2016)

An example of this is Walmart teaming up with IBM and Tsinghua University in Beijing to look into digitally tracking the movement of pork in China on a blockchain (Hackett 2016). Blockchain technology, according to Paul Chang, supply chain lead at IBM, is designed to provide the retailer, e.g. COOP Trading, with a way to indelibly record a list of transactions indicating how a product has flowed through a commercial network, from farm to fork (Ibid).

"The missing piece was a shared forum where companies could begin to see each others' transactions and develop trust" Chang argues, and *"that missing piece is something like the blockchain"*. Blockchain is presented as a substantial improvement over earlier projects that solely used barcodes and radio ID tags (Ibid).

Advocates argue that with the information stored on the blockchain, fraud and inaccuracies are much harder to get away with (elaborated on in 2.2.1). The information includes, but is not limited to, details related to farm origins, factory data, expiration dates, storage temperatures, and shipping details (Ibid).

2.2.2 Smart contracts

Before we deal with 'smart contracts', I have to describe 'multisig'. Multisig lets parties use multiple authenticating signatures or keys rather than a single private key to be able to complete a transaction. This is what the community usually refers to as a multiple-signature, multisig. In short, a multisig is like a lockbox requiring multiple physical keys to open. So when Bob and Alice, with a third-party (blockchain), decide to transfer funds, Alice would send her e.g. bitcoin to Bob, which can be viewed by

everyone, but no one can access it. Once Bob sees the funds have been posted, he can fulfill his end of the bargain. But if a disagreement arises and Alice feels the product is not up to standard then Bob and Alice can look to the smart contract as a third-party arbitrator, to help solve it (Tapscott 2016: 104 & Zaninotto 2016).

In Ethereum, each contract carries a mini-database, and exposes methods to modify the data. As contracts are replicated across all nodes, so is their database. Each time a user calls a method on the contract and therefore updates the underlying data in the contract, the command is replicated and replayed by the entire network. This allows for a distributed consensus on the execution of a promise (Tapscott 2016: 105).

This idea of pre-programed conditions, interfaced between users, and then broadcast to everyone, is called a smart contract. A contract is a promise that signing parties agree to make legally-enforceable. Proponents of smart contracts claim that many kinds of contractual clauses can be partially or fully self-executing, even self-enforcing, or both. The aim of smart contracts is to provide security, which is superior to traditional contract law and to reduce other transaction costs associated with contracting (Tapscott 2016: 105-108). Buterin explains it as: *"(...) then we can cut costs to near-zero with a smart contract."* (Parker 2016).
Notedly, smart contracts don't make anything possible that was previously impossible, but they solve the common problems in a way that it minimizes trust issues. Minimizing the possibility for trust issues and subjectivity makes things more convenient, by allowing human judgments to be taken out of the loop, to prosper from complete automation (Baker 2015: 361). Nick Szabo, widely credited for developing the idea of self-executing smart contracts, imagined in the mid-1990´s smart contracts to utilize objective "if-then" techniques, as he states: *"When a pre-programmed condition is triggered, the smart contract executes the corresponding contractual clause"* (Baker 2015: 361).

Factbox:

"An asset or currency is transferred into a program and the program runs this code and at some point it automatically validates a condition and it automatically determines whether the asset should go to one person or back to the other person, or whether it should be immediately refunded to the person who sent it or some combination thereof."

(BlockGeeks)

2.2.3 Provenance - Tracking tuna on the blockchain

To further clarify the origin and what has shaped my scope of interest of this thesis, I will refer to the pilot study completed by Provenance, as this thesis will draw upon parallels from their approach and findings. This chapter will be largely based on a former assignment (Petersen 2016).

The pilot study is called *From shore to plate: Tracking tuna on the blockchain*. This chapter will shortly outline the case. All information regarding it comes from Provenance's own description of the case. Provenance is *"(…) a framework for knowledge."* (Provenance 3) and their goal is to provide the possibility for open and accessible information about businesses' products and supply chains, through a transparency-enabling technology.

The WHAT

The case was a 6-month long pilot project conducted by Provenance in May 2016 in which they show how blockchain technology can trace yellowfin and skipjack tuna fish in Indonesia, from shore to plate. The project aimed to show how mobile, blockchain technology and smart tagging could be used to track each catch by a verified fisherman right into the hands of a consumer and thereby illustrate how blockchain technology can aid in creating an open system for traceability for, in this case, tuna and other physical goods and items. Provenance's goal with this pilot project was to provide a solution for visibly tracking goods securely in a format that would not require a data management system. The pilot

project was successful as it found that blockchain technology could live up to the need for a thorough and easily-accessible format to trace complex supply chains end-to-end.
The pilot study has assisted with framing my thesis, and shaped my research methodology by understanding and learning how Provenance went about gathering information.

The WHY

In Indonesia, tuna fisheries are considerable sources of employment for the 60 million people living in coastal communities, but slavery, overfishing, unregistered catches, etc., are threatening the seafood industry on several fronts.

The problem with tracking the supply chain from the catch of the fish to the consumer eating it is that the only way to get the data and transaction transparency is through a governing third party, but these organisations or NGO's or industry associations would in the end become a point of weakness vulnerable to hacking, bribery, or incompetence. Therefore, Provenance explains blockchain technology as the solution to traceability where no single stakeholder has the only key to the backdoor of the system, i.e. seemingly no points of weakness.

The pilot project aimed to make all data interoperable throughout the entire supply chain between all actors and systems. This alternative method would store all data with a batch ID - identity of the fishermen catching the tuna, the location of the item, material attributes, certifications and audit information - in a decentralized format protecting all identities of involved parties and thereby secure all data verifications.

The thesis aims to investigate the same issues, but with a focus on EVOO, because the EVOO in your kitchen marked "Extra virgin olive oil" is very probably a fake, or of lesser standard. Either it's low quality falsely marked as virgin or extra-virgin, or has maybe even been mixed with other oils of dubious provenance (Høi 2015). So I investigated to understand the complex supply chain of EVOO, to learn how to gain greater traceability, information- and documentation sharing. This is to understand

how a blockchain solution might assist COOP Trading, both internal and with external suppliers, to have the right and truthful information about an EVOO product.

The HOW

In their pilot project Provenance investigated all the phases of the supply chain, which this thesis also aims to do, as in depth as possible. This serves to understand how Provenance aimed to implement a blockchain solution after their investigation. Which is what this thesis ultimately should conceptualise for COOP Trading.

Provenance found three phases (figure 3):

- Registration and data collection from the "first mile".
- Linking the blockchain with existing systems.
- The consumer experience and building an interface for trust.

The first phase had the aim of registering the fishermen's tuna catch with a simple SMS from the fisherman in question. This SMS would become a new asset on the blockchain, accompanied by a permanent and unique ID, which would link the fisherman with the asset forever. The asset would then be transferred from the fishermen to the supplier in question - physically and digitally. The fisherman and the supplier is thereby linked as well on the blockchain. The next step is the verification of the social and environmental conditions of the fisherman by a local NGO. The NGO is then validated in regards to their compliance to external standards. Provenance argues then that their platform and system is a 'standalone'.

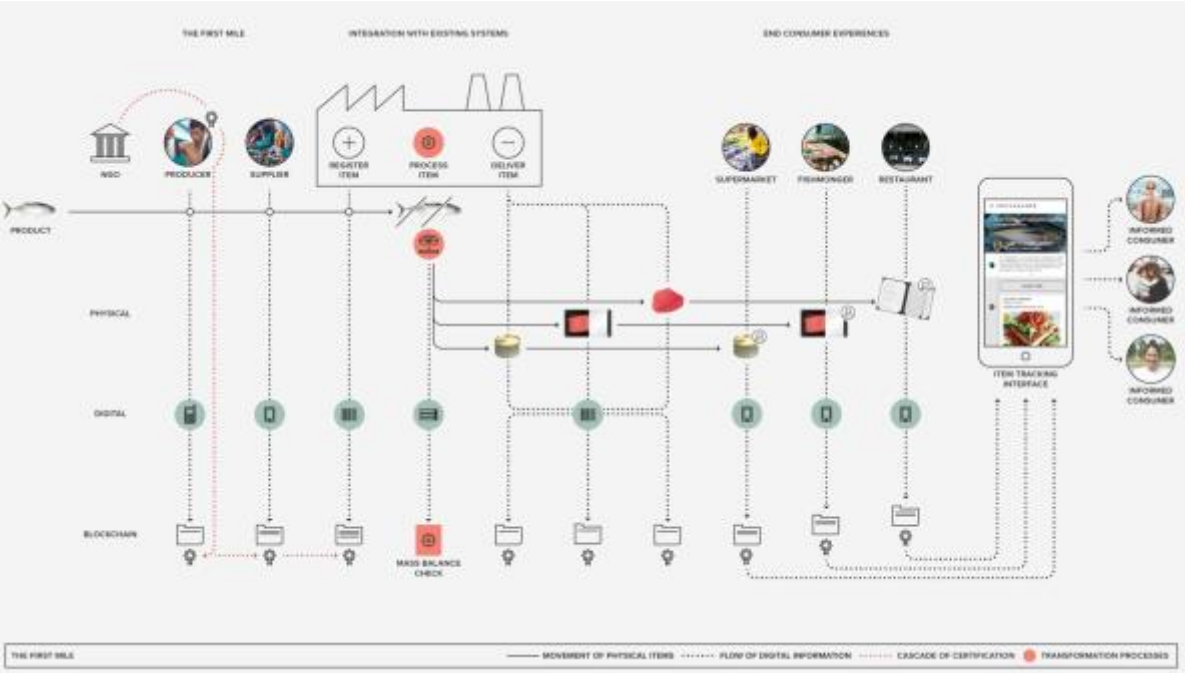


Figure 3 (Provenance 3)

The second phase of the project was to link existing systems such as ERP (Enterprise Resource Planning) systems to the blockchain to ensure total interoperability. The blockchain allows for an audit layer, which rests on top of ERP or other managements systems, to share the data all the way throughout the supply chain. A complete record of the asset from start-to-finish is then accessible without the need to juggle several existing interfaces, as it is all gathered in one place.
The third phase in the project was to look into the very last step in the supply chain: the consumer. Even though this is an important part, but due to the focus of this thesis, it will not be illustrated as Provenance have, as it is deemed more important to investigate the production. The solution by Provenance was to use smart stickers on the products and in-store tablets for the shoppers to view the stories of each product from their smartphone, to access the complete start-to-finish chain of supply.

In summary, the thesis draws upon parallels and the “Proof of Concept” (PoC) from Provenance, which needed to be elaborated as this has inspired and shaped my focus of field of study. This is particularly true regarding the interview guide, where their knowledge and former assignments has inspired the interview guide used here. I don't see this as a limitation, but a way to help narrow the scope, to utilize

their knowledge and build upon that to gather deeper, more supported insights to add the literature of blockchain in supply chain as a whole.

2.3 Theory - Trust in interorganizational exchange

The role of trust is chosen, due to the coherence with blockchain technology, as this technology might provide *digital trust* in inefficient interorganizational exchanges. There are major issues with interorganizational exchanges, where friction and uncertainties make supply chains and international trade inefficient. An analysis made on international trade (Jensen et al. 2014) investigates that issues span from peer to peer communication between the participants, manual retyping and copying of information, and different communication channels with limited access possibilities, e.g. paper versions of certificates and declarations still have to be in original version on official paper with stamps and signatures for every imported container. The analysis (Jensen et al. 2014: 22) shows a fragmented landscape of information and documents which are communicated through various forms of communication, ranging from telephone calls to faxes, from e-mails to physical papers, etc., or can only be accessed in certain information systems by actors having the right permissions.
So how can we restore or strengthen trust in supply chains in interorganizational exchanges? The pressure is high to deliver efficient and transparent supply chains, and blockchain might serve that purpose. With immutable records on every aspect of a transaction: from the source of the raw material to where and how the products are manufactured, to their distribution, maintenance, recall and recycling histories, blockchain could be the new basis of trust. Information about ownership, origin, contracts and price are also all held in the blockchain (Lehmacher 2017). But before I can analyze the effect of blockchain on trust, trust will have to be further explained.

The role of trust is hard to make tangible in interorganizational exchanges. Trust can have numerous meanings and many different forms, but is a critical factor in interorganizational relationships (Seppänen 2005: 249). This chapter serves as a theoretical underpinning to explain the meaning of trust in interorganizational exchanges. First, empirical research on measuring interorganizational trust

is presented, to clarify the different aspects of trust. Following this, the mechanisms of trust in interorganizational relationship are examined, looking into the key terms where blockchain might influence trust. Consequently, the last part is a discussion on how the role of trust is influenced, partially or fully, by blockchain technology. This serves to gather new insights on trust, to compare theory and data-iterating, building a theory which will be more closely fit due to the data collected (Eisenhardt 1989: 541).
Related to the case, this should serve to gain knowledge about the role of trust in the supply chain of EVOO for COOP Trading, as to identify how blockchain technology can help with strengthening traceability, information and documentation sharing.

2.3.1 Measuring interorganizational trust

Many researchers have identified certain critical success factors for interorganizational relationships. One of the most critical is trust. Seppänen, Blomqvist and Sundqvist (Seppänen 2005) analyzed the theoretical approach, the conceptualization, and operationalization in studies on interorganizational trust conducted from 1990-2003. They state that trust facilitates more open communication, information sharing and conflict management (Seppänen 2005: 249). In general, their focus on trust is seen to reduce transaction costs; the more individuals can rely on each other, the lower the transaction cost. Despite the increased interest among academics, the theory of trust is still in development. Researchers on the topic disagree on the nature and definition of this complex concept. Studies conducted so far take very different approaches depending on the researchers' different theoretical backgrounds and the chosen empirical context. Despite the acknowledged role of trust, there have not yet been any theoretically and empirically coherent attempts to measure trust in an interorganizational context. For this reason the authors collected studies deemed relevant to explore the role of trust in interorganizational relationships.

Trust-studies in disciplines of psychology, social psychology, and sociology have influenced trust literature in the field of business studies and economic approaches. Understanding the social mechanisms behind the collaboration between the actors of different organizations is at the core of

trust research. But even if similar theoretical approaches are used, trust is not necessarily defined in the same way. It is conceptualized in most studies as a multidimensional construct, yet the content, role and number of dimensions are not universally agreed upon. As shown in figure 4, Seppänen et. al. have divided the studies into sociological/psychological approaches, economic approaches and in-between.

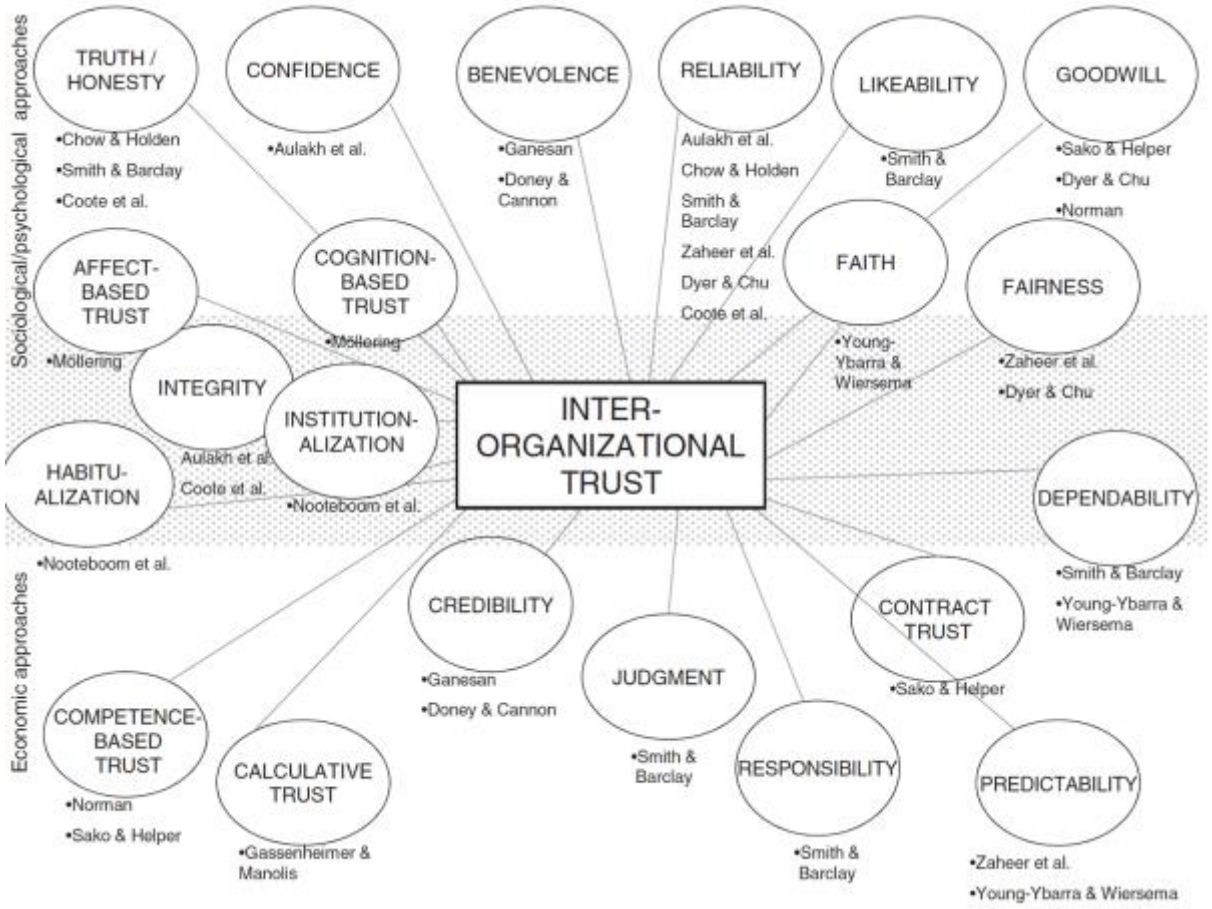


Figure 4 (Seppänen 2005)

The most common factor from the studies, seem to be *reliability*, yet Seppänen et al. argue that there seems to be no consensus on the semantic meaning of these words. As an example, some authors use the terms capability or ability, instead of competence or credibility in their conceptualization of

reliability. This overlapping use of vocabulary makes the assessment of trust-measurement efforts very difficult (Seppänen 2005).

Seppänen et al. organized antecedents, dimensions, and consequences of trust by the authors in the figure 5 below. They state that one of the major reasons for the ambiguity and confusion in defining the antecedents, dimensions, and consequences of the trust construct could be causality. This suggests that, partially, trust is a reciprocal concept, being potentially both a cause and partly an effect in interorganizational relationships.

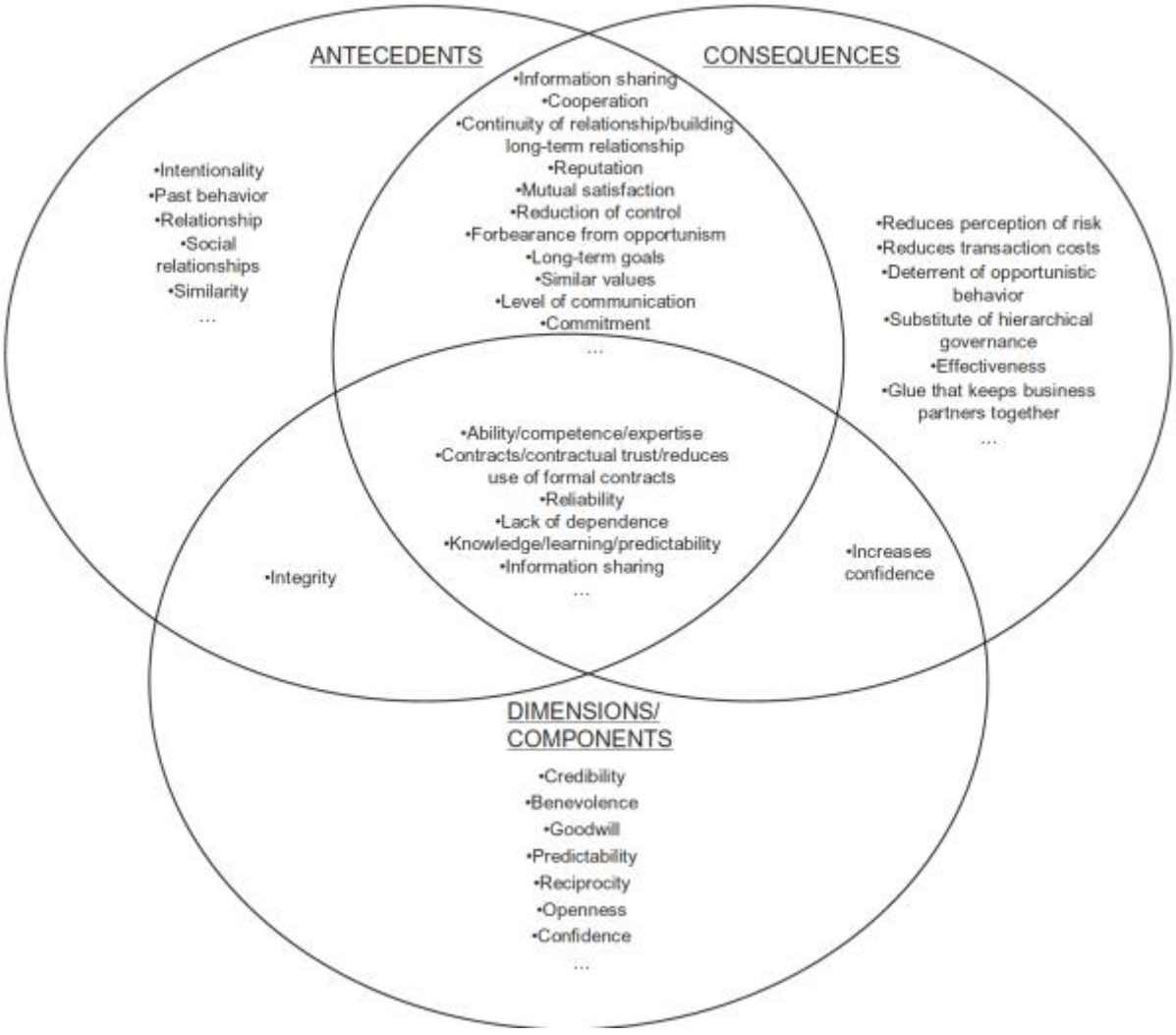


Figure 5 (Seppänen 2005)

All in all, the review by Seppänen et al. revealed a great variety of conceptualizations and operationalizations in attempts to measure interorganizational trust, but also demonstrated just how much variation there is in academic attempts to define trust.

2.3.2 Mechanisms of trust

This section will introduce the many approaches to how trust can be established. In general trust can either contribute with positive or negative effects on the relationship in a supply chain. Seppänen et. al. highlighted the different approaches, but only a few will be analyzed further, as they are deemed most relevant to depict in relation to a blockchain conceptualization, and due to the scope and time constraint of this thesis.

As stated above, trust is hard to measure and define, but focusing on certain aspects of trust will help to narrow the scope and specify the possible contribution made by blockchain. The aspects examined, in relation to figure 4, are: *Contract Trust, Predictability* and *Dependability*.

2.3.2.1 Contract Trust

Mari Sako (Sako 1998) empirically tested if trust improved business performance, by doing a large-scale survey. In her research paper, Sako states that trust is the expectation that a trading partner will behave in a mutually acceptable manner (Sako 1998: 3). Furthermore, she also investigated *predictability*, and how to minimise *opportunism*, were opportunism is practice of exploiting circumstances in self-interest. Sako categories other factors of predictability; “contractual trust”, “competence trust” and “goodwill trust”. Contractual trust is if the other party will carry out its contractual agreements, and rests on a shared moral norm of honesty and promise keeping (Sako 1998: 3-4). Contractual trust is a governance mechanism, where it acts as a safeguard against opportunistic behaviour.

The survey found that written contracts did not have any significant impact on opportunism nor trust. This is partially due to the fact that when other mechanisms are present, contracts as "stand-alone" fail to be sufficient to enhance trust or be a safeguard to attenuate opportunism. A possibility could be that the actual content of the contract may differ, so the more explicit the content, the greater the effect (Sako 1998: 18).

The effect of a contract is something that Rosalinde Klein Woolthuis et. al. has analyzed (Woolthuis 2005)[1] by examining how trust and contracts are related. In their investigation, they looked into how and why trust and contracts can substitute or complement each other, and how the various combinations of trust and contracts affect a relationship. They conducted longitudinal case studies that revealed the relationship between trust and contracts as complex. Their findings were that trust and contracts can be complementary or act as substitutes for each other (Woolthuis 2005: 813).

Another aspect, as a reference to Sako´s definition stated by Sitkin & Roth (Sitkin 1993), is the use of contracts as a legalistic mechanism in interorganizational relationships, to counter where trust is lacking or as a substitution. With the lack of trust, trust can take the form of governance mechanisms, which focuses on the use of formal (often legalistic) mechanisms that serve as administrative or symbolic substitutes for trust that can enhance the legitimacy of an otherwise suspicious relationship (Sitkin 1993: 369). Sitkin & Roth suggest that legalistic responses are more or less effective: *depending on the specific nature of the expectations that have been violated* (Sitkin 1993: 370). Trust can be restored when violations are specific to a particular context or task (e.g., the use of contractual product-specific quality standards). This notion is also illustrated by Handfield & Bechtel (Handfield 2001), where contracts are a known method of creating trust, and detailed, signed contracts will potentially increase the buyer's perceived level of trust in the supplier (Handfield 371). However, Sitkin states when more sociological/psychological values are violated, e.g. trustworthiness, then legalistic remedies are ill-suited to restoring lost trust (Sitkin 1993: 370). Contracts are best suited for a particular context or product-specific situation.

[1] It should be noted that the text by Woolthuis et. al., is not part of the Seppänen study, as this text was published in 2005.

2.3.2.2 Predictability

"*You know in advance that it will happen or what it will be like*", states the Oxford Advanced Learner´s Dictionary about predictability. In relation to figure 4, Zaheer et al. (Zaheer 1998) and Young-Ybarra & Wiersema examined the role of trust, where they looked into the influence of predictability (Young-Ybarra 1999). For Zaheer et al., predictability is when a partner in an interorganizational relationship will behave in a predictable manner, and will act and negotiate fairly when the possibility for opportunism is present (Zaheer 1998: 143) even though the possibility of betrayal is present. This is the probabilistic element of trust; to take a *leap of faith*. It is when one places confidence in a relationship without knowing with absolute certainty that the future actions by the other partner in the relationship will not produce unpleasant surprises (Zaheer 1998: 143). This was examined by investigating if there was a relation between interorganizational trust and interpersonal trust. Their findings were that the more the buyer trusts the supplier representative with whom the buyer deals with, the more the buyer's organization (COOP Trading) trusts the supplier organization (EVOO supplier). This relationship can operate in the opposite direction as well, suggesting mutually reinforcing effects of trust at the two levels, i.e. reciprocal effects (Zaheer 1998: 153).

Similar to Zaheer et al., Young-Ybarra & Wiersema also apply predictability as part of trust (Young-Ybarra 1999: 443). In their study, trust positively impacted transaction cost economics. Being in an alliance or partnership entails vulnerability. Therefore, parties will seek ways to associate with partners that exhibit characteristics of dependability and predictability, even in unforeseen situations. They argue that partnerships that exhibit trust will survive greater stress and will display greater adaptability (Young-Ybarra 1999: 443).

Associating with partners that exhibit predictability can also strengthen one's access to information. As a reference to Zaheer on predictability, Ring & Van de Ven (Ring 1992), state that parties with successful transactions are less likely to suffer the adverse effects of information asymmetry. When sharing information, a reduction in technological or commercial risk compels parties to not act opportunistically when given access to proprietary information. This enables the same parties to view the information they received from each other as more reliable, which is necessary in establishing trust (Ring 1992: 489).

2.3.2.3 Dependability

Some of the aspects of trust overlap, so when Young-Ybarra & Wiersema examined the role of trust, their definition also contained dependability. Young-Ybarra states that dependability refers to expectations that the partner will act in the alliance's best interest (Young-Ybarra 1999: 443).
J. Brock Smith & Donald W. Barclay (Smith 1997) investigated the effects of organizational differences and trust, with a focus on the effectiveness of selling partner relationships. Here dependability was a component of their definition of trust. They examined how perceived trustworthiness can alter one's assessment of the professional reputation of a partner in an interorganizational relationship (Smith 1997: 6). Specifically, differences in professional reputations may help parties assess each other's dependability (and reliability), as well as their selling and business skills, which can influence the perception of the appropriateness of partner behaviours and decisions. Professional reputations are known to and are used by companies and persons in making decisions about exchange relationships (Smith 1997: 10). Smith's research found some aspects of perceived trustworthiness are better predictors of trusting behaviours than others. Most notably, dependability still remained as an important relation to perceived trustworthiness (Smith 1997: 16).

Summary

Companies that are involved in a collective relationship of any kind, are twofold. On the one side, they are supposed to collaborate and cooperate for common ends. However, they are likely to have conflicting interests, because at the same time they are either competing on the same markets or even selling to the same clients. They may also have diverging goals, which can lead to an increase or decrease in the trust between the companies. All these sources of ambiguity may undermine reciprocal trust and raise the scope for opportunistic behaviours by a company in the supply chain.

By limiting the scope of examining interorganizational trust with an economic approach, this thesis diverges from more "intangible" sociological and psychological aspects. With more "tangible" aspects, contract trust, predictability, dependability, the scope is focused on an economic approach. This is due to the possibility of an economic gain with blockchain, that a higher degree of trust is the mean

towards an economically gainful end, e.g. lowering transaction costs. In other words by Seppänen; *"the economic approach to trust is often calculative, emphasizing its risk-decreasing nature, and enhancing the prediction or expectations of the other actor's future behaviour"* (Seppänen 2005: 254).

2.4 Blockchain influence the role of trust

With the emergence of information technology, such as the personal computer, optical fiber networks, the explosion of the Internet and the World Wide Web, the cost and availability of information resources allows easy linkages and eliminates information-related time delays in any supply chain network. Therefore, companies are looking to new technologies to reduce supply chain cycle time and increase *digital trust*.

These technologies are supply chain "enablers", in that they can substantially reduce paperwork (e.g. contracts back and forth), improve communication, and reduce supply chain cycle times if properly implemented. For blockchain to work, an important requirement is that buyers (COOP Trading) develop relationships with suppliers (EVOO), to share and receive information and work in a collaborative manner to improve efficiency and increase digital trust (Handfield 2001: 368).

This trusted distributed ledger, blockchain, can remove the need for reconciling each transaction with a supplier, which will minimise errors and increase trust. Blockchain can also implement business rules, *smart contracts*, which means a transaction only takes place only if two or more participants endorse them, or if another transaction has been completed first, due to the hashing method (Economist 2015).

Trust is the key element of blockchain technology; to trust the code. When transactions are executed and settled on a distributed ledger, suppliers and buyers do not need to have an established trust relationship. If each participant in the transaction trusts the blockchain itself, then they do not need to directly trust each other (Leibowitz 2016).

If blockchain can acquire that trust between buyer and supplier, then trust can be shifted from, or contain, contract trust, dependability, predictability and so on. It will enable all involved parties to trust technology as the underpinning of the relationship between companies in the supply chain.

With a critical lens, it is hard to qualify trust, as there are numerous approaches to how it is measured, and it is both a cause and an effect in partner behaviour.
Furthermore, cultural matters are seen to affect trust. Trust can be perceived by the individual respondent, and is based on his/her personal values. National culture can affect the role and nature of trust, and how trust can be perceived. It is proposed that the individual's experiences, analytical skills, and judgment may also affect trust (Seppänen 2005: 261).
The impact of the industry culture, the organizational culture, and the professional subculture, may also have an effect on the respondent's view of trust. Blockchain might be the simple process that has the potential to transform how people and companies cooperate in a supply chain (Seppänen 2005: 261).

The role of trust is a part of the analysis due to the core component of identifying opportunities and challenges with blockchain as a platform of traceability, information and documentation sharing. Trust serves as an important theoretical foundation, with particular focus on the three aspects examined, contract trust, dependability and predictability, due to the collation of the field of study of identifying opportunities and challenges with a possible blockchain solution.

To gain a strong academic approach, the next section serves to explain the methodology applied in the thesis.

3 Framing of the thesis

This section serves explicitly as the framing of the thesis, the fundamental methodological considerations behind the thesis. First, the theory of science is briefly applied, which leads to a description and elaboration on the unit of analysis. With a point of departure in the unit of analysis, I will then elaborate on the methods used. In the last part, I will briefly summarize the narrative structure of the thesis.

3.1 Theory of Science

The thesis is based on my curiosity about new technological breakthroughs which will architect the future in numerous ways. It is driven by my desire to understand the practice and the challenges that come with breakthroughs and I therefore seek a greater understanding of how they affects a given context.
I have mainly been exploratory in the beginning, where the literature on the field is examined.

Forming the thesis has changed my insights and ideas, due to new and expanded knowledge. This means that I have had to expand, reassess and redefine some of the first assumed conceptions I had. This methodological approach is termed *abduction* and is one where there is a constant alternation between research, my preconceptions and the methodological approach.

As any researcher, I have my preconceptions, from former research and assignments in the past. I can not leave out of account that I have preconceptions, as I can not disconnect from what I have already learned. Instead, I remain aware of it and keep an open mind during my research and production of this thesis.

3.1.1 Abduction

Abduction is the fluctuation between inductive and deductive approaches. A deductive approach explores the relationship between theory and research in which the latter is conducted with a

reference to ideas and/or hypotheses from the former (Bryman 2012: 711). An inductive approach is the opposite, in which theory is generated from research (Ibid: 712). Abductive reasoning has strong ties to inductive, as I ground a theoretical understanding of the context and people that I study, the language, meaning, and perspectives that form their worldview (Ibid: 401). What distinguishes abductive from inductive, is that the theoretical account is grounded in the worldview of those one researches (Ibid: 401).

Preconceptions I had before this thesis have assisted in shaping the field of interest. I have produced several assignments where blockchain was the focus, exploring its potential as a business model and the social context blockchain is developed in (Petersen 2016). In particular, I reflect on a former assignment regarding Provenance, and their vision for a new supply chain utilizing blockchain (Petersen, 2016). Therefore, Provenance was depicted in section 2.2.3, as it has shaped my understanding of the potential of blockchain, in connection to supply chain.

3.1.2 Questioning Technological Determinism

As I am researching how new technology might alter how we share information on products, my stance is that we need technology to handle this. This section contributes to a critical point of view of new technological advancements, that can enhance “digital divides“ and is the force driving change.

Anyone who owns a computer knows how much they have influenced and altered the texture of our daily lives. Even those who do not have a computer, have to accommodate to their (computer) ways of requirements, whether it be at the bank, airline, hospital and so forth (Marx 1998; X). We are relying more and more on Information Technology to take care of our daily lives, and assist us at work. There seems to be an implicit assumption that technology provides the only feasible solution to our complex problems, (Miranda 2009; 25) and that information and communication technologies possess quasi-magical powers that provide the solution to the world´s greatest problems, and even our daily problems (ibid: 25). There is the belief that the technological change is a rational, objective and

inevitable process, which is the constant driver of social change. But there are winner and losers in this process. Those who are the drivers, that pursue change with new technological advancements and have the power to decide, will set the standard. Those who are driven, have to adapt and be the bystander of what the technology might inflict on their daily lives (ibid: 37).

In relation to this thesis field of study, blockchain might be perceived as a technology that possess quasi-magical powers, in this pursuit to greater trust between partners in the supply chain of EVOO. But there will be winners and losers in this change, of letting a new technology be a digital opportunity. This section requires that I remain critical of my findings, as I not only consider the possibilities with blockchain technology, but also cast a light on its limitations and challenges, as to get a more nuanced picture of the end result of the requirements and recommendations when I analyze the findings.

3.2 Research design & methodological approach

In this section I will explain my choice of the case study as a research design. I will apply Robert K. Yin's "Case Study Research" (2009) to frame the study of case. In addition, I will elaborate on the methods I have used to collect empirical data (Brinkmann 2015; Eisenhardt 1989; Bryman 2012; Corbin 2008; Eisenhardt 2007) to explain the used empirical methods' influence on the process and how I came to my findings. As it might seem, this has not been a linear process, but iterating process going back and forth.

3.2.1 Case study - Robert K. Yin

The thesis makes use of Yin to structure the research design, to enhance and soundly-base the thesis methodology approach as one does in academia.

COOP Trading was chosen due to its partnership with COOP. As the products are purchased, quality-controlled and handled by COOP Trading, it seems logical that my case partner is COOP Trading. COOP Trading also has the authority to choose the suppliers across the range of private label products, which

makes it a decision-maker with the standard of traceability, information and documentation sharing of the products the members want to purchase.

As I want to investigate a "how or why" question, the case study is a particularly well-suited method (Yin 2013: 50). In relation to the research question, the first part is descriptive, *how can blockchain technology influence the role of trust and solve the challenges*, where the second part is explorative, where I want to investigate how a blockchain technology can *solve the challenges in tracking and tracing extra virgin olive oil throughout its supply chain, and what would a conceptual blockchain design look like?*

Yin has four basic types of case study designs; *holistic single case study*, *embedded single case study*, *holistic multiple-case study*, *and embedded multiple-case study*. This thesis is based on the embedded single case study (Yin 2013: 50). The embedded single case study has more than one analysis unit within one case. In relation to the research question, with the case of olive oil I aim to *solve the challenges in tracking and tracing extra virgin olive oil throughout its supply chain, and what would a conceptual blockchain design look like?* The research question thus contains more units of analysis; when investigating the supply chain, the suppliers will also be units of analysis similar to COOP Trading.

The embedded case study approach is found particularly relevant, when a examination of an environment where the boundaries between the phenomenon of interest (EVOO) and context (supply chain) are not clearly evident, due to the complexity of supply chains.

The single case study is chosen due to the limited time frame and as the primary focus is COOP Trading, and its key challenges and possibilities to adapt a potential new technological solution. I do not compare the empirical data, interviews and questionnaires to other similar companies like COOP Trading, which is deselected due to the extent to examine that (Eisenhardt 1989: 534).

The single case also sets out to confirm, challenge or extend the theory. As the information on blockchain technology cases is limited, the thesis aims to explore the initial idea of blockchain as a supply chain technology, but also to challenge the technology to examine its limitations. This should in the end expand the knowledge and domain of blockchain use cases, so insights are gathered to have a more nuanced picture of blockchain in supply chains (Yin 2013: 51).

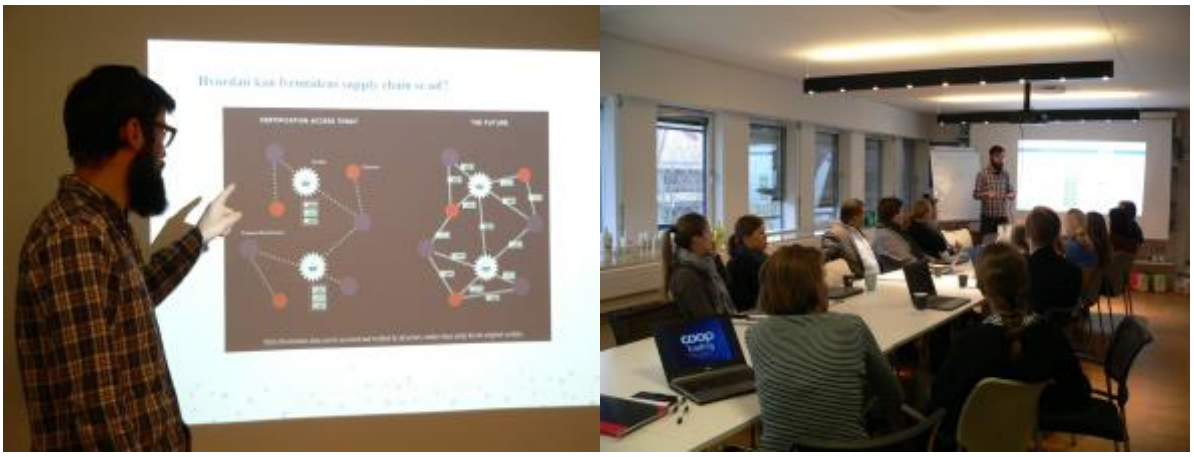
3.3 Empirical approach

As my thesis has a focus on practice, I have chosen to apply qualitative and quantitative methods to understand and elucidate the essential and actual factors at COOP Trading and the supply chain of EVOO. Below I will elaborate on the methods that I have used and why these have been selected.

3.3.1 Kick-off meeting

To kick-start the thesis, I held a 30 minute "kick-off meeting" for 15-18 of COOP Trading´s employees on 7/2-2017. It was a diverse group, spanning from those working in quality control, sourcing managers, label designers, and more. The main goal for this presentation was to inform as many employees as possible about the focus of my thesis, so they knew what I was working on and why I might need to interview some of them.
The presentation was an introduction to blockchain, by first explaining the concept of bitcoin. There was then a case related lead-in to how blockchain can transform the current way of traceability, information and sharing of documentation, illustrated by the findings by Provenance.

The presentation concluded with questions from the audience, as this technology can be hard to grasp, which the questions clearly demonstrated. However, this presentation was not meant to explain all the aspects of blockchain, but to create interest and develop further interest on this technology.



3.3.2 Desk research

Desk research was done to gain insights within the focus of the thesis. At the start it was mainly to gather insights on the supply chain field of study, which I have never before examined.

To start the empirical findings on possible theory, blockchain, COOP and COOP Trading, desk research was the first method to gain knowledge.
I used Google Scholar and Search IT to find theory and blockchain literature, and relevant books at the ITU library or communal library.

3.3.3 Interviews

To gather in-depth material and be able to provide a possible concept of a blockchain solution, I conducted 10 interviews with 11 respondents. The interviews supported the desk research and the field work as well, as interviews helps to explain the worldview. This is to get as close as possible to the worldview of the respondents and potential users and their experiences, to form a well-informed third person perspective (Brinkmann 2015: 31).
The respondents from COOP Trading were picked out in partnership with my contact person (QA Manager). COOP Trading employees who handle a process of EVOO were naturally selected, but to be

sure I interviewed all the relevant employees, in the end of each interview I asked the respondent if there were any other employees I should interview.

By primarily letting COOP Trading choose the respondents, I got as varied a group as possible, and thereby gained a solid and credible understanding of the supply chain of EVOO and its challenges. The table below depicts an overview of the respondents.

Table 1: Overview of respondents

Appendix number and Title	Company	Duration
6.1 Quality Assurance (QA)	COOP Trading	75 min
6.2 Buyer	COOP Trading	59 min
6.3 Senior IT Project Manager (IT Manager)	COOP Trading	55 min
6.4 Quality Control (QC)	COOP Trading	69 min
6.5 QC Manager	COOP Trading	65 min
6.6 Supplier 1 Export Manager	Supplier 1 (Italy)	60 min
6.7 Supplier 1 Purchasing	Supplier 1 (Italy)	25 min
6.8 Supplier 1 Quality Control (QC)	Supplier 1 (Italy)	28 min
6.9 Supplier 2 Export Manager	Supplier 2 (Greece)	35 min
6.10 Supplier 3 Export Manager	Supplier 3 (Spain)	37 min

I employed Brinkmanns` guidelines in relation to semi-structured interviews, where my interview was divided into themes, which were specified beforehand (Brinkmann 2015). The questions had a point of departure from the overall research question, and the themes for each employee interview therefore were: their role, methods and tools used, challenges and possibilities with traceability, information and

documentation sharing. The advantage of applying themes is to also maintain a focus on the research-related investigation, because conversations can easily go off-topic, and this helps the interview stay on track (Brinkmann 2015: 37).
In addition, the interview guide was adapted to each respondent as well as adapted along the way based on the respondent's answers. The latter is, that the interviews are semistructured as they were adapted to the individual respondent during the interview situation, so all questions have not necessarily been answered in all interviews (Brinkmann 2015). An example of this was the interview with the IT Manager. He has no direct contact and knowhow on the supply chain of EVOO, so was thus unable to answer. The respective interview guides can be found in appendix 2.

Respondents were sent an email, with a brief prior to the interview to prepare them, while I did my best to meet the criteria for "sound interview practice" during the interviews (Bryman 2012: 475; Brinkmann 2015: 33). The interviews with COOP Trading employees took place at their company site in Høje Taastrup and lasted approximately 55-75 minutes. All of the interviews were face-to-face interviews, allowing the respondents to better tell their own stories and oppose my questions or interpretations (Brinkmann 2015). The interviews with the suppliers were conducted both face-to-face and via Whatsapp. The interview with supplier 1 was face-to-face, as this was the supplier I visited. The two other supplier interviews were carried out by the use of Whatsapp; one was a video call, the other a “normal” non-visual, audio call. The interviews with COOP Trading were recorded with an external microphone, supplier 1 interviews by phone and the other suppliers by the external microphone. Audacity was used as recording software.
The interviews have a pragmatic and communicative validity, as the collected empirical content contains privileged knowledge of general practice at COOP Trading as well as insight into the thoughts of the respondents on the concrete use of methods in relation to the challenges they face (Brinkmann 2015). To validate and do further work on the gathered information, I held a workshop. This will be elaborated on later in this section.
By utilizing interviews, this is not meant as an unbiased or neutral technique in way to get data and knowledge. The interview is an active interaction between two parties or more, which leads to social,

negotiated answers (Brinkmann 2015: 30). It is not unbiased due to the theoretical enlightenment of the interviewer, but here the interviewer should keep an open mind and a "conscious naivety." It is impossible to achieve this ideal of a clean theoretical slate. But in attempting to gain as ideal of a theoretical slate possible by interviewing and not testing the hypothesis, one must remain aware of and impartial to preordained theoretical perspectives or propositions that may end up limiting the findings and create bias. One should formulate a research problem and possibly specify some potentially important variables, with some reference to extant literature (Eisenhardt 1989: 536) while keeping an open mind, but not an empty head (Brinkmann 2015: 37; Corbin 2008: 67). One can compare this to how a doctor should approach his patients, not asking why the they are sick, but seeking a description of the symptoms and experiences of e.g. pains (Brinkmann 2015: 40)

3.3.4 Questionnaire

To support the interview findings, as the interviews only could gather insights from a couple of suppliers, the use of questionnaires was applied. A questionnaire is a great way to gather data from multiple respondents, especially when working within a limited timespan. The primary use of the questionnaires was to gather insight from supplier suppliers, to strengthen my assumptions and investigation of the supply chain of EVOO. I could not get access to interview the supplier suppliers, as they did not want to reveal them. So we made a compromise, that I instead could send them a questionnaire so they could remain anonymous, which then the interviewed suppliers would distribute to their specific subsuppliers. I sent the suppliers a questionnaire in English. This one received no answers, even after several attempts to push the suppliers to send it again. Since that did not seem to work, I had friends translate the questionnaire from English to Spanish and Italian, and emailed it again, hoping for better results. With no answers still, I therefore found a website[2], where contact information of Greek, Spanish and Italian olive oil farmers and producers is listed. I manually copy-pasted those lists, to send out approximately 200+ emails in total, with brief information about why I contacted them, and a link to the questionnaire in their mother language, except for Greece, which

[2] http://www.oliveoilsource.com/page/companies-all

was in English. It should be noted that several bounced back, around 50, as the email could not be found or the account had been deleted.

The questionnaire was built in themes with *closed questions*. Closed questions was primarily applied, where I as the researcher already had a defined number of response categories that the respondent can cross off. The advantage of closed questions is that it generates quantitative data. This means that it can be counted and thus summed up in, e.g. percentages, shares or averages. Only a few of the questions was *open questions* as it is generally not advisable to have too many open questions, as it confounds the ability to generate quantitative data. In appendix 2 is the sent email and in appendix 3 is the questionnaires.

3.3.5 Field work

Field work is a method to grasp how truism occurs, is maintained or changes within the setting of specific social communities. Field work is a sound method to gain knowledge of what occurs between humans (Brinkmann 2015: 55). Through field work and having an office space at COOP Trading in Høje Taastrup, I gathered a deeper insight into the olive oil supply chain.
To learn first hand about the supply chain of olive oil, I travelled to Milan from 7/3-9/3-2017 to meet with one of COOP Tradings' suppliers (supplier 1). I took field notes as data on my thoughts and what stimulated my theoretical ideas at the time, since I might forget them at a later point (appendix 7). Field notes are data that contain some conceptualization and analytic remarks. My notes were mainly observational notes (Corbin 2008: 123-124). As a researcher, this added valuable insights to my understanding on how work was carried out and the setup.
Having an office space at COOP Trading is not directly considered field work, but it gave me insight on their working environment and their collegial co-operation. It made it easier to contact them personally if minor questions arose, or if I needed to arrange an interview or attend a meeting, with a subject to my interests.

3.3.6 Meetings

As a part my fieldwork, I attended staff meetings. This was to get knowledge of their everyday work life and gain valuable insights of their processes.
I attended the monthly morning all staff meeting to implicitly spread knowledge about my thesis and blockchain in general, so as many people as possible could be aware of why I was there and what they could learn from my being there, i.e. about blockchain.
I also attended team meetings and a meeting where a new employee was introduced to COOP Tradings' Ways of Working (WoW).

3.3.7 Documents

To give me, as a researcher, an overview of the field of study, COOP Trading and Supplier 1 gave me access to documents, reports, company material and publication material.

The documents made it easier for me to follow the interviewees' thinking processes during the interviews because I conducted them with a general knowledge of internal concepts, processes, and abbreviations that I gained from reading the material beforehand.

The documents from COOP Trading and supplier 1 are divided into primary and secondary documents. Primary documents refer to documents which are not publicly available and only circulate among a limited set of actors. Access to primary documents is limited as they usually contain sensitive information. Secondary documents refer to documents that are publicly available, but not necessarily have the public as a target group (Brinkmann 2015: 154).

The documents were sent in relation to an interview or supplier visit.

Table 2: Overview of documents

Document Name	Type	Type of material
COOP Trading: WoW - Ways of Working	Primary document	PowerPoint that describes how COOP Trading works
Guide for documents for supplier	Primary document	An Excel sheet describing what and who sends information to suppliers at COOP Trading.
Document High Level	Primary document	PowerPoint that describes COOP Tradings' data setup
Extra Virgin Olivolja (Jansson 2016)	Primary document	An internal report on EVOO produced by COOP SE.
COOP Trading Abbreviations	Primary document	A word document explaining the internal abbreviations
Grocery Team Presentation 16.0	Primary document	A PowerPoint that describes the different roles at COOP Trading
Supplier 1	Secondary document	Advertising material

3.3.8 Workshop

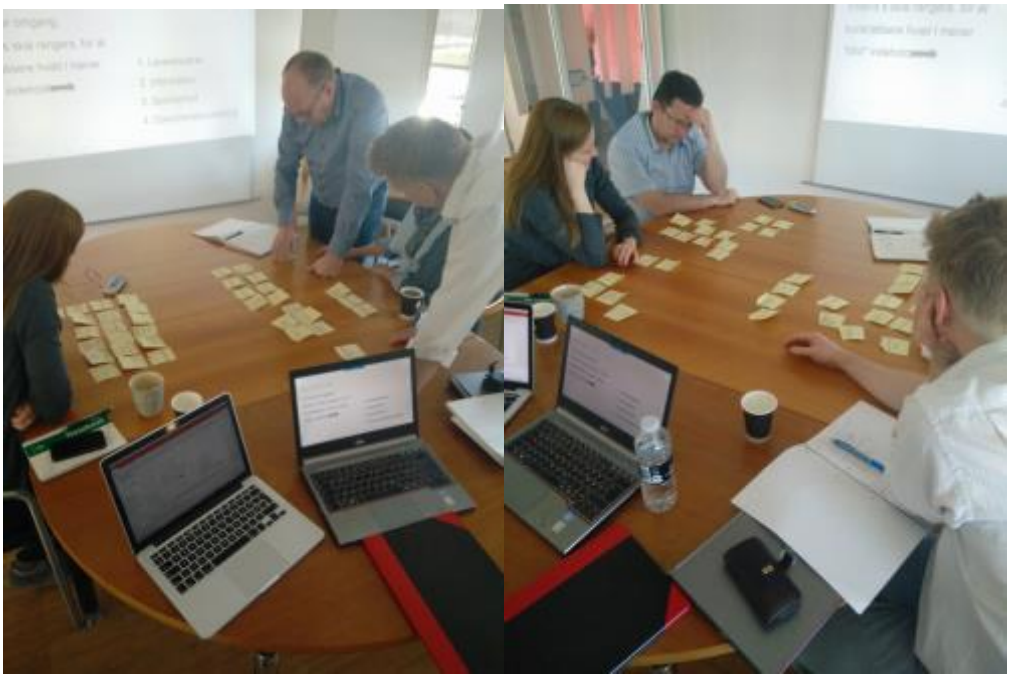
During the period of writing the thesis, I decided to hold a small workshop at COOP Trading to get feedback on the issues at hand. On the 3/5-2017, at 1:30-3, I held a workshop with five employees from and at COOP Trading (appendix 4). Present was a person from QA, QC, IT Project Manager, Buyer and a QA Manager. All expect the QA Manager were former interviewees, so they had knowledge of

my project and were chosen in light of that. The workshop had three parts: an update on the thesis so far and the narrative structure, exercise on the role of trust, and finally feedback from the attendees on my conceptualizations. This was inspired by Johnson et. al. use of strategy workshops, from the publication "*The Ritualization of Strategy Workshops*" (Johnson 2010).

The main focus of the workshop was to give the employees insight on the progress of the thesis, and to show them the narrative structure (see section 3.5).
Afterwards I split them into two teams to complete a word-task in order to clarify or concretize what the word "trust" contains in regards to: suppliers, information, traceability, and documentation sharing. They had a predetermined list of words to choose from, which came from the study of Seppänen (2005) (See section 2.3). Each team had to choose 5 out of the 21 possible words, in or to help define what they thought "trust" contained and deemed its most important aspects (in relation to suppliers, information, traceability, documentation sharing). Getting them to reflect and concretize the role of trust, from their worldview and practical perspective, helped in the building of what sort of connotations they impose on the general word of trust. Which in line with Johnson et. al. is shown in the table below (Johnson 2010: 8). Pictures were taken of the chosen post-its for each round and the work process, as shown below.

Table 3: Workshop

Workshop	Purpose	Clarity of purpose to participants	Outcome (success vs. failure)
COOP Trading	To get the participants reflections on what trust entails, as they all (during the interview) stated that trust was one of the most important aspects of their relationship with their suppliers.	*High* Participants engaged energetically in the discussion of what trust entails, but had a difficult time choosing just five.	*Success* As their reflections gave deeper insights on what they deemed as most important features of trust, in relation to suppliers, information, Traceability and documentation sharing.



Their reflections and thoughts were recorded, to help the analysis and summary afterwards (appendix 5).

The second part of the workshop, due to time constraints, only had the QA Manager present (contact person) to give feedback on my visualizations of the conceptualizations. The conceptualizations were then altered in proportion to the feedback. All of the feedback will be applied as a part of the analysis and results of the thesis.

3.3.9 Data processing and analytical strategy

The strategy for the data analysis was inspired by Corbin and Strauss (Corbin 2008: 65-87) and Brinkmann (Brinkmann 2015), to have a strong academic analysis foundation.
I decided not transcribe the interviews in full, but to write notes to clarify what the respondent stated through the interview, which is evident in appendix 6.1 - 6.10. After the light transcribing, the interviews were themed and analyzed through colour coding inspired from Grounded Theory (Eisenhardt 1989). The coding developed from articulations with common characteristics (Brinkmann 2015: 47). Instead of using software, I colour coded what the respondents stated, when they talked about the challenges and opportunities regarding: trust (blue), traceability (red), information (orange), and documentation sharing (pink), so I easily could relocate them later.

All of the documents were read and analyzed to gather insight on how the work process is at COOP Trading and who takes care of what. I made notes of the different documents, to get an overview and be able to illustrate the process of EVOO. All together, this assisted me to express and convey the supply chain of EVOO and COOP Trading practices while identifying patterns and challenges. These led me to the second part of the analysis, which consists of the identified challenges and opportunities in practice where the challenges are divided respectively into trust, traceability, information and documentation sharing.

3.4 Theoretical foundation

As mentioned before, former assignments, lectures, and conferences have shaped my understanding of the use of blockchain, and in what ways blockchain can bring change. I could have chosen many different approaches, as blockchain in general enables possible changes in, but not limited to, transaction cost, security, IoT (Internet of Things), legislation, car ownership and finance.

Ultimately, I found the field of *trust* to be interesting, as articles and advocates on blockchain stated its impact on trust, blockchain as the trust machine, to trust the code. But drawing on my own and a general knowledge of trust, it can have many different meanings and outcomes.
The general proposition is that blockchain will enhance or remove trust from the equation. I found it interesting to investigate, and to strengthen the knowledge of trust in combination with blockchain. So, inspired by Grounded Theory, I wanted to compare theory to data, and build upon that. The central idea is that I, as a researcher, constantly compare theory and data-iterating toward a theory which will be as closely fit, clear, and defined as possible, due to the collected data. The closer fit is important, as stated by Eisenhardt: *"A close fit is important to building good theory because it takes advantage of the new insights possible from the data and yields an empirically valid theory."* (Eisenhardt 1989: 541).
In the raw essence of building theory, research is begun as close as possible as if no theory has been under consideration, and with no hypotheses to test (Eisenhardt 1989: 536). In my case, that was impossible, but I had an open mind to not limit myself and my research.

By investigating trust in interorganizational exchanges, which were explained in greater detail in section 2.3, and "only" investigating a single case, that can hinder the ability to construct generalizations. A key response to this challenge, is the clarification that the purpose of this research is to develop theory, not to test it, and so theoretical sampling is appropriate (Eisenhardt 2007: 27). Eisenhardt relates it to laboratory experiments, which are not randomly picked out, but chosen for the likelihood to offer theoretical insight: *"so too are cases sampled for theoretical reasons, such as revelation of an unusual phenomenon, replication of findings from other cases, contrary replication, elimination of alternative explanations, and elaboration of the emergent theory."* (Eisenhardt 2007: 27).

3.5 Narrative Structure

After explaining the methodical approach, it is beneficial to illustrate the thesis as a whole, to explain the two-sided contribution. At the center is the research question, framing the thesis and indicating the direction. Method is the backbone, which is the approach to gather sound results. The domain is literature on EVOO, COOP Trading, empirical data and so forth, to end up with practical knowledge, which is a conceptualization of a blockchain solution. The theoretical side is based on supply chain, trust, interorganizational exchanges and so forth, to investigate and contribute to new academic literature and knowledge on trust. The literature examined for both domain and theory could be the same.

The analysis is based on empirical data, to examine the supply chain of EVOO, its challenges and opportunities, which is discussed and concluded on in the results, and in the end produce a practical (blockchain) and theoretical (trust) contribution.

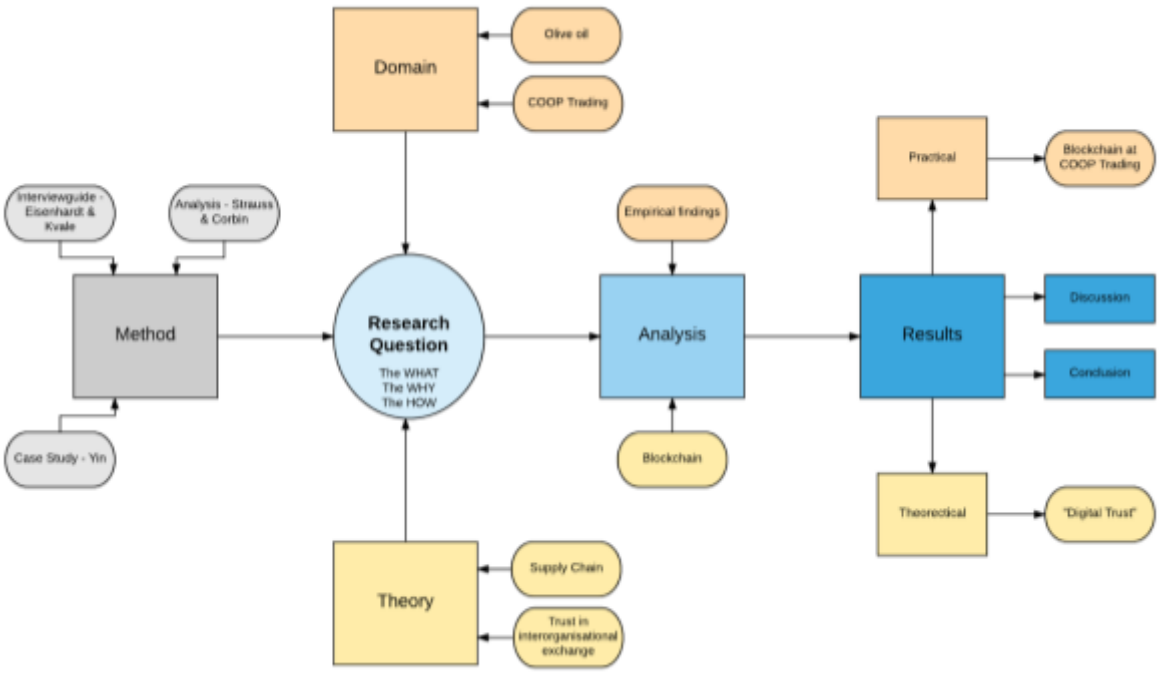


Figure 6

4 Analysis

4.1 Introduction

The following section will depict the current supply chain of EVOO, to consequently illustrate a blockchain conceptualization.

Therefore, the following section is going to explain the supply chain of EVOO, from interviews at COOP Trading and interviews/questionnaires with suppliers, supplemented by literature. After mapping the supply chain, identification of the key challenges from interviews and questionnaires is presented. Following this, the opportunities on how to overcome these challenges will be addressed.
As the second part of the analysis, the challenges and opportunities associated with blockchain technology in supply chains as found in collected data and literature will be examined, to investigate how blockchain can or cannot solve the challenges.
Consequently, this leads to the final part, where a conceptual representation is displayed and to demonstrate what a blockchain-based solution of tracking and tracing EVOO could look like.

4.2 The supply chain of extra virgin olive oil

To identify how blockchain might serve as a supply chain of EVOO, I must first describe what EVOO is, then why there is a need for blockchain in the supply chain of EVOO, and finally how the current supply chain is organized.

4.2.1 The WHAT - Extra virgin olive oil

EVOO is the highest quality standard for olive oils. Virgin olive oil is defined as: the olive oil obtained directly from olives and solely by mechanical means. There are three categories of virgin olive oil based on quality level, which are defined as: *extra-virgin olive oil*, *virgin olive oil* and *lampante olive oil*.

Lampante (lamp oil) is a virgin olive oil obtained from bad fruit or careless processing and it is of such a low quality that it cannot be used for human consumption (Peri 2014: 11-19).

Standards are divided into two groups and are established by law as indicators of *quality standards* which aim to classify extra-virgin, virgin, and inedible lampante olive oil, and *authenticity standards* which aim to identify oil adulteration by mixing virgin olive oil with refined olive oil or oil of other kinds (Ibid).

Quality standards are analytical parameters that allow virgin olive oils to be classified according to a scale of quality. Accordingly, these parameters indicate oil spoilage, and one can assume that the lower their values, the higher the quality of the oil.
Authenticity standards are analytical parameters that allow an oil to be declared as "virgin". In general, these parameters indicate the presence of *refined olive oil* (breach of solely by mechanical means) or *other vegetable oils* (breach of being obtained directly from olives) (Ibid).

Olives and olive oil are predominantly grown and produced in Spain, Italy and Greece. Spain is the largest producer of olive oil with 1,401.6 mt, Italy 474.6 mt and Greece 320.0 mt in 2015/2016 (Int. Olive Council).

4.2.2 The WHY - Fraud

Fraud with olive oil might not seem like a critical health issue, but massive amounts of money is at stake in this billion euro industry. Well-known olive oil producers are accused of passing off the slightly lower quality virgin olive oil as extra-virgin. But there are different ways of doing "fraudulent" behaviour, as defined by the European Commission (EC) and Global Food Safety Initiative (GFSI) (Moyer 2016: 358):

- adulteration (e.g., ingredient substitution, dilution etc.)
- tampering (e.g., date code tampering and refilling containers)
- theft (e.g., employee theft, shoplifting, and cargo theft)
- diversion (e.g., gray markets and parallel trade)
- unauthorized production and counterfeiting (e.g., intellectual property rights infringement) (Ibid)

Within the scope of this thesis, fraud is defined as adulteration and/or tampering. In the book Extra Virginity (2011), by American journalist and olive oil expert Tom Mueller, he states that an Italian Head of Customs declared: *cheating with olive oil contains as great profit opportunities as the cocaine trade - and there is no risk*. Tom Mueller lists how four out of five of the olive oils being sold as Italian are not Italian, and how 60 percent of the oil that is sold as "extra virgin olive oil," is, in fact, a less expensive oil (Høi 2015). The same was stated in my interviews with Supplier 3, Supplier 2 and Supplier 1´s Export Manager and Purchasing. They were well aware of the history with fraud in the olive sector. Supplier 3 said: *"Yes, yes yes, there was a huge scandal in the US a couple of years ago"* (Supplier 3, 28 min), and when asked why, *"to earn more on a product (...)(...) normally it´s to sell a virgin as a extra virgin"* (Supplier 3, 28 min). This was supplemented by supplier 2, who said: *"Of Course (...)(...) especially in Italy"* (Supplier 2, 23 min). However, they also all state that it could be the storage and transportation of the olive oil, as Supplier 2 states: *"sometimes it´s a matter of storage and transportation, that it's not storage correct (...)(...) Damaged due to light and heat"* (Supplier 2, 24 min).

In Denmark this March (2017), The Danish Veterinary and Food Administration action team found adulterated EVOOs at Dagrofa and Dansk Supermarked. Out of the 35 tested bottles, only 6 could be classified as EVOO; 15 were "just" virgin and 12 were so poor that they could not be sold to consumers. The last two needed more testing at the Spanish laboratory to figure out how to classify them (Carlsen 2017).

Fraud happens in very complex supply chains, or in interorganizational relationships that rely on unfounded trust (Moyer 2016: 360). It is mainly an economic gain and loss avoidance that drives fraudulent activities. Examples are price-fixing to maintain sales revenue, and substituting sub-standard or even waste by-products into genuine products to reduce the costs (Ibid: 359). In established interorganizational relationships, the supply chain activities and monitoring are focused on logistics, inventory traceability, and quality control.
That sort of monitoring is not usually designed to detect, deter, or even prevent fraud, but rather to control and test for traditional threats, such as bag bugs and bad contaminants. Safety Management systems assume supply chain relationships are trustworthy and trying to do the right things right (Ibid: 360).

With globalized supply chains, the monitoring and controlling of the suppliers' supplier is changing and transforming. In the past, the main players were small, family-based entities, where the market was very fragmented and locally oriented. Now, efficiency, expansion, competitive nature, and the ability to adjust rapidly to changing conditions are the valued factors. Even though many farmers are still family based operations, it is drifting away from that.
The agri-food[3] supply chains are facing global challenges that can be met with the support of Information Technologies. IT opportunities are key tools in the agri-food supply chain activities and can contribute to optimization and a more efficient process (Jerić 2010: 139).

4.2.3 The HOW - Mapping of current supply chain

This section will map the current supply chain of olive oil, which serves afterwards to illustrate the challenges. The mapping of the supply chain will be based on interview data (appendix 6.1-6.10) and data from the questionnaires (appendix 3), to identify the traceability, information and documentation sharing of the oil. Where literature (Salmone et al. 2015, Peri 2014) will act as the knowledge-base and supplement. Supply chain systems in today's EVOO chains are too diverse to make a general

[3] Relating to the commercial production of food by farming.

description. Therefore, this mapping is an illustrative example of the current supply chain that I have gathered from my data sources.

The supply chain of EVOO encompasses all activities associated with the flow and transformation of oil from the raw materials stage (extraction), through to the end user, as well as the associated information flows (Handfield 2001). The first description of the process of EVOO will be divided into four parts, to gain an easier overview. For each sub-part, the process of the product and information flow will briefly described. The first sub-part is the agricultural/cultivation phase, then the production phase, leading to the tapping phase, which finally leads to the transport/distribution phase. These four processes have different structural and operational requirements, and therefore are usually managed and owned by different companies (Peri 2015).

Agricultural/cultivation phase

The cultivation phase includes the cultivation of olives using different treatments, such as *soil management*, *pruning*, *fertilisation*, *irrigation*, *pest treatment* and *harvesting*. Each of these treatments can be carried out in different ways depending on whether the process is, in general, manual or mechanised (Salmone 2015: 60; Supplier 1 Purchasing: 20 min).

The olives can be cultivated (cultivar) in different ways, which are best suitable for the climate and end-product. The climate plays a major key to the success of the cultivar of olives and is a critical control point (CCP). With changes in climatic conditions, e.g. frostbite or pest attack, olives are seriously damaged, and the unavoidable consequence is an irreversible loss of yield and quality (Peri 2014: 8; QC: 50 min).

The farmer keeps a record of the cultivar, so when the olives are harvested, the information about the treatment of olives and olive sort can be shared with the mill for auditing and control. The information is usually shared via paper (Supplier 3: 17 min).

Production phase

In the production phase, there is either manual or mechanised harvesting of the olives. If done by hand, it is expensive and slow, but safer. If done by machine, it is quicker and cost effective but easier to break the skin of the olives, which means higher risk of olives that cannot be used for EVOO. Here the farmers also *separate the olives which are in the tree and the olives fallen on the ground* (Appendix 3). According to Perri, the harvesting phase is very important, because changes in the acidity level of olives occur after harvesting, and other changes occur depending on the harvest methods, as mentioned before. Then the olives are transported to the mill as soon as possible, to be cleaned, washed, and made ready to press. The pressing is either by the traditional/classical system or through the use of a centrifugal separator. On average, around 200 kg of olive oil is produced from 1 ton of processed olives. When the oil is pressed, it is usually transported to be tapped. The CCP of this process is that the production is carried out to the required standard of making EVOO. If anything goes wrong, the process is irreversible (Supplier 2: 28 min).

All of the information regarding traceability and documentation is stored in a register, with date of storage, the origin of the oil, and the destination, in order to be audited and controlled (Appendix 3; Supplier 1 Purchasing: 22 min).

Tapping phase

The oil is transported in bulk by truck, and then put into huge tanks. At supplier 1, which I visited, their QC tested the oil before it was put into the tanks from the trucks, to ensure the quality. They had 10 similar fully-automated production lines, which could blow plastic bottles to the wanted size, then be cleaned by air, and next have oil filled into them. If glass bottles, it surpasses the step were the bottles are blown. Next, a lid gets placed on the bottle, then the bottle is labelled, and afterwards packed in cardboard boxes. One of the last steps is the packing, where an amount of the boxes are placed on a pallet, for the final step of being wrapped (Appendix 7). The CCP for this sub-process, is the quality control when oil arrives, and the storage of the oil.

In regards to my visit, all information about the specific oils was kept in a data register, regarding traceability and documentation, to be audited and controlled by COOP Trading if needed.

Transport & Distribution phase

The last phase is transporting the oil to the store. It is usually by truck, as was the case of supplier 1 (Purchasing supplier 1: 43 min). If from further away, e.g. Spain, then it travels by ship (Supplier 3: 1 min). The oil is usually transported with no climate control along the supply chain.

Each shipping operation should be accompanied by a corresponding consignment control record, where traceability and documentation is found through barcodes (Appendix 3). This will be depicted in greater detail in the next section.

4.2.3.1 Workflow of EVOO

This section will depict the product (EVOO) workflow in more detail and illustrate it, to build upon the previous section (The HOW). To illustrate the process, interviews, workshops and internal documents on workflow process from COOP Trading, and interviews and questionnaire with suppliers, will serve as the foundation. The workflow is investigated to gather the requirements for a blockchain conceptualization, to consequently indicate the challenges and opportunities after this section. First, I will illustrate the product flow.

4.2.3.2 Product Flow

The product process of EVOO runs through a series of *data points*, e.g. when the product is transported by truck, or is delivered to production sites (illustrated by green buildings) (Figure 7).

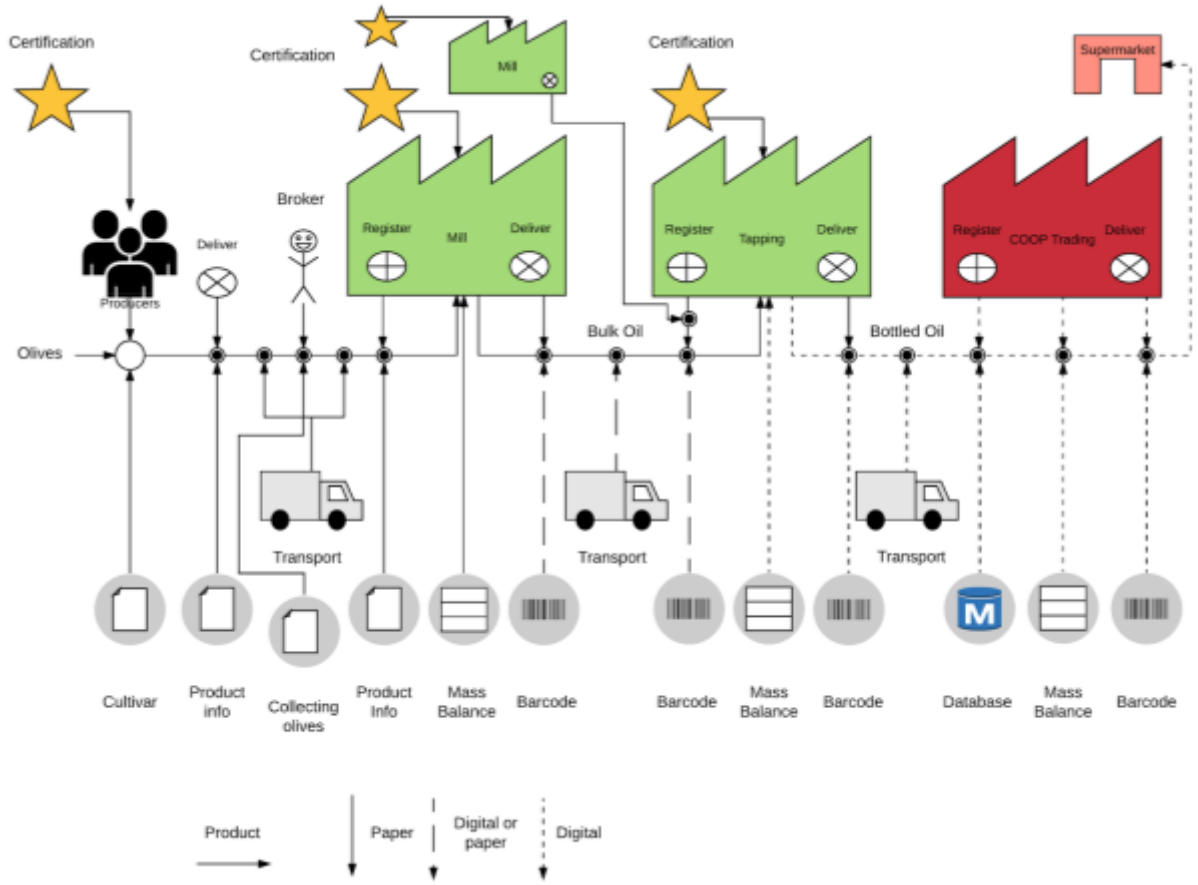


Figure 7

The horizontal line is the journey of the physical product, with data points illustrated with vertical strings, which are points where data is done, e.g. by paper or by barcode registered in a data system (e.g. ERP system). This is to also illustrate that each company has their own system or ERP system. These *data silos* discourage interoperability and rarely cover the product's full supply chain, and are often unable to capture the first mile from the original producer source (Purchasing Supplier 1: 29 min; Buyer: 32 min). With each participant handling their own, trusted third parties in the shape of a certification organization, are utilized to approve and authorise that the participant is acting within law requirements, food safety etc. An example is CSQA. CSQA provides ISO certification to food companies, including quality and management systems, with focuses on food safety, sustainability, business continuity and information security (CSQA).

Even with this simple overview, it illustrates many data points, and many of these are of different formats, ranging from a paper slip from the farmer to the mill, to dot net systems run by barcodes at COOP Trading (Purchasing Supplier 1: 29 min; IT Manager: 21 min).

4.2.3.3 High Level - data points

The next layer in the product workflow is to illustrate high level data entry points. This is done by applying Unified Modeling Language (UML), which is is a general-purpose modeling language in the field of software engineering. UML can help to specify, illustrate, and document models of software systems, including their structure and design (UML).

The illustration, figure 8, depicts the overall workflow process. Each vertical swimlane is a participant, five in total, and each rectangle is a process with arrows linking the product flow between each process. This also demonstrates the intertwined process flow, between the participants.

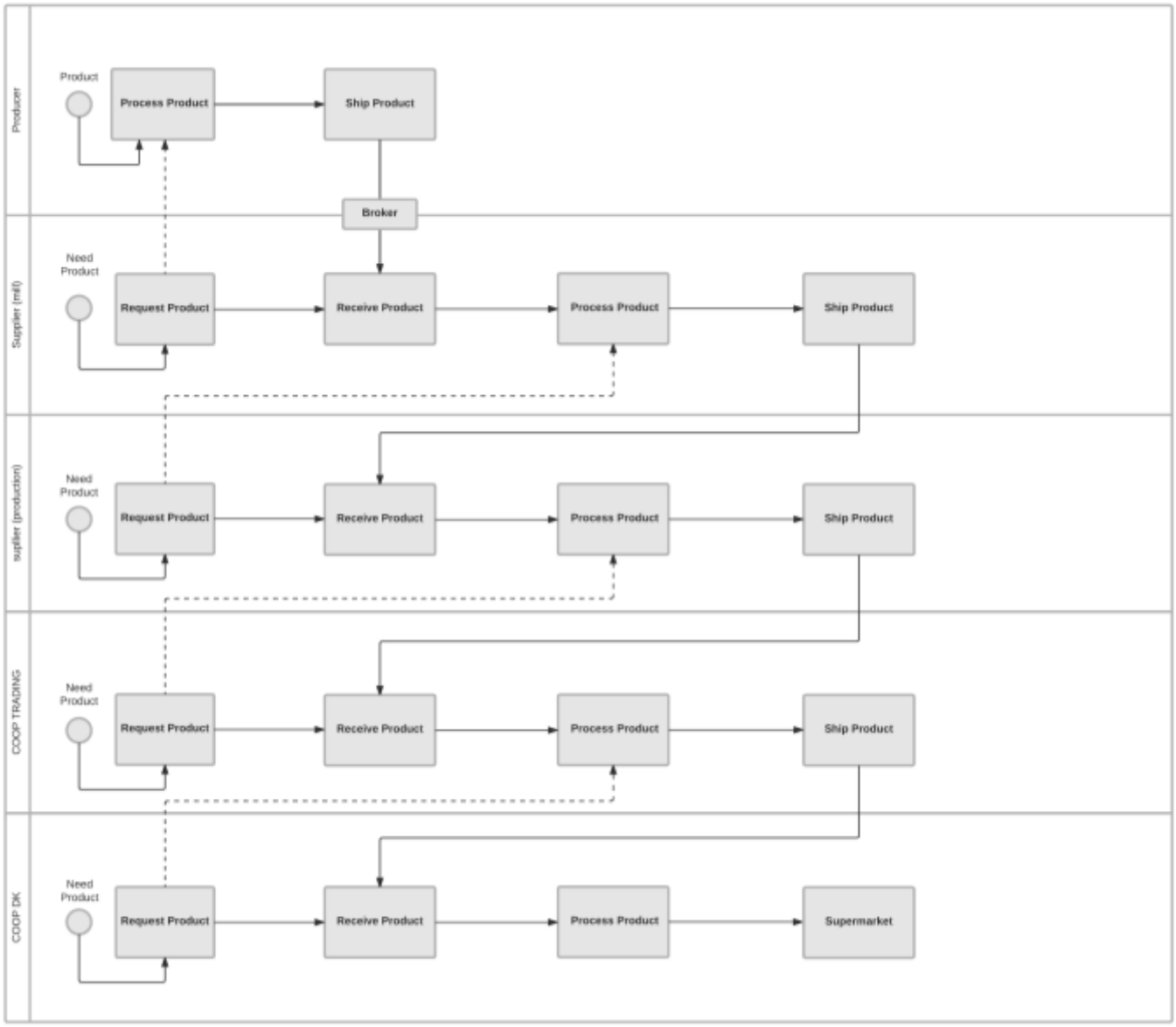


Figure 8

4.2.3.4 Business Process Flow

To further depict the process flow, and in the end look at how a blockchain conceptual design can solve challenges in the current supply chain, the next illustration goes into greater detail (Figure 9). The process flow will be divided into three parts, to be able to depict the many data points along the chain of EVOO.

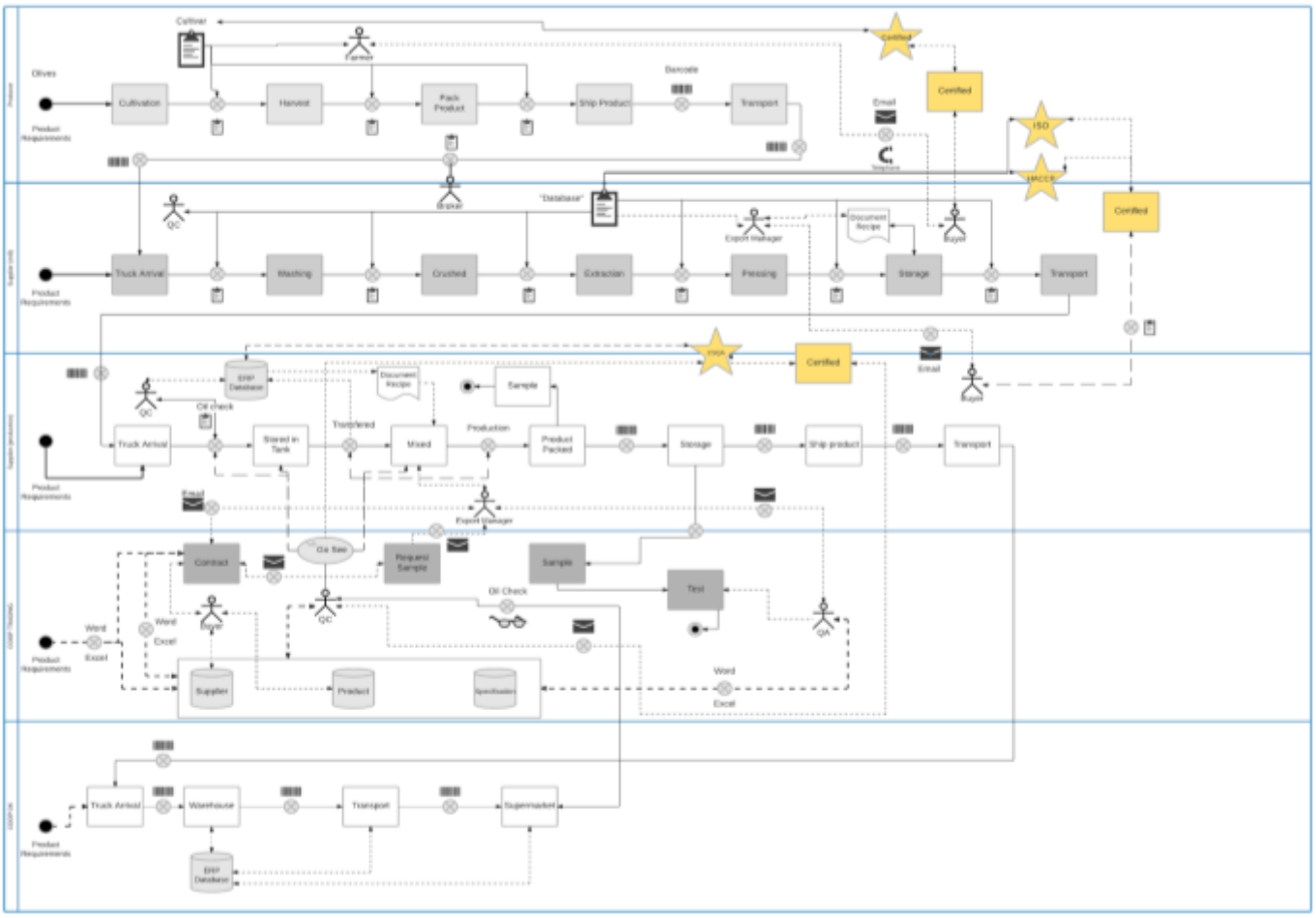


Figure 9 (and on Google Drive)

As with figure 7, the filled lines are a physical process, where the line from process to process is flow of product, and the black are data (ex. paper). Dotted lines are digital information going back and forth between actors, or database systems. The first part is the farmer/producer and mill (Figure 10).

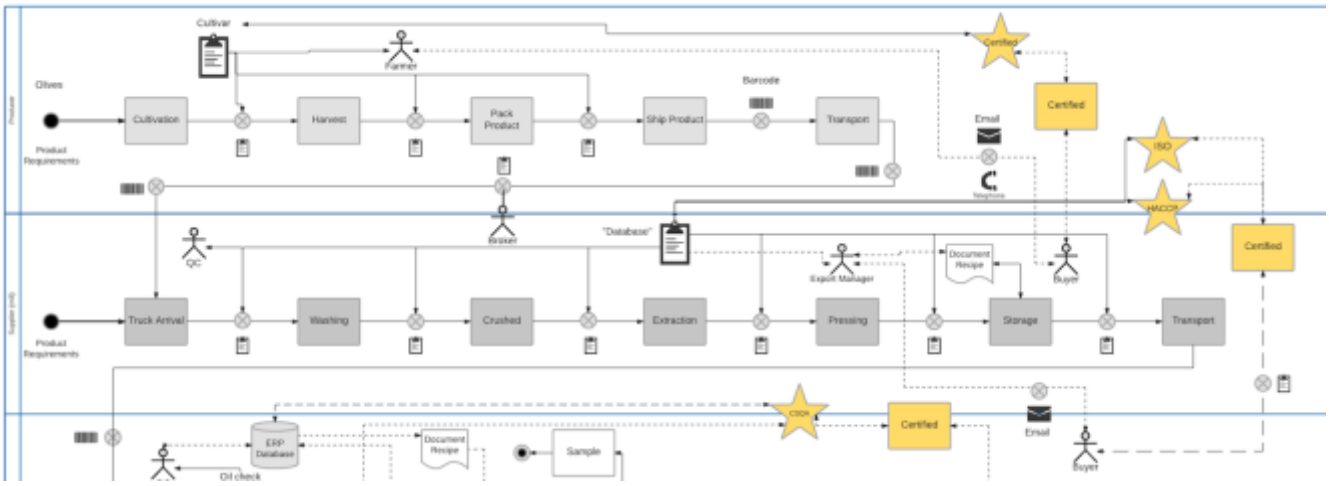


Figure 10

The olives are produced by the farmer, who handles all the cultivation and harvest of the olives, and usually keeps records of this in a paper register of some sort (Supplier 3: 17 min). Either the farmer has contact with the buyer from the mill, through telephone or email, or this is done through a broker. It should be noted, that some of the olive farmers are small family run businesses (Supplier 3: 35 min). The farmer is certified through a third party certification body, as this is a requirement for the suppliers to COOP Trading. After harvest, the product is either shipped directly to the mill, or through a broker, who acts as an independent sales agent who negotiates sales for the farmers.

After the delivery of the olives, a chain of processes take place, which are kept in a non-digital registry. Their QC oversees their process, so they can also get certifications that prove their handling is within the law requirements and to be able to deliver their product to suppliers to COOP Trading (Supplier 2: 13 min). As the last step, the oil is transported to the tapping production site.

The second part (Figure 11) is depicting the process from COOP Trading's suppliers to COOP Trading.

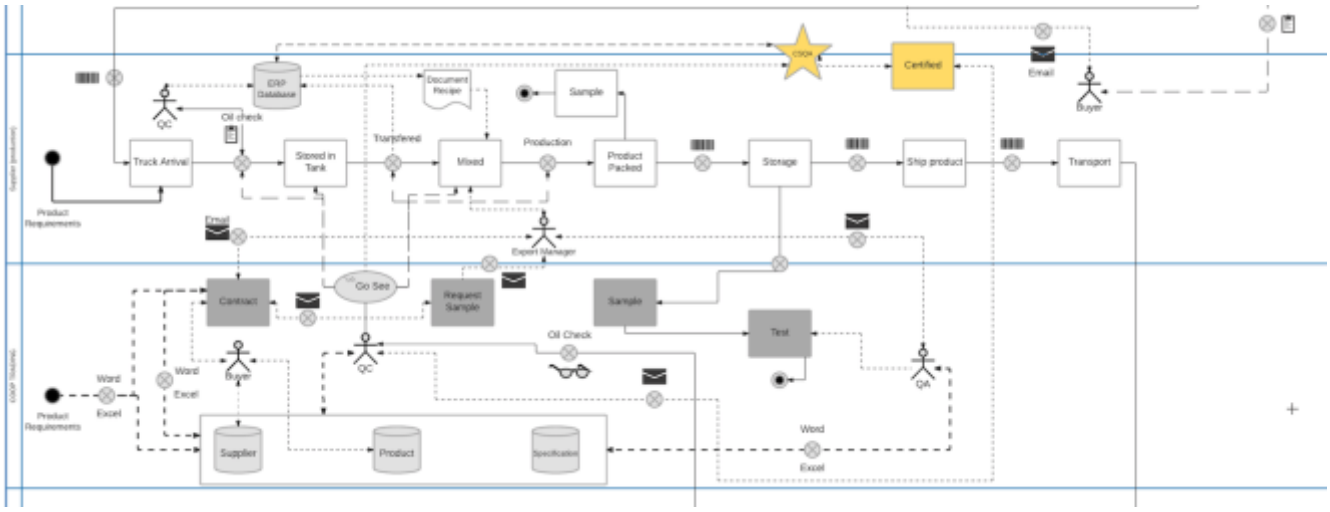


Figure 11

The oil is received at the supplier, and before it is filled into the tanks, it is quality tested by their QC staff. If it is up to standards, then it is filled into their tanks. After that, a series of processes is carried out, with all of that data stored in an ERP system (Purchasing, Supplier 1: 36 min). The suppliers also play an important part, as they handle the digitalization of the products' data points from the mill, paper, to data files (Purchasing, Supplier 1: 36 min). After the product has been packed, barcodes are used to keep track of the specific parcels until transportation.

COOP Trading handles the procurement of products, so the product itself, is transported directly to, e.g. COOP DK´s facilities. The only physical product COOP Trading handles, is a sample that the buyer requests, so that QA at COOP Trading can analyze the product to match the suppliers QC analysis. This acts as a safety measure. COOP Trading's QC oversees the suppliers production and certifications by checking both in person and their product information. COOP Trading´s QC then places that information in their data systems, to update the information about the supplier, the product information or the specification (the product recipe).

The buyer at COOP Trading handles the contract negotiations with the Export Manager of the supplier. The contract is based on formalized product requirements, either in excel or word format (QC Manager: 25 min). COOP Trading has formalized (still a work in progress), their WoW (Way of Working) guide, which acts as a detailed overview of "who does what". This is supplemented with the *Guide for*

documents for supplier, which describes which employee sends which information, and who places the information where (database) (Section 3.3.7).

As the third and last part (Figure 12), the process flow is between COOP Trading and one of their partners, e.g. COOP DK.

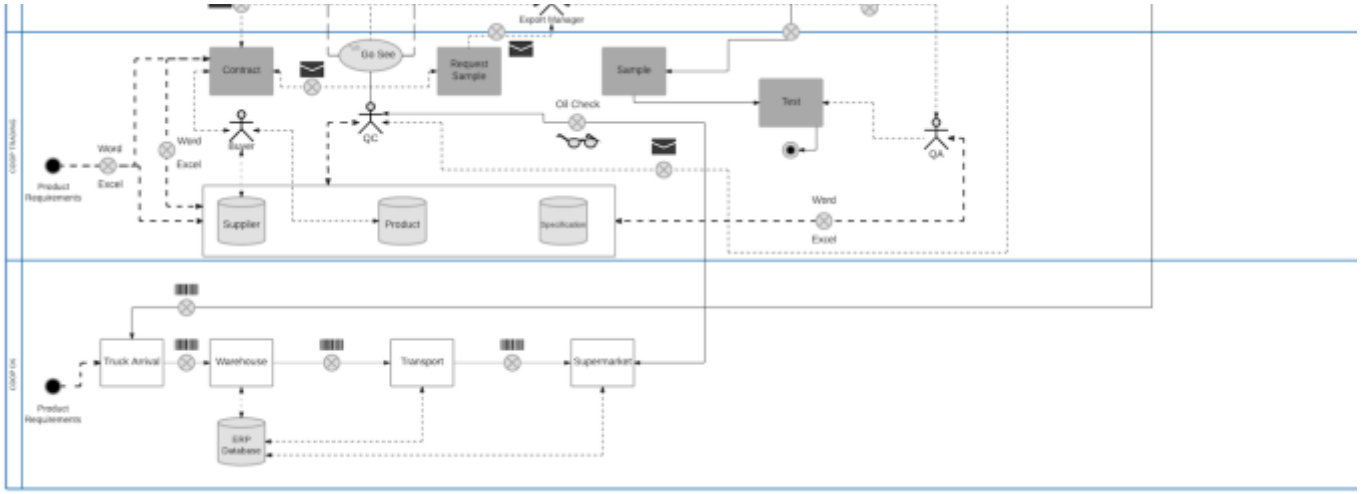


Figure 12

This part of the supply chain has not been the focus of the thesis, but remains equally as important as the rest due to the fact that when interviewing the suppliers they were keen on knowing that information, to be sure that their product was handled and stored correctly (Supplier 3: 25 min, Purchasing Supplier 1: 39 min). The product is transported, again through a series of processes, to get to the final destination, the supermarket. Here QC of COOP Trading can quality check the product, after some *shelf time*. Again as a safety measure, to be sure that the transportation and shelf conditions haven´t downgraded the EVOO. However, this is based on risk, where they apply a system to assess where the QC department should prioritize quality checks.
The actual supply chain from COOP Trading to COOP DK has not been depicted. This was not a part of the findings due to the focus on COOP Trading's suppliers and sub suppliers. The process is still illustrated, as it serves an important part of the supply chain.

4.3 Identification of challenges & opportunities

Now that I have explained the supply chain, it is time to clarify the challenges and opportunities that have arised from the empirical data. To explain the current challenges and opportunities, statements from interviewees serve as the foundation, supplemented by supplier questionnaire data, and literature to support the statements, if relevant.
The paragraphs are outlined thus, to give an improved overview and to depict each area individually, but at the same time keeping in mind that the challenges/opportunities are interdependent.

4.3.1 Identification of Challenges

The challenges are divided into "categories": *trust*, *traceability*, *information* and *documentation sharing*. This is a result of the focus of the research question and the theoretical foundation.

4.3.1.1 Trust

As explained by literature, defining trust can be difficult. This can lead to different perspectives on how to qualify trust. This was clearly indicated by COOP Trading employees. For the QA employee this was based on a gut feeling: "*It becomes some sort of gut feeling (...)(...) you trust them (suppliers), until something changes that"* (QA: 48 min). Meanwhile the Buyer had some personal criterias, which he acted upon: *"For me trust means everything (...)(...) to have open communication about what I want"* (Buyer: 42 min), as he further elaborates when challenges occurs: *"Trust is also when a challenge arise, how it is handled, so reliability is quick response, communication, analyze and dialog"* (Buyer 42 min). Some of the interviewees stated that, a long relationship with their suppliers, was a key part in how trust was defined: *"Trust is built, through years of collaboration"* (QC Manager: 45 min).

Trust is difficult to measure and qualify. But is very important to measure due to the inherent level of fraud with EVOO: *"Well, is really important, because of olive oil is one of the, fraud, is the first food with*

fraud." (Supplier 2: 20 min). The difficulties to define and qualify, is due to the many aspects that trust can contain, as supplier 3 state it on how to rely on their suppliers:*"I can not explain, there is no 1 or 2 or 3, many things that works on this (...)(...) the main thing is they do their business right, as they suit and follow the process that we have agreed upon and so on."* (Supplier 3: 23 min). All of the actors interviewed, relied on control mechanism and certifications; analysis of the product, inhouse and external analysis, and audits of production site. And by these mechanisms try to measure the trustworthiness and expected behaviour.

When talking about expected behaviour, the QA employee elaborates on how she in general has to have the assumption that, what the supplier says and inform her about, is true:*"No matter what product, or which supplier, I have to believe that, what he tells me, is correct. I may question it if something looks strange, but otherwise I will have to trust it."* (QA: 23 min). Which the QC Manager also refers to, on how you approach your suppliers: *"You can discuss on how you look upon your suppliers, is it based on, saying that they are frauding and cheating us, and this is the way we work with, or is it, we base it on that we trust our suppliers (...)(...) that changes from time to time, due to the pressure from our partners (COOP)"* (QC Manager: 46 min). There seem to be a general consensus about, that you trust your supplier, and the saying, *they are innocent before proving guilty*.

Although this may be true, that form of trust can also make you blind. After years of building trust with a supplier, that they always deliver the correct results and quality, might lower the guard. An example is QC at supplier 1 talking about how they always do a quality control of the oil that arrives to the production site by trucks, before they unload they oil from the mill. That they always check if the quality is up to standard, the truck has to wait a couple of hours before it unloads. But the Export Manager from the same company on the contrary states, that because it is trusted suppliers: *"But since we probably have a strong selection of suppliers, we know already. We do the test but we are sure that the goods, the oil is according to our expectations (...)"* (QC, Supplier 1: 16 min), which might lead them to unload the oil before the analysis of the oil is finished.

As the QC Manager also comments on, that relying on tests and analysis of the oil as documentation, can blind you not to question if the results always are too perfect: *"Trust can make you blind, that can*

also be a problem (...)(...) you can also get results that looks to good, that you have to question sometimes, if the supplier always delivers perfect results, but we sit with a product that we know have errors" (QC Manager: 45 min).
For that reason, traceability can help to serve with knowing the origin of the product, but that has challenges as well.

4.3.1.2 Traceability

With any complex supply chain, traceability is always a challenge to tackle, and that applies to EVOO as well. During my interviews, it became very clear that the issues with traceability was a major concern, and there is a focus on strengthening the current forms of traceability "systems".
At COOP Trading, the QA, who makes sure that the product information is in their system, extranet, is available and up to date, there can be issues with actually knowing about the traceability of the product. As she states: "*So our system, that is, the system I'm sitting with, reaches only back to what the supplier gives me information about, I don't have any (information) prior to that, I have faith that what my suppliers are telling me, is correct. (...)(...) I have no touch or sense of where the oil has been pressed at."* (QA: 21 min). The traceability is usually done by lot numbers, so the suppliers can retrieve information through that, if e.g, there is a disease breakout from a product (QC Manager: 29 min).
As olive oil is a product where fraud or fraudulent behaviour is a major risk factor, the suppliers to COOP Trading are well aware, that they need to do something. A challenge is to strengthen the traceability so the consumers, can trust that the product they buy are, in fact, what the bottle says is it, as stated by one supplier: "*To give transparency to the consumers. Suffered many attacks (olive oil) (...)(...), there is a need for the consumers, to be guaranteed that what is in the bottles is what there are paying for."* (Purchasing Supplier 1: 19 min).
But to give the traceability or transparency, the suppliers and their suppliers have to go beyond the law, as the law requirements only enforces traceability one step back, and one step forth: *"Our traceability is stopping there, at the mill, if there is a problem, then the authority goes to the mill, and the mill has to guarantee that where the olives come (from). The law requirement is until the first step*

(mill)" (Purchasing Supplier 1: 29 min). So, as the interviewed supplier of COOP Trading states, the traceability stops at the mill.

Before the olives arrives at the mill, brokers can be a intermediary, where they buy and sell olives for the farmers. The Export Manager from the Supplier 3 did not mince his words, when the subject of the steps before the product arrived at their production facility. Here the broker was mentioned: *"(We) buy directly from the mills or by broker. That's another problem, the broker is the worst person in the sector, as he just have to buy and sell, buy and sell."* (Supplier 3: 35 min). But he could understand why there was a use of a broker, by the farmers. They were usually small family owned businesses, where they don't have time or the knowledge to look into how to sell their produce. They want to focus on their olives/oil, and then hire a broker to sell their olives/oil. So, even though, the interviewed supplier didn't want to work with brokers, they had to, to be able to get olives/oil needed (Supplier 3: 35 min).

Which leads to another challenge, that to have full or greater traceability, you will need to accommodate small farmers, which don´t have big quality control departments and SAP systems, they handle their information usually by paper or email (Supplier 3: 7 min; appendix 3).

4.3.1.3 Information

Information about products, can be stored in different formats and entail a lot of details about a product. As illustrated earlier, information is usually stored in silos, where it is up to the individual participant to gather, store, and maintain it.

When the interviewees were asked about how they handle information, it is clear that a lot of time is spent on retrieving and handling product information (QC: 8 min). One of the challenges for COOP Trading is, what is *enough* product information: *"It may be a bit unclear what or how much documentation we need. What is good enough, or it might also be too much. Do you have to wear a strap and braces (...) (...) because you can spend a lot of time collecting information (...)(...) we ask our suppliers for extremely much information."* (QA: 27 min). With all the information that they need, the COOP Trading employees also mentioned that they use different platforms, to store the product information. There seems to be a confusion with, where to search and store product information data: *"our challenge in the department, is finding the information we need (...)(...) we know where to search,*

but we have to search many different places. Another challenge is that when we get information from suppliers, that it gets filed properly so we actually can find it again." (QC Manager: 28 min). She adds that they usually use Word to store information, and then have an Excel sheets for overview of who takes care of what (QC Manager: 25 min).

A more general challenge is, the many different formats that information can be stored in/as. As mentioned earlier, many farmers are small and low-tech, therefore information about the cultivar or oil are kept on paper. One supplier (supplier 2) says that they get their information to them in many possible ways: *"The information or documentation that we want, are either giving during the visit, or are giving to us through email or fax or any other electronic means."* (Supplier 2: 19 min). That is consistent with the feedback from the questionnaires, were they answered through; paper, or email, data system or other (being fax, telephone, in person) (appendix 3).
One of the key information issues that the suppliers were missing, was the information about how their product was stored at the supermarket. As they felt that, that played a large part in the quality of the product, the circumstances, because light, artificial light and heat can make the EVOO fraudulent, even if it was a EVOO when it arrived at the supermarket. So COOP Tradings suppliers wants a strengthened documentation sharing, to combat this challenge (Purchasing Supplier 1: 42 min; Supplier 2: 25 min; Supplier 3: 26 min).

4.3.1.4 Documentation sharing

Sharing the information at the supermarket, is not the only challenge. Business critical information, lack of digitization and Frame Purchase Agreement (FPA) is also challenges to overcome.
As with any partnerships of businesses, there are information that cannot be shared every part and all employees. An example at COOP Trading, is that the Buyer cannot have access to the recipe of the products, as this will hinder fair competition when choosing new suppliers or re-negotiating new contracts (Buyer: 26 min). In the more grander schemes of things, as COOP Trading procures to SOK (Finland), information about price and other relevant product data cannot be shared with SOK. This is

due to SOK is imposed to not have access, because of monopoly on the Finnish market (IT Manager: 10 min).
Something that has already been touched upon is the lack of digitized data. Many of the farmers and mills still use paper, as a mean of documentation, which can lead to easier alteration of the data, if participants want to and more difficult sharing due to many different sort of formats.
One of the legal challenges, due to the contractual conditions, is the Frame Purchase Agreement (FPA), as the QC at COOP Trading says: *"We have to look at the legal aspects, we have a FPA, were we can go to the supplier, we can´t go directly to the suppliers supplier, because we have to go through the FPA and let the supplier contact their supplier. COOP Trading, legally, only have access to one step back"* (QC: 15 min). Which can hinder the cooperation of documentation sharing along the supply chain.

In summary, the challenges with trust are diverse and very hard to concretize, as it's very ambiguous of what it entails but is a key ingredient in having an effective supply chain. With traceability, the different suppliers have to go beyond what the law requirements are, because the low traceability hinders an effective supply chain, especially when fraudulent behaviour seems a great concern. COOP Trading tries to combat this fraudulent behaviour, but finds it difficult to manage and keep track of all of their data, while their partners handles data in many different formats.
With the last part of documentation sharing, a major challenge was the FPA and how to handle internal business critical information, if this needs to be shared among participants in the supply chain. The next chapters will look into, how these challenges can be handled.

4.3.2 Identification of Opportunities

After I have analyzed the challenges, I will now analyze the opportunities that arose from interviews, questionnaires and workshop. This will serve to depict what opportunities the interviewees perceive to overcome the current challenges, and how blockchain might assist in being the platform to solve the challenges.

This chapter will have the same structure as the challenges chapter, for a better overview and to show the interdependence.

4.3.2.1 Trust

After the first interviews, it was clear that the role of trust and how qualify it, needed further research. This was the reason for a minor workshop with COOP Trading employees, to deeper examine their view of what trust means for them in relation to suppliers.

As stated in the method section (3.3.8), the five employees were split into two groups and asked to chose the words, to what they deemed most important with connection to *suppliers*, *information*, *traceability*, *documentation sharing* in relation to trust. The table (and appendix 4) below, shows the selected words. Economic approaches are highlighted with italics (and bold for the depicted), socio-psychological approaches with regular font.

The thesis will not dive into all the aspects of their reflections. The aim is to show if their reflections contain some of the aspects depicted in the literature section (contract trust, predictability and dependability), to where blockchain might be an opportunity to influence trust.

Table 4: Feedback from workshop

Round	Group 1		Group 2	
1. Suppliers	*Credibility* *Responsibility* **Contract Trust**	Truth/Honesty Reliability	*Credibility* *Responsibility*	Truth/Honesty Integrity Reliability
2. Information	*Competence-based Trust* *Responsibility* *Credibility*	Reliability Truth/Honesty	*Credibility* **Contract Trust**	Reliability Truth/Honesty Confidence
3. Traceability	**Contract Trust** *Responsibility* **Predictability** *Credibility*	Reliability	*Responsibility* **Contract Trust** *Competence-based Trust*	Reliability Truth/Honesty
4. Documentation sharing	*Credibility* **Contract Trust** *Responsibility*	Reliability Confidence	*Responsibility* **Contract Trust** *Credibility*	Truth/Honesty Reliability

At first, they found it hard to translate the meaning of the words to Danish, for a better understanding of the words, so much of the time during the first round was spent on what they as individuals thought the words meant. After that, they lively discussed what five words they deemed important, in relation to suppliers, information, traceability and documentation sharing.

The words that the employees chose is primarily the same (table 4), with a few exceptions, and with an even balance between economic approaches and socio-psychological approaches. By letting the employees reflect on what trust entails, shows the variety of the meaning of trust, especially if it has a focus, e.g. an supplier.
By doing this exercise, the employees had the opportunity to reflect upon how to better measure and qualify what, "to trust in X" means, instead of basing it primarily on a *gut feeling* (QA: 48 min).

In regards to the the relevant assessed forms of trust (bold), that blockchain might influence, *contract trust* is most prominent. This is due to their partnerships with suppliers is bound by contracts. Contracts is a governance mechanism, where it acts as a safeguard against opportunistic behaviour

from suppliers and detailed signed contracts can potentially increase COOP Tradings perceived level of trust. This will be examined further in the discussion, in relation to smart contracts.

When reflecting on trust in relation to *information*, the employees had a critical stance towards the information that they receive. Historically, it had shown them that information about products from their suppliers, not always is truthful. When asking for product information, due to the contract agreement, it might not be the correct information after all (Workshop: 21 min). That, even though the suppliers deliver the product information, might not necessarily earn the supplier more trust, because COOP Trading don´t know the origin of that information (Workshop: 21 min). The origin of the information is important, as this can assist in the predictability of the supplier, that partnerships with successful information transactions are less likely to suffer from information asymmetry, instead of just accepting at its face value.
Which are similar with *traceability* and *sharing the documentation*, where the origin of the product comes from and who actually manages it. That all the parties can view the relevant information they received from each other, thereby strengthening interorganizational trust and creating a form of *digital trust.*

4.3.2.2 Traceability

Even with the challenges that arose from the data, there is great willingness from COOP Tradings suppliers to change the status quo. An example from one of the suppliers, was that they had developed their own full traceability system (Purchasing Supplier 1: 13 min). They started two years ago, with their own products, where the customer through a QR code can scan the bottle and get all the information about the cultivar, seeds, energy consumption and so on (appendix 8). Basically a traceability system going all the way back to the tree. The supplier states that this traceability system also is physically isolated from other products. Meaning, the olives are separated from the others, and at the mill in separate lines and tanks as well when arriving to their own site, where they have a particular code/name and stored in isolated tanks from other products (Purchasing Supplier 1: 13-26 min). This

process is certified by the third party certification and verification company CSQA, and the supplier and their suppliers are ISO 22005 certified to be able apply this traceability system (Purchasing Supplier 1: 16 min).

An other of the suppliers also have a full traceability system. Where they use the production date to find the EVOO in their system, and by the productions date they can find a 5 digit lot number to trace that oil back to the tree. This is handled by the QC Department.

These initiatives is a result of the market forcing greater traceability in the supply chain of EVOO, demanding better traceability of products due to the vast examples of fraud in the sector (Supplier 3: 10 min; Purchasing Supplier 1: 19 min). Of course it comes at price, to have this full traceability system, so the suppliers are asking to be financially compensated for their efforts.

If COOP DK and COOP Trading can connect with their data inputs of the transportation and storage, the supply chain of the product will have sufficient sources of data to start with.

COOP Trading can make use of this data and traceability to create *storytelling* about their products. To tell the story of a family of olive growers on a hillside in Greece, by exploring the use of blockchain to tell the actual process of EVOO, truthfully, as the IT Manager suggests, with reference to Line Aquavit (IT Manager: 51 min; QC: 55 min). A QC employee talks about the use of using QR codes, as the mean to show if the cows come from farmer Jensen or another, what is has been fed and so on (QC: 55 min). Which will be an advantage that the blockchain might can utilize.

4.3.2.3 Information

But to create that story, the information to support it, has to tangible for a technological solution. It seems that there is a lot of product information at COOP Trading, but it is scattered on different platforms and data storages, which might be lacking some overall IT governance. But that is not within the thesis to address.

By looking to utilize a new technology, either as the foundation or as a part of the stack. Therein lies a great opportunity, to re-think the information needed for a solution to track and trace a product

through its life cycle. Furthermore, also look to the different sorts of information gathered, that could assist with improved data, with the e.g. of a supplier also storing the number plate of the truck that delivers the oil to their tapping facility (Supplier 3, 7 min). The same supplier said, after learning about blockchain from the information material sent via email (appendix 2), that: *"the blockchain, as in your project, that would be perfection, I mean, you know every step. You know where it is stored, but it is stored in a bad way can get information about storage (...)(...) But in this way you can see that it wasn't a fraud."* (Supplier 3: 30 min). To implement a tech solution across a supply chain with various participants having their agenda and stake in it, everybody has to obtain benefits from it, to be convinced that they benefit from adopting it. Weather that be greater knowledge about the products or more resource efficient, or both.

The IT Manager at COOP Trading also talked about the value of implementing new technologies. He believed more in RFID (Radio-frequency Identification)[4] chips, to give the proper information about products, as he states: *"I believe more in RFID. Because, in my experience with data, is that data quality can only be achieved at an acceptable level, if people have a share in it. What's in it for me."* (IT Manager: 39 min). But, he sees a great opportunity in having new data sources: *"To get some informations about the products, which we haven't had before"* (IT Manager: 39 min).

It is not an idea that has gone unnoticed with the use of RFID in supply chain, but also combining RFID and blockchain. RFID and sensor technology company Mojix, is teaming with Microsoft to offer a blockchain-enhanced version of its solution, so that participants can view their transactions related to RFID tag reads via blockchain-empowered smart contracts, for an optimized documentation sharing (Kastelein 2017).

[4] *A Radio Frequency Identification Tag (RFID tag) is an electronic tag that exchanges data with a RFID reader through radio waves. Although RFID tags have similar applications to barcodes, they are far more advanced. For instance, reading information from a RFID tag does not require line-of-sight and can be performed over a distance of a few meters (Technopedia).*

4.3.2.4 Documentation sharing

When the employees were asked to reflect upon what a potential new technology should feature, to improve the challenges in their daily work, automation was mentioned by all the employees. (QC Manager: 36 min; QC, 56 min; IT Manager: 51 min; Buyer: 38 min; QA: 40 min). Although by automation, both meant internally at COOP Trading and all along a products supply chain. As the QA employee states on internal matters: *"When the documentation arrives, it is automatically fed into the system."* (QA: 40 min). The Buyer talks about how information bottlenecks takes of a lot of time, so if you don't have to wait for the documentation to be shared, that would free up a lot of time (Buyer: 38 min). Of course they know at this time this is wishful thinking, as it is only 5-6 years ago that everything was strictly based on paper documentation.

On automation along the supply chain, there are added value to be discovered, as the IT Manager formulates: *"If you had an absolute knowledge about where this product comes from (...)(...) if you could automate the whole process, so when you in fact buy the bottle at the supermarket, that this exact bottle of extra virgin olive oil, in reality been on this trip."* (IT Manager: 52 min).

With most of the information still stored by analogue manner, there is still a long way to complete automation of data. But there is hope. In the questionnaire, with 5 out of 6 answering "yes", to the question if they don´t use computer systems right now, if they would look into data systems in the future (appendix 3).

When the supply chain participants are digitized, in one way or the other, then the participants could benefit from smart contracts, for contractual clauses which can be partially or fully self-executing.

In summary, the opportunities with adding or basing the supply chain on a blockchain solution, seems to have it advantages. By taking advantage of the how blockchain can positively improve contract trust, and how the traceability of products can help to serve a improved storytelling of the products. Especially if it's combined with other technologies like RFID for greater automation.

With every new technology that emerges in interorganizational exchanges, it has its beneficial attributes, but also critical aspects that needs to be addressed. The next chapter serves to analyze this.

4.4 Blockchain - Challenges & Opportunities

To give as clear a picture of blockchain as a supply chain platform as possible, these chapters serves to explain and analyze the present challenges and opportunities with blockchain for COOP Trading. This assists to identify what needs to be overcome, to be a platform of traceability, information and documentation sharing, to thereby reinforce trust. Which will be taking into account when conceptualizing the possible solution in the end of the analysis.

4.4.1 Trust

Blockchain technology may not be ready, at the moment, to conquer the world as the trust machine, but there is small steps in the right direction.
With trust, one might make more calculative, risk-decreasing, and enhancement of the prediction or expectations of the other actor's future behaviour in interorganizational exchange.

To strengthened trust to suppliers, blockchain as a stand-alone will not prevail, but act as a part of the stack to help fortify trust, as trust also contains socio-psychological aspects that blockchain cannot assist with. As a technology based solution, blockchain cannot assist with issues of human moral character, such as honesty, feelings and confidence. But it might assist to bring suppliers across the supply chain closer together, and stronger alliances among the relationships by smart contracts.

By analyzing *contract trust*, it was found that it was best suited for a particular context or product-specific and by applying the blockchain smart contracts for transactions, you can write *if* these criterias are met, *then* we have an agreement on this product delivery. That could be the quantity, price, delivery date and so forth. Nevertheless, with the possibility of smart contracts, an employee still needs to put the data into the system, each time the contract changes. But you can build on existing contracts.

Smart contracts are meant to be stand-alone agreements, that not are subject to interpretation by outside entities or jurisdictions. Meaning, the code itself is ultimate arbiter of "the deal" it represents.

With smart contacts, not just two parties can agree on terms, but all the parties can see the terms of the agreement. In order to move forward, expectations have to be met, and when the parties meet those expectations, the contracts can be fulfilled. This could be a great way to improve the supply chain management and contract trust. With the use of smart contracts, COOP Trading can make sure the different suppliers are meeting their obligations, due to the contract. COOP Trading can see deliveries at multiple locations, and the possibility to track shipments based on the fulfilment of smart contract terms. Smart contracts can help to reduce uncertainty and delays. Smart contracts, when fully deployed and functional, are autonomous and automatic. This can reduce the potential for human error and increases the predictability to timely and valuable information that one can depend on.

With the current system, as illustrated earlier, certifications play a significant role in the dependability and predictability of the suppliers. With the current system, certifications act as an unbiased third party system, to strengthen trust in the supplier. Every participant have to be individually certified, which is a costly affair. There are many different sorts of certifications, ISO, CSQA, HACCP, and panel tests for EVOO tasting (Supplier 3: 21 min). According to COOP Tradings suppliers, certifications is essential to be able to justify, that information and products are handled within requirements, standards and regulations (Purchasing Supplier 1: 31 min; Supplier 3: 21 min).

4.4.2 Opportunities

In continuation of above, there is a lot of potential to minimise the need of individual certifications, either to establish new *blockchain certifications* or look into which is relevant, of the current, with a blockchain solution. It would be in the pipeline to create blockchain certified supply chains, as Provenance has done to ensure the consumer of traceability of where the tuna came from (see 2.2.3).

Another possibility is real time data entries. When the products flow through the supply chain, the information about the product is entered as it passes through, for suppliers and COOP Trading to oversee. This would act as a proxy.

Blockchain enterprise solutions is still under construction, with Enterprise Ethereum and Hyperledger Project examining and testing different methods to possible applications of industry grade solutions. As outlined in the literature background section (section 2.2.1), COOP Trading have to weigh the advantages and drawbacks with the sort of solution they are seeking, either fully private or consortium blockchain, to develop upon what their requirements is and their suppliers as well. As of now, Hyperledger is focusing on enterprise level with their first version of Fabric as their solution. Enterprise Ethereum is still in the making, but with the aim to produce the industry standard, open source, free to use blockchain solutions that will be the foundation for businesses (Weare 2017). For now, Hyperledger seems most promising as a platform for the near future, but Ethereum is maybe worth the wait.

4.4.3 Challenges

One of the main issues is interoperability. Linking a system meant for verifying digital assets, to link physical products to a digital system. One of the key challenges is *garbage in, garbage out*. If a blockchain is utilized, the information going into the database needs to be of high and truthful quality. The data stored on a blockchain is not inherently trustworthy, so events need to be recorded accurately in the first place. If it´s not correct information all the way through the products supply chain, then garbage in, garbage out holds true in a blockchain system (Bauerle 2017). This is one of the main reasons of looking into combined solution with RFID tags.
Interoperability is also by the way of compatibility with the current data storage systems of participants, which need to be addressed, and in the end, when different sorts of blockchains also have to be compatible to each other.

The challenge of rules and regulations has already been depicted, with the Frame Purchase Agreement (FPA). On a larger scale there is EU regulations. This is however still in the initial phase, as the EC and European Parliament, this May (2017) held a workshop dubbed: *Spotlight on Blockchain: a new generation of digital services* (Boucher 2017). The aim was to cautiously approach the who, what and why of blockchain legislation. This was to listen to the blockchain community, to prepare for the challenges and opportunities it presents with the potential impact of blockchain(s). Furthermore, they discussed the interaction of blockchains with existing legal and regulatory frameworks. The workshop was moderated by MEP Jakob von Weizsäcker, who stated: *"It's probably too early to intervene at this stage, because we as legislators don't yet see sufficiently clearly to know what the main issues are going to be – so in order to not to stifle innovation, we don't want it to be now."* (Acheson 2017)
The EC is also looking into the challenges and opportunities of blockchain technology for various industrial sectors. The policy lab began #Blockchain4EU: Blockchain for Industrial Transformations in March 2017. This project aims to explore the possible uses and impacts of these technologies across a number of areas, including authentication and certification, supply chains, assets monitoring and so forth (Boucher 2017). So, for now, EC and EU are letting innovation take its course, for the time being.

These was just some of the issues, that blockchain implementation faces. There are many other galactic and specific challenges that needs to addressed for blockchain to become a reality, but due to the results of the interviews and their input, the thesis aims to focus on these. This will be further elaborated on in the conclusion.

4.5 Conceptual representation of a blockchain-based solution

In this chapter, a conceptualization of a blockchain solution will be outlined and illustrated, according to the previous visualizations. This is based on a combined analysis from the empirical data sources. It will be depicted and illustrated by the same token as the current process, first the product flow, to then illustrate and elaborate on the conceptualization in the end.

4.5.1 Product Flow

The major change from the current product flow (Figure 7), is the addition of blockchain connecting the different data points, along the product flow. The biggest changes is the first mile of EVOO, where the information needs to be digitized (Figure 13). Inspired by the Provenance example, they looked to the use of mobile phones, to deliver the information to the blockchain and to the next participant in the process. The use of mobile phones can be seen as an affordable way to digitize data capture along the supply chain to make data truly interoperable. Mobile phones are almost a household item, and if not (Supplier 3, 17 min), it is affordable to buy one. At first, this might be a duplicated process for the non-digitized, to make the smoothest transition and to have a backup.

The use of certifications can act to verify that the information is correct, as they physically oversee processes to hinder *garbage in, garbage out*, all accessible through blockchain.

When the product flows through, each data point will be a block added to the blockchain, so the product is visible at all times, for the intended participants. If combined with RFID to track and trace during transport, the system can contribute with stronger traceability, accurate and real-time information, and documentation sharing is as automated as possible.

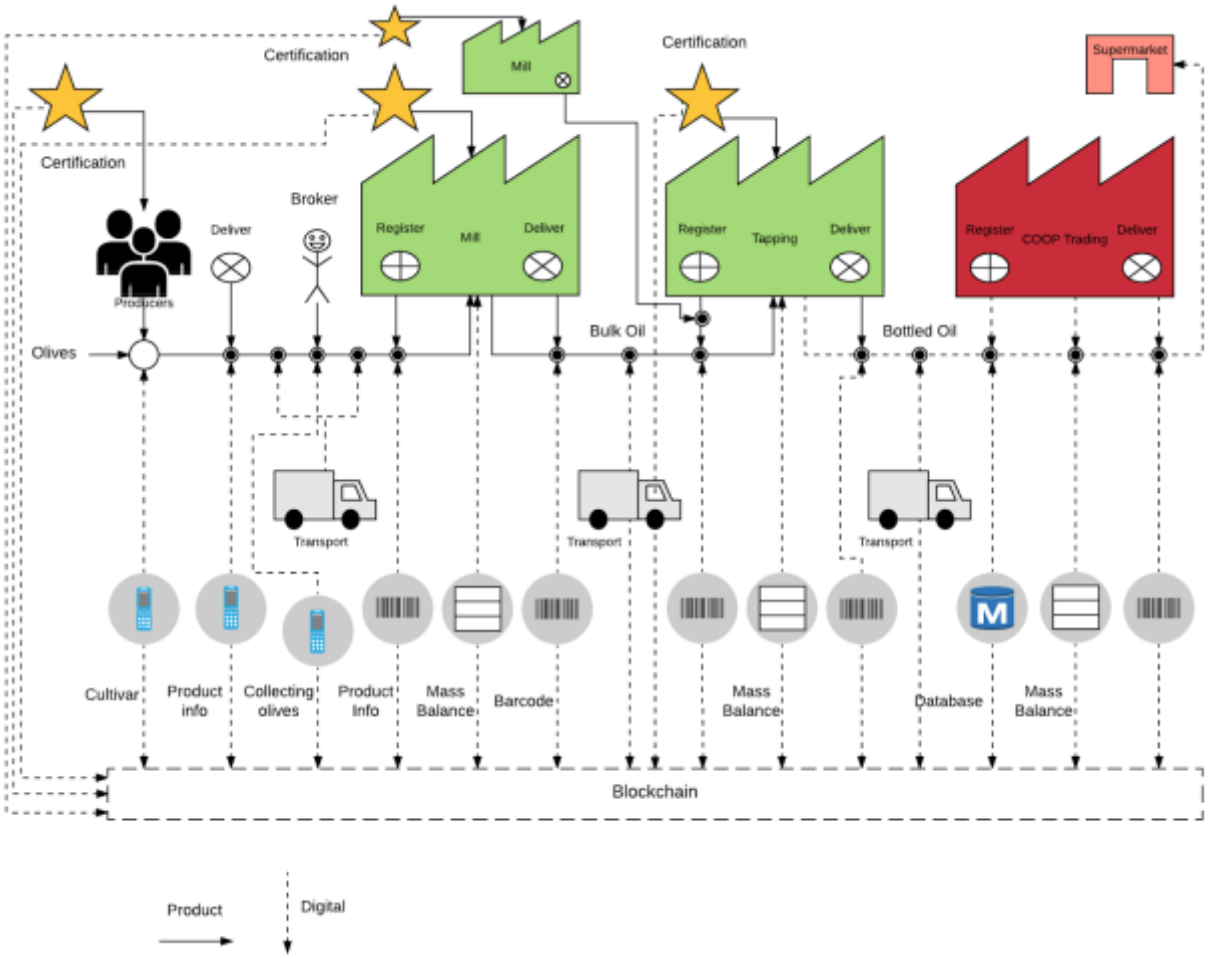


Figure 13 (and on Google Drive)

4.5.2 Business Process Flow

The process flow will be divided into three parts, to depict the many data points for the blockchain conceptualization of EVOO. The first is again the process between the farmer/producer and the mill (Figure 14).

The product flow (green line) is the same as before, but now information is shared to the blockchain application (the blue rectangle to the right). The farmer still has the information based on paper documentation, but now when the product is going to be shipped, the product information is shared by mobile phone either between the farmer and the broker, or directly to the buyer at the mill. The

information: company name, date of delivery and quantity and variety of olives is shared with the blockchain application, and in accordance with the smart contract between the parties. This is one of the most important steps in the blockchain, as this acts as the first block in the chain. To ensure that the information is correct, a certification body certifies it, and shares that with the blockchain for the parties to observe. There are two transportation scenarios, with barcode or RFID. With RFID tags the transport company scans the RFID tag, to identify the means of transportation and ability to track and trace all long the its supply chain. If done by barcodes, which will be the most likely, additional information can supplement the barcodes. At this point, pictures can serve as a valid form of documentation, with e.g. a picture of the truck and plates at departure and arrival, to ensure that it's the same truck from the farmer to the mill.

If the product goes through a broker, the information is shared to the blockchain by e.g. mobile phone, based on the conditions of the smart contract.

When the truck arrives at the mill, the process is the same before, but now the change is that the documentation needs to be digitized, for an API[5] to access the information and add it to the blockchain (illustrated by the thicker dotted line). The process is certified by ISO, HACCP and other certification bodies, and shared to the blockchain. This can, as with the farmer, also act to digitize that the product flow documentation is up to standard, if a database is still not possible.

The information of what needs to be delivered goes through the smart contract, between the Buyer from the tapping company and the Export Manager from the mill. The buyer can also see the certifications through the blockchain. When the product is shipped to the tapping company, the two earlier scenarios of RFID and barcodes is applicable here as well.

[5] *An application-programming interface (API) is a set of programming instructions and standards for accessing a Web-based software application or Web tool. E.g. a software company releases its API to the public so that other software developers can design products that are powered by its service* (Roos).

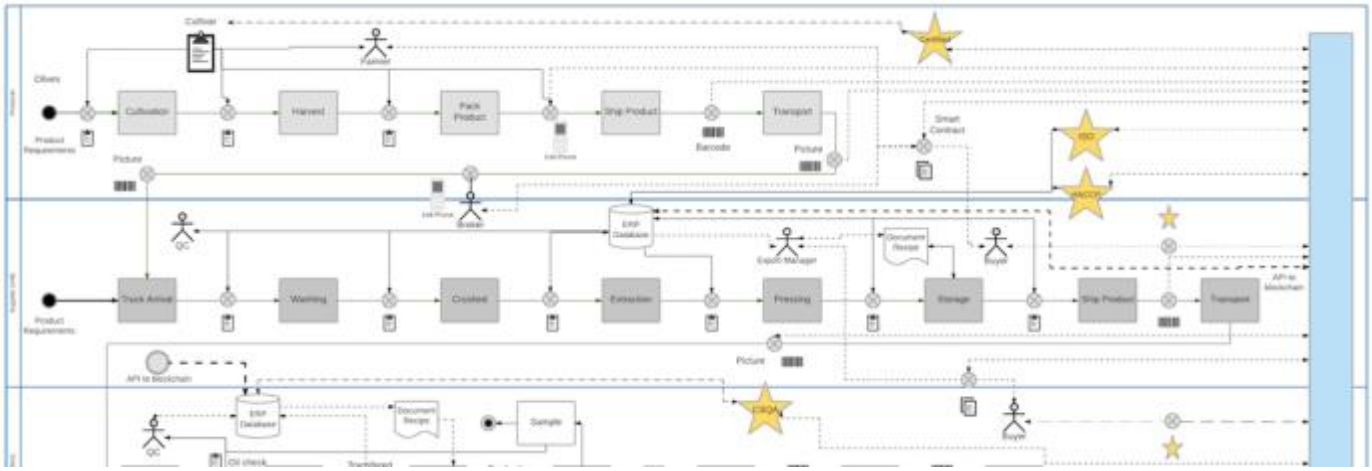


Figure 14 (and on Google Drive)

The start of the second part (Figure 15) is the product arriving at the tapping company, where the information shared to tapping company's ERP system is: date of delivery, quantity, quality of the oil, company names and trucks plate[6] (Supplier 3: 7 min). Again, API access from the ERP to the blockchain platform.

The quality of the EVOO is checked by QC staff (Tapping company) before it goes through all of the processes, to being shipped. When the product is bottled, based on the conditions agreed upon by the Buyer from COOP Trading and Export Manager, the analysis of the sample is stored for the QA at COOP Trading to examine via the blockchain. QA and QC at COOP Trading can see the certifications and test results of the product. An given the smart contract terms, the QA gets a sample to test the product, to examine if the analysis match with the suppliers QC analysis. COOP Tradings QC still oversees the suppliers production and certifications, but now only in person as information comes through the blockchain platform.

[6] The use of truck plates was only mentioned by Supplier 3 (7 min).

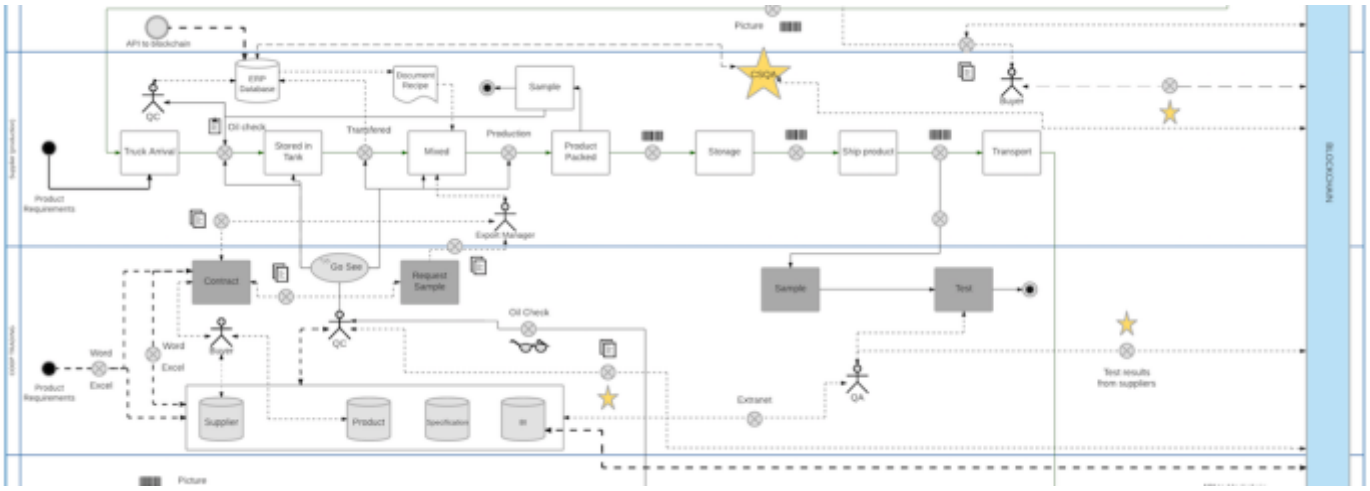


Figure 15 (and on Google Drive)

Third and last part (Figure 16) is the process flow is between COOP Trading and one of their partners, e.g. COOP DK. The product comes from the supplier and then passes through different stages at COOP DK, to end up in the supermarket, where the QC from COOP Trading have the possibility to check the EVOO, and store that information through the blockchain platform.

Again, a API access to the blockchain platform is needed to get the transaction information of the product from their BI (Business Intelligence) database, which act to add layers of information when the product passes through the last part of the supply chain (IT Manager: 30 min).

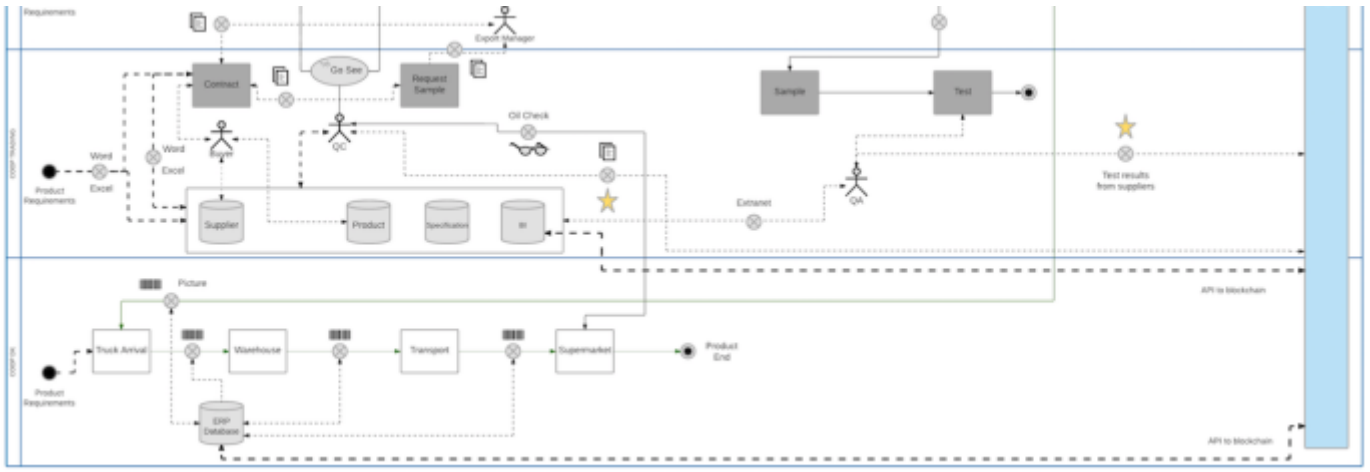


Figure 16 (and on Google Drive)

The last visualization (Figure 17), is which actor that needs to sign the smart contract, before the EVOO product can move to the next step in the supply chain. When a participant sign or updates the document, it is updated simultaneously. This visualization draws upon video material from an IBM and Maersk demo (Powers 2016).

Figure 17

The first step is when the olives are sent from the producer, that initiates a smart contract when the producer makes a packing list. Then the:

- broker signs that is the right information
- certifiers sign that the olives are within requirements
- transporters sign and photo document what they have transported
- mill Buyer signs if the product delivered is what is agreed upon

Second step, is when the product leaves from the mill. That indicates the following:

- that the Producer/Broker signs that the litters of oil pressed corresponds to the quantity delivered

- that the mill Export Manager signs the correct amount which to be delivered to the tapping company
- that the transportation signs for what they have transported to the tapping facilities
- that the Buyer signs, if product is what agreed
- that the QC analysis is stored of the delivered oil
- that the certification bodies sign the documentation that everything is up to their standards

Third step from the tapping company to COOP Trading, where the:

- Export Manager signs what is going to be delivered to COOP Trading (COOP DK)
- transporters sign what they have received and delivered
- Buyer signs that the product received is what was agreed upon.
- QA signs that their sample test is acceptable
- QC signs that they can guarantee approval of the supplier and their suppliers

The process from COOP Trading to COOP DK has not been examined, due to the focus of exposing the possible “fraudulent” steps of the supply chain of EVOO.

The conceptualization should enable close to real time exchange of original supply chain events and documentation through a digital infrastructure, or data pipeline, that connects the participants in a supply chain ecosystem. This promotes sustainable and transparent transport by integrating transportation processes and partners, and establishing evaluation frameworks through increased transparency and a more trusted access to information.

4.6 Summary

The analysis aimed to depict the aspects of the supply chain of EVOO and trust. The quality standards of EVOO are analytical parameters that allow the oil to be classified according to a scale of quality. That quality is under pressure from fraudulent behaviour, that aims to label other types of olive oils as EVOO. Which is exemplified by the The Danish Veterinary and Food Administration action team that found adulterated EVOOs at Dagrofa and Dansk Supermarked. Fraud occurs in very complex supply chains, where IT can assist to an optimization and to a more efficient process.

The process of EVOO is in primarily in four phases, agricultural/cultivation phase, production phase, tapping phase, which finally lead to the transport/distribution phase.

When depicting the product flow, it was found that information was stored by each participant, data silos, and in many different formats making it hard to track and trace products. For that reason, certification bodies act to ensure that everything is handled correct, according to legislation.

A detailed business process flow was illustrated, to show the intertwined process of the product and the participants that are a part of the supply chain process. With a complex supply chain, there inherently is challenges. The identified challenges were the difficulty to qualify trust as it's very ambiguous of what it entails, but is key to an effective supply chain. That was attempted to qualify by a workshop, where contract trust was mentioned to influence trust. The challenges with traceability is the different suppliers have to go beyond the contractual and law requirements to hinder possible fraud. Here one supplier had executed their own full traceability system, because they knew the need for greater traceability. With information, COOP Trading employees finds it difficult to manage and keep track of all of their data, while information at different suppliers are in different formats. The opportunity, when a potential technology needs to be developed, is to look to what are the required information. To get monotonous information, RFID serves as a potential to gather real time and trustworthy information. Finally, with documentation sharing, the major challenge is the FPA and how to handle internal business critical information at COOP Trading. This is challenges that needs to be addressed on higher authority level. But the opportunities were to look into smart contracts for automation of the information flow.

The blockchain chapter examined smart contracts, as the mean to enforce contract trust. The opportunity to influence trust, is the real time data entries, that one can oversee the product from a to z. But the challenge with information data is garbage in, garbage out, the interoperability with the system and the physical products. Consequently, the issue with the contractual FPA and the law requirements for a possible solution, because of the great uncertainty about the formulation of by, e.g. EU and EC on blockchain in general.

To round off the analysis, a conceptualization of a possible blockchain solution was illustrated and a visualization of who needs to access to sign the smart contract along EVOOs supply chain.

The next section serves to outline the results of the thesis, by discussing key issues from the analysis to discuss the contribution to the literature and practical implications.

5. Results

In this section, the results of the thesis is outlined in a discussion and a conclusion. This serves to explicit the findings, by discussing and concluding the contribution to literature and the practical implications. Which in the end will suggest key issues that needs further research and investigation.

5.1 Discussion

The purpose of the discussion is the practical implications that needs to be addressed, before the blockchain conceptualization can serve as a possible supply chain technology.
Is there a need for a new technology like blockchain in supply chain? It would seem so, since today's current systems, can not yet deliver the proper solution, since fraudulent behaviour or adulteration/tampering of agri-food is still taking place. Even if the historical track record shows that companies invest in technological solutions, such as ERP systems and SAP, there still seems to be an

implicit assumption that technology provides the only feasible solution to our complex problems. Blockchain might be perceived as the technology that holds somewhat quasi-magical powers, in this pursuit to influence or reinforce trust, strengthen information quality and automate documentation flows in interorganizational relationships.
But when we have to combine technology and the real world, there seems to be an interoperability challenge with trusting the technology and to trust that participants in the supply chain shares truthful information to the system. Because participants can act opportunistic in these complex supply chains, with a globalized market where no one person can oversee everything, blockchain as a technology, might assist in creating greater traceability, strengthened information and documentation sharing.
But, as examined in the analysis, the challenges of interoperability and what is gained by implementing blockchain needs further discussion. This will be discussed with a focus on information quality, legal issues and contract trust.

5.1.1 Information quality

How is this system better than others? It is still humans that interact and fills data into the blockchain system, so there is still an inherent problem of *garbage in, garbage out*.
The garbage in, garbage out discussion is far from recent, but with blockchain is essential due to the chain of records is connected to each other.

With implementing any new technology, the requirements to that technology should be as clear and explicit as possible, e.g. what sort of information is required. If COOP Trading or COOP in general wants to investigate the potential, a in depth discussion on what sort of information needs to be a part of the blockchain solution is critical. Because, as stated in the analysis (section 4.3.1), there is confusion on how much information is needed on a product and where to store that information. The employees use a lot of their time retrieving information, and finding it again when it needs to be utilized.
Even though, COOP Trading have made an excel sheet of WoW (Ways of Working), to explicit what is to be send to the supplier and if to stored in internal data systems. This could be an obstacle for an

implementation, if the information and documentation added into the system, are of quantity instead of quality. By exploring an implementation of a new technology, this could serve to discuss what the added value of the information is, to determine what information is required to be a part of a blockchain solution.

The mind-set of *from zero to hero* could be a way to address the situation. From zero to hero is an expression that states, that to make a change, you have to start from scratch, the genesis, to at some point be able to utilize the full potential in the end. You start small scale as an incremental innovation, learn the system and its potentials and limitations to how it works live. Then gradually roll-out, to include different agents along the supply chain of EVOO. This is also applicable for the blockchain conceptualization, for a successful future implementation, that COOP Trading try and fail in small steps, to gather knowledge before applying it in a full scale. In the end, COOP Trading have a PoC (Proof of Concept), then that PoC could organically be applied to other high-risk products, such as fish or honey, with other channels of information and issues (Hero).

By building a genesis and something unique like a blockchain solution in supply chain, you need to be aware of the costs (ROI) and the learning effects, to evaluate the efficiency gains and investment cost in the effort to create the solution.

One of the proclaimed efficiency gains is the automation of the data, by the use of smart contracts. Smart contracts is a governance mechanism, that lets intelligent, embedded program code, be built into terms by participants. These terms of conditions and other logic are built into these contracts. The idea is that it allows business partners to automatically monitor prices, delivery times and other conditions, and automatically negotiate and complete transactions in real time. This should in the end assist the participants in tracking and tracing, to get the truthful information and automated documentation of a product.

But the key challenge is getting truthful data into the system, to limit garbage data, as the employees reflected upon at the workshop. Smart contracts as a technology will not solve the problem on its own, there is need to ensure the interoperability between the physical and digital world. One of the ideas analyzed was the use of RFID tags in a combination with blockchain. This seems as a possible solution

to combat faulty data. The use of RFID can assist to get as close as possible to legitimate correct data. By the use of RFID instead of barcodes, is greater security as it cannot be easily replicated, and consequently, increases the security of a product. RFID tags can store data, whereas, a barcode has the ability to only read digits. But to digitize products, comes at a cost. RFID can prove too expensive to implement in products, and also have interference problems from other devices. In relation to EVOO, it can be difficult for an RFID reader to read the information, in the of case tags being installed in liquid or metal products. The challenge is that, liquid and metal surfaces tend to reflect radio waves, which can make tags unreadable (Buzzle). RFID has its pro's and con's, but has the potential to secure truthful data. COOP Trading can also look beyond RFID and investigate other potential tracking systems, such as NFC technology (Faulkner 2017) and nano-spirals (Wood 2015).

A combined strategy with RFID of getting truthful data, is to let the person that handles the specific process, enter the data. In the blockchain conceptualization, the use of mobile phones can be applied to digitize the where data usually is in paper formats and let the actual person enter the data. Which can explore other possible data sources, e.g. pictures. Pictures is a powerful tool in storing the correct data. If CCP of the process of EVOO was photographed, this could assist in ensuring that these two pallets of olives was delivered at that time, or photographed trucks when they departed and arrived, to minimize the risk of the oil being transferred by different trucks, making it harder to substitute the oil along the transport. This can still be garbage data, but making it explicit who has entered the data along the supply chain or been a part of the process, might incentivise to think twice, as a personal responsibility is at stake. This can also flip the knowledge of the product's journey, that it is not only COOP Trading and consumers that can see the full supply chain of EVOO, but also the farmer being able to oversee the process of his produce, making him a more important part of the whole process. In general, the initiatives can be seen to make it harder to tamper and adulterate information.

But it eventually might come down to governance and legislation. If the implementation needs to be up to certain standards and what a blockchain solution needs to withhold to be able to operate. There are many potential initiatives that can be taken, to strengthen the information inputs, but if it goes against

the legislation on the field or if there is lacking governance on the matter, it can hinder an effective solution.

5.1.2 Legal implications

One of the major issues surrounding blockchain in general, is its impact on current legislation. You can compare blockchain software with a that of regulating a car, as Noelle Acheson blockchain lecturer and CoinDesk producer uses to clarify the challenge. If the car isn't used, it's not to harm or does not inflict any problems on the current system. But, when someone is behind the wheel, that can change. Rules and legislation exist to regulate intended behaviour of the builders and users. The design of a car and blockchain requires certain security precautions. A driver of a car need to know that the brakes will work and that the engine won't blow up when ignited. Of course, hardware in terms of a car is not the same as software, but the premise that some guarantees of security are necessary still holds (Acheson 2017 2).
One can argue that legislators can let the market decide. Just with car makers, those who don´t take extra steps to ensure the design integrity, is also those that tend to go out of business, so could the market of blockchain craftsmanship, that poorly crafted blockchains will be irrelevant, as the market can comprehend a well-crafted from a poorly engineered (Acheson 2017 2).

The challenge is, we don't yet know what the actual uses of blockchain in supply chain will be. Is the adaptation going to be the public, fully private or consortium blockchains? As analyzed, is to weigh the pros and cons of what the different solution offers. We are only in the first steps of developing industry grade solutions, outside the Bitcoin framework. Hyperledger has just released its first version, Fabric, and Ethereum consortium is still in the making of their solution, building their EntETH 1.0, which will be the protocol that is the basis for the consortium alliance’s ongoing work. The architecture seeks to accomplish three key objectives: configurable consensus, privacy and rules based access control (EEA 2017).

It can be assumed that COOP Trading will look into consortium blockchains, as this, while utilizing the general possibilities of blockchain, can ensure that the right to read the blockchain may be restricted to certain participants, so sharing of business-critical information is limited to those who requires the information. This is what hundreds of pilots and proofs-of-concept currently are investigating, what the actual potential is for applications.
With looking to legislation, the actual application of either private vs consortium networks require two different approaches. While it's possible to draft legislation regarding the development of private blockchains, creating it for consortium is harder, as many participants will need to have their say, due to their stake and role in the supply chain. Which then will be legal questions, that origins as result from the intrinsic features of blockchain technology (Stark 2017).

As result of trying to develop blockchain applications, there is still a need for a *stamp of approval*, that these blockchains has some sort of certification, emphasized by the interviewed suppliers, that a supplier needs a certification to illustrate their capabilities. Certifications in supply chain plays an important part. Certifications is utilized to approve and authorise that the participant is acting within law requirements, which is a demand from COOP Trading, that they have to be certified by legal bodies to be their supplier. But when blockchain comes into play, there will be a demand from suppliers to get some sort of certification. One of these could be ISO, as ISO in general is an accepted and required standard in supply chains, with ISO 22000/22005. ISO develops voluntary, consensus-based, market relevant international standards to support innovation and provide solutions to global challenges. ISO are currently in the process of a standardisation of blockchains and distributed ledger technologies. This is to support interoperability and data interchange among users, applications and systems (Courtney 2016). This is a step in the right direction, as regulated applications and use cases would imply a certain level of security, which the market and COOP Trading will likely prefer. Even if innovative opportunities arise in more unregulated areas, there would still emerge an advantage of approval from trusted certifiers and standardisation bodies.

EU and EC appears to be following this path of innovative opportunities arise in more unregulated areas. With EU´s and EC´s, with von Weizsäcker in front, innovation-first philosophy could end up supporting development of applications, contributing to work on solutions to see what works in different sectors. As the supply chain sector needs different legislation than handing money to refugees in Finland (Daily Fintech 2017). Noelle Acheson states, this could support the development from two angles. This could encourage the exploration of use cases, which then will test the impact and laws, and secondly give entrepreneurs confidence in, that their "approved" applications will be more trusted in return (Acheson 2017 2).

One of the current legal challenges, due to COOP Tradings contractual conditions with their suppliers, is the FPA. This is due to the FPA inflicts with sharing or accessing product information beyond the supplier. COOP Trading it not legally entitled to have access to the supplier's subsuppliers information, this have to go through the FPA (QC: 15 min). Where is states in the contract that the supplier shall provide, upon COOP Tradings request, the product data that has been agreed on (FPA). But it also states, under exchange of information that: *The parties (supplier and COOP Trading) undertake to exchange immediately any information concerning possible damage risks and any cases of damage that have already occurred. They undertake to work together cooperatively in measures taken to avert risks to ensure that these measures are carried out smoothly.* (Ibid). Which might open for the possibility to exchange any information, and not just when damage has been done. But that requires further investigation, which outside this thesis to explore.

It is apparent that legislation and certifiers play a very important role in defining the governance surrounding blockchain in general, and the specifics within the field of blockchain in supply chain creating the framework for e.g. COOP Trading.

5.1.3 Contract trust

I have already discussed smart contracts in relation to garbage in, garbage out challenges. But as with many of the aspects depicted in this thesis, parts are intertwined. This also applies for smart contracts, as it is intertwined with trust. This chapter serves to discuss the contribution of blockchain to literature of trust and the influence on trust. As explained in the literature section, trust is a very intangible. This was the main reason for a workshop with COOP Trading employees, to examine the field and make it more tangible. This tangibility is of course from the viewpoints of those who participated, so it is based on their reflections, whereas suppliers might have different views. This assumed valid, as it is COOP Trading that seeks to discover the possibilities with blockchain. From their reflections, contract trust was, out of the three depicted, the most prominent in their selection of what trust contains. This is the reasoning for examining contract trust further.

As examined, classical contract theory states contracts are defined as agreements in writing between two or more parties, which are perceived, or intended, as legally binding (Woolthuis 2005: 817). But these contracts can vary in the degree of completeness, i.e. some contracts contain more specific clauses. As a rule of thumb, the more complete a contract is, the more legally binding it is. Consequently, because more clauses can cover more aspects of the relationship between the participants, and because more specific clauses are easier to interpret and enforce. Accordingly, incomplete contracts leave more open to interpretation and are thus less legally binding (Ibid: 817). Therefore, it is essential to make the contract as complete as possible, to ensure that if anything goes wrong, the responsibility can be targeted at the right agent.

How are trust and contracts related? Contracts are very explicit, and trust is something implicit, as stated by Sako (1997): *"An expectation held by an agent that its trading partner will behave in a mutually acceptable manner''* (Seppänen 2005: 252). Therefore, it is easy to put emphasis on contracts as a basis for trust, since it limits the opportunities and incentives for opportunism by suppliers. However, contracts can also be hurtful to trust development, since contracts can be interpreted as a sign of distrust by other participants. Why is there a need for a very extensive contract, if the supplier

always has held their end of the bargain and have nothing to hide. In other words, contracts and trust can also be negatively related (Woolthuis 2005: 833). Contracts can reduce the level of existing trust and/or disable the further development of trust, if contracts throw unfounded suspicion at a supplier.

With the case analysis by Woolthuis et al (2005) the studies found evidence that *high trust and formal control are found together and can be conceptualized as complementary mechanisms in inter-firm relationships*. But on the contrary, some studies found evidence that if there were other forms of trust, this could reduce *the need for contracting and monitoring and hence trust can be conceptualized as substituting for formal control.* So, it seems to depend on the circumstances that surrounds the specific relationship (Woolthuis 2005: 818). But with the inherent risk in the supply chain of EVOO, contracts can serve to clear expectations and act as a safeguard, to be able to intensify focus on other matters of trust. This however still rests upon that the challenge of truthful data, is handled.

If blockchain succeeds to overcome the challenges to connect the physical and digital worlds, then we could talk about *digital trust*. Digital trust, would be a form of calculative trust, that one can place trust in a technology to handle what is to be expected of it, without being worried about breaches. Digital trust would then be a technology that can bridge the gap between the two worlds. As more and more companies look to technological solutions, there might be a need to define how one can qualify digital trust. Blockchain has some inherent qualities that qualifies the technology to accomplish a form of digital trust, by managing one of the approaches to measure trust, contract trust. Blockchain, can remove the need to reconcile each transaction with a supplier, thereby minimise errors. By implementing business rules by the use of smart contracts, transactions can only take place if approved or certified, or if another transaction has been completed first that puts an automation in motion. By the possibility of handling contract trust, that could turn focus to other forms of trust that a blockchain cannot assist with, sociological/psychological trust.

The relationship between trust and contract is complex and dynamic, to then add a technology like blockchain that still is under configuration, can make it more difficult to understand by participants and

employees in the supply chain. Participants and employees that fear opportunism and fraud view their contracts as a safeguard against opportunism, whereas participants and employees that have a trustworthy relationship, due to their history tend to interpret contracts as a way to develop distrust (Woolthuis 2005: 833).

In sum, there is still many aspects that needs to be addressed, before a blockchain solution will handle the supply chain of EVOO or other products. Some of the other aspects that the thesis did not address, is given account for in relation to boundaries of the thesis.

5.1.4 Evaluation of boundaries

This chapter serves to explicit the boundaries of thesis and to evaluate the results, to reflect upon credibility and applicability of the thesis's findings.

The theoretical underpinning of trust, was chosen due to the noticeable coherence with blockchain technology being dubbed the new basis for trust. This was also noticeable in literature about interorganizational exchanges. This excluding of not examining other theoretical perspectives can make it a one-sided affair. There are other theoretical domains that could have contributed with valuable aspects, by investigating transaction costs, change management, IT governance, IT implementation and so forth. But as the theoretical and qualitative analysis have shown “trust” in itself, as a research field, to be very multifaceted and intangible. Consequently, as a result of this, it was important to unfold the theory of trust to understand the many aspects, to be able to qualify what “trust” is, in relation to the technology and case.

5.1.4.1 Method

In regard to the method, on how the thesis was constructed, it is worth to explain the boundaries that I did not investigate or what could be improved. By adopting the stance of Corbin, when discussing qualitative research, that instead of using the terms *reliability* and *validity*, use the term *credibility*. As

he states: *"To me, the term "credibility" indicates that findings are trustworthy and believable in that the reflect participants`, researchers`, and readers´ experiences with a phenomenon but at the same time the explanation is only one of many possible "plausible" interpretations possible from data."* (Strauss & Corbin 2008: 301-302). To make the findings more trustworthy, it is essential to explain the boundaries of the thesis.

Credibility

By addressing the credibility of the thesis, there are certain aspects, that could have improved the findings.

One of the major improvements would be the ability to test the results and findings. At this point the visualization is "only" a conceptualization of a blockchain solution. It would have been beneficial to have explained and presented it to other participants, by getting feedback from suppliers on their stance, and general feedback from every participant on a EVOO product.

It would indeed be beneficial to get feedback on how the blockchain would act, when in operation. This testing would add valuable insights, to reflect upon what needs to be changed due to spillover effects. Spillover effects is valuable findings, as new technologies might act differently, when outside a closed environment. But as blockchain technology is in its early stages of development and adaptation, it's too soon to say how the actual implementation will be, with many unanswered questions still remaining.

In relation to the collected data, qualitative interviews have implicit challenges. Achieving reliability is challenging due to each interview is somewhat unique. This variation of interviews may not be thought-through, because there are differences between interviewers in terms of the questions asked, the atmosphere, the physical surroundings. This is not necessarily a deliberate effort to distort the process, by the interviewer, but rather due to the interactive nature of the interview and the various biases and limits that impact on human decision-making. This is clearly visible when interviewing five employees at COOP Trading, three onsite and two skype interviews with suppliers, there will be variations and unanticipated situations.

An improvement is extending the limited extraction of interviews. The possible implementation of blockchain will have consequences for participants that have not been a part of the data collection, e.g. farmers, brokers, banks and so forth.
To strengthen the qualitative findings, I have personally visited a supplier to see at first hand the process of EVOO, and arrange in-person interviews. Consequently, also arranged a "workshop", to strengthen my theoretical findings and blockchain conceptualization, by receiving their reflections to data-iterate.

In regards to the quantitative data, the clearly lack of respondent feedback is a hindrance to make more general assumptions about the results. This was tried to be managed by generating closed questions and translating the questionnaires into the mother language of the recipients (Note: that the questionnaire send to Greek participants was in English).

Applicability

By examining the applicability of the results of thesis, it most prominent to state the boundary of the analysis of the supply chain. By not taking into account all of the participants, e.g. customs, banks etc., there is a possibility that this could have resulted in different findings, to depict the actual supply chain as whole. But as the underlying premise was fraud with EVOO products, it was prioritized to focus on the critical participants that produce and process EVOO.
Following this, it was to investigate the process flow between these participants to discover what and how information was shared. As this is of high importance to examine more closely what information blockchain should handle. A boundary is still how this information process of physical data is reflected in the digital world, and vice versa. The issue with garbage in, garbage out needs clarification, as this is a critical bedrock for blockchain to serve its purpose, and thereby be a more sustainable solution than existing. A possibility is the adjacent technology RFID, which can be altered to certain needs, so it can serve the purpose of receiving and sending truthful information.

As described earlier, that the conceptualization needs to be tested, to study the spillover effects, which can hinder to know the full applicability potential.

In summary, this serves to explicit the boundaries of the thesis, to create a trustworthy foundation. To be explicit about what the thesis findings, can and cannot, influence.
As Corbin states on what is "quality" in qualitative research: *"It is research that is creative in its conceptualizations but grounded in data. It is research that stimulates discussion and further research on a topic.* (Strauss & Corbin 2008: 302).

5.2 Conclusion

To conclude the thesis, I will state the research question to form a argument on how I have answered the research question:

How can blockchain technology influence the role of trust and solve the challenges in tracking and tracing extra virgin olive oil throughout its supply chain, and what would a conceptual blockchain design look like?

To answer the research question, the section has been divided into chapters, contribution to literature, contribution to practice of the challenges and the conceptualization of the solution, consequently discussing future research.

5.2.1 Contribution to literature

To answer the first part of the research question: *How can blockchain technology influence the role of trust?*, I examined the field of trust in interorganizational exchanges, to discover what kinds of trust, researches before me had investigated. This led to academic literature by Seppänen, Blomqvist and Sundqvist (Seppänen 2005), as they have analyzed the theoretical approach, the conceptualization and

operationalization of trust from 1990-2003. Seppänen et al. found a great variety of conceptualizations and operationalization's attempts to measure interorganizational trust. But to align it with the potential influence of blockchain, trust was concretized to *contract trust, predictability* and *dependability*, as this was deemed where blockchain might influence trust. Following this, a description of the three aspects was outlined, were contract trust is contracts that acts as a legalistic mechanism in interorganizational relationships, to counter opportunism, and where trust is lacking or as a substitution. With predictability, that one knows in advance that something will happen, as this can prevent information asymmetry. In similar terms, that dependability refers to the expectations that the partner will act in the alliance's best interest.

When I interviewed the employees at COOP Trading, on the subject of trust in relation to suppliers, trust had a ambiguity. Trust was hard to qualify and what it entails by the employees, but it is a key challenge in having an effective supply chain. For the interviewed suppliers, trust was partly relied on control mechanisms and certifications, as they knew that EVOO was a subject to fraudulent behaviour. To make trust more tangible for COOP Trading employees, I held a workshop that showed the variety of the meaning of trust, and what trust entailed. Contract trust was most prominent of the three depicted. This is due to suppliers are bound by contracts. Contracts acts as a governance mechanism, to safeguard against opportunistic behaviour and detailed signed contracts can potentially increase the level of trust. However, conflicting academic studies on, if contracts strengthen the level of trust or the other way around. It seemed to depend on the circumstances that surrounds the specific relationship and their historical relationship.

As a result of the workshop, it was found that employees sometimes had a lack of confidence in the product information received, which would affect contract trust. So trust was intertwined with the garbage in garbage out issue, with information needed to be of genuine authenticity for blockchain and smart contracts to operate. If that succeeds, to connect the physical and digital worlds, then there might be a emergence of *digital trust*. Digital trust would be, that technology can bridge the gap between the two worlds. It was found that blockchain and smart contracts inherent qualities, might qualify the technology to accomplish a form of digital trust, by managing one of the approaches to measure trust, contract trust.

Therefore, the relationship between trust and contract is a complex and dynamic one, sometimes reciprocal. Then to incorporate a technology like blockchain, which still under configuration, can make it even more difficult to understand the potential by participants and employees in the supply chain. Blockchain have great opportunities to influence the role of trust, by developing a form of digital trust, but critical issues need to be addressed before that can take place.

5.2.2 Contribution to practice - Conceptualization

This section serves to answer how blockchain can: *solve the challenges in tracking and tracing EVOO throughout its supply chain*. By addressing this, subsequently illustrate: *what would a conceptual blockchain design look like?*

As there were many possible interpretations from the data on the challenges, the thesis focused on information quality and legal and certifications.

5.2.3 Challenges of developing a blockchain at COOP Trading

This trusted distributed ledger, blockchain, can remove the need for reconciling each and every transaction with a supplier, implement business rules, by applying smart contracts. That a transaction only takes place if two or more participants endorse them, or if another transaction has been completed first, due to the built-in method (hashing). But as analyzed, there are challenges that need to be addressed.

Internal

As COOP Trading is the case partner, it is worthwhile to explicit the hands-on challenges. Through the work process, by examining internal documents and interviewing employees, different challenges presented itself.

COOP Trading only transitioned from paper system to IT 5-6 years ago, therefore the work process of handling documentation is based on Excel and Word files. Which leads to the inherent challenge of getting, handling and storing the data correct. As the quote from the QC Manager sums up: *"our challenge in the department, is finding the information we need (...)(...) we know where to search, but we have to search many different places. Another challenge is that when we get information from suppliers, that it gets filed properly so we actually can find it again."* (QC Manager: 28 min). COOP Trading is working on their approach with the internal process (WoW).

Following this, the information they receive from their suppliers is bound up on trust, that they trust their suppliers to deliver correct information, so they can obtain traceability of EVOO, by information and documentation sharing. This trust also has a connection to certifications of their suppliers. But that trust is hard to qualify, but at the workshop, they reflected upon what "to have trust" in relation to their suppliers entailed.

For the possibility to gain or strengthen that trust, blockchain could assist as the solution. But the internal challenge is the cooperation with existing data structure, to allow API access to the relevant systems (BI database). This would be related to the work process, as documentation currently are in Word and Excel files. Accordingly, also take into account the specific internal challenges, as some employees can't have access to specific product information, e.g. the Buyer. The blockchain solution also rests upon the choice of platform from either Hyperledger or Ethereum and the actual execution of how it is build. In general as a public, private or consortium blockchain with the many trade-off´s along the planning, design and construction phases due to choices.

External

To develop a blockchain solution, will also encounter external challenges. Intertwined with the internal challenges is FPA and certifications.

The FPA is a illustration of contractual conditions, that inflict one of many legal challenges that lies ahead. The FPA obstructs the possibility of freely sharing product information, by only letting COOP Trading go through their suppliers to get information from the supplier suppliers. This is overcome by relying on certifications, to approve and authorise that the participants is acting within law

requirements of EVOO, *a stamp of approval*. The challenges arise from blockchain technology pushing the boundaries of former solutions, so the legislation is not in place to handle all the different implications, for now. Rules and legislation exist to regulate intended behaviour of those who build and end users. Compared to the design of a car, the driver of the car need to know that the brakes will work and that the engine won't blow up when ignited.
Consequently, is the challenge of not blowing up the car, by feeding it incorrect data. This is the challenge of *garbage in, garbage out*. This is a crucial challenge because a blockchain solution is only as strong as its weakest link, where the information fed into system needs to be of real authenticity, as the chain of records is connected to each other. This is one of the known challenges, but when in operation, there will be spillover effects that the developers did not think of and therefore are unforeseen challenges.
The consequences of the intertwined challenges above, will need to be addressed in further detail than this thesis allows, but I, informed by literature, qualitative and quantitative data illustrate a possible conceptual solution.

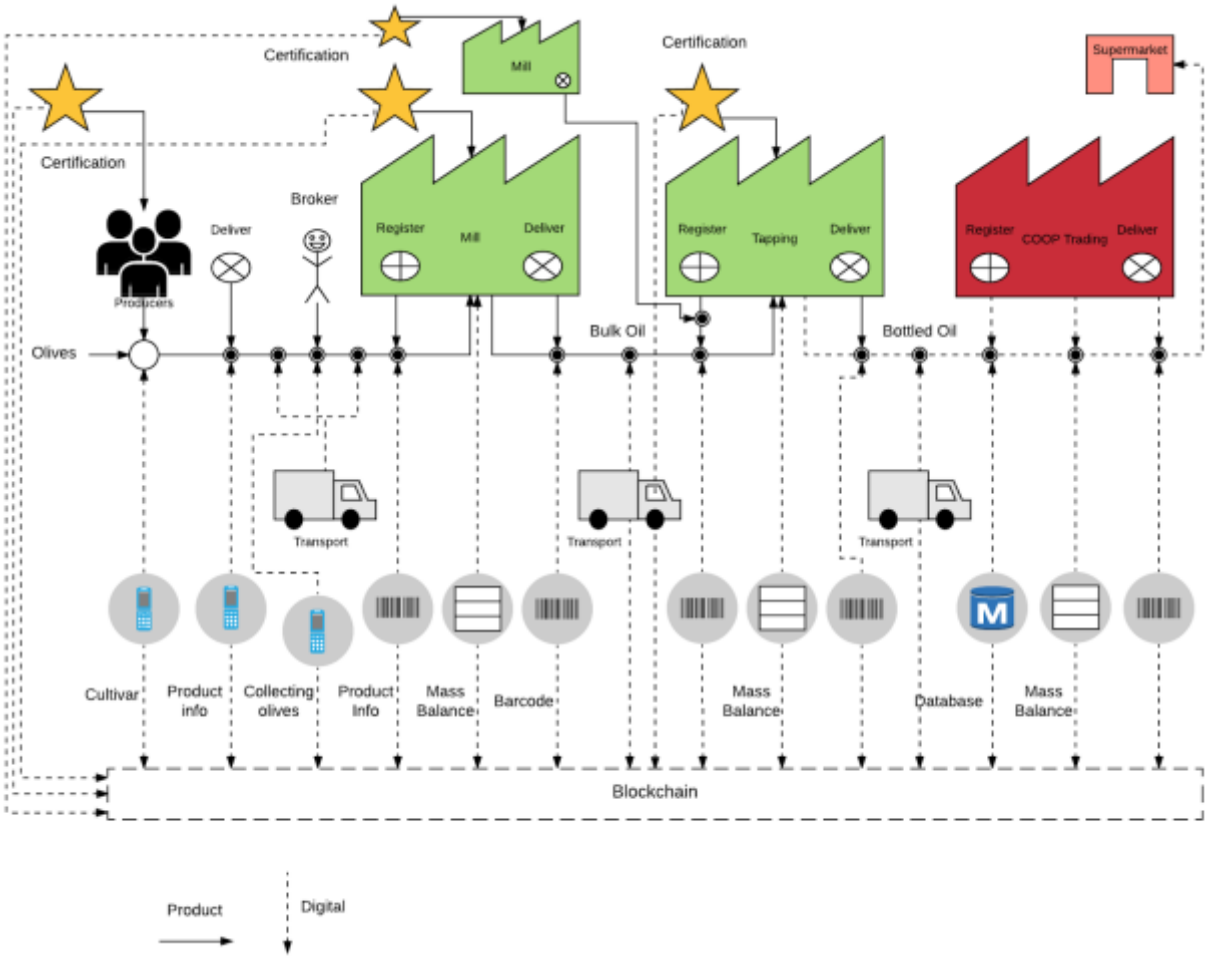
5.2.4 Possibilities of developing a blockchain at COOP Trading

The conceptualization of a blockchain solution for COOP Trading, is not to neglect all of the current and possible challenges that lies ahead, but the creative conceptualization I have illustrated is grounded in data, consequently will stimulate further research and discussion.

There is a general mind-set among consumers, to know the origin of the products we eat or use. Blockchain might be the technology to contribute with that information. The potential to transform how people and businesses co-operate in a supply chain. The supply chain of EVOO is complex and filled with obstacles to bring forth the possibility to know the origin of EVOO. Because of its complexity, there is an inherent threat of fraudulent behaviour in the process, with an economic incentive. This can affect negatively on the trust that suppliers have with each other. To counter this, control, audits and certifications tries to bring suppliers “closer together”, by relying on third parties to ensure that you can trust, that your suppliers handling of the product won´t be of lower quality or health treating. But

with the recent incidents of possible fraud with EVOO, there is a need to look into if something can be done. That answer could be blockchain, due to its technological construction. Through the analysis, I have tried to identify the opportunities and challenges with blockchain as a platform of traceability, information and documentation sharing, on the theoretical foundation of trust. Blockchain has been dubbed the trust machine. But during the process of this thesis, it has been illustrated that there are challenges that needs to be addressed, before it can live up to its nickname.

I have examined the ambiguity of trust, to clarify how one can create digital trust. Digital trust could be, that a technology like blockchain can bridge the gap between the two worlds, physical and digital. It was discovered that blockchain and smart contracts have inherent qualities, that might help to qualify and accomplish a form of digital trust, by managing one of the approaches to measure trust, contract trust. To remove human judgements, and thereby minimize the role of trust, often make things more convenient, that one can prosper from complete automation. That does not mean that the role of trust is insignificant, it just means that trust can be focused, on more sociological/psychological aspects, that technology cannot handle, but humans can.


Certification
Mill
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Broker
Deliver
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Tapping
Deliver
Register
COOP Trading
Deliver
Producers
Olives
Bulk Oil
Bottled Oil
Transport
Transport
Transport
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Product info
Collecting olives
Product Info
Mass Balance
Barcode
Mass Balance
Database
Mass Balance
Blockchain
Product
Digital

Figure 13

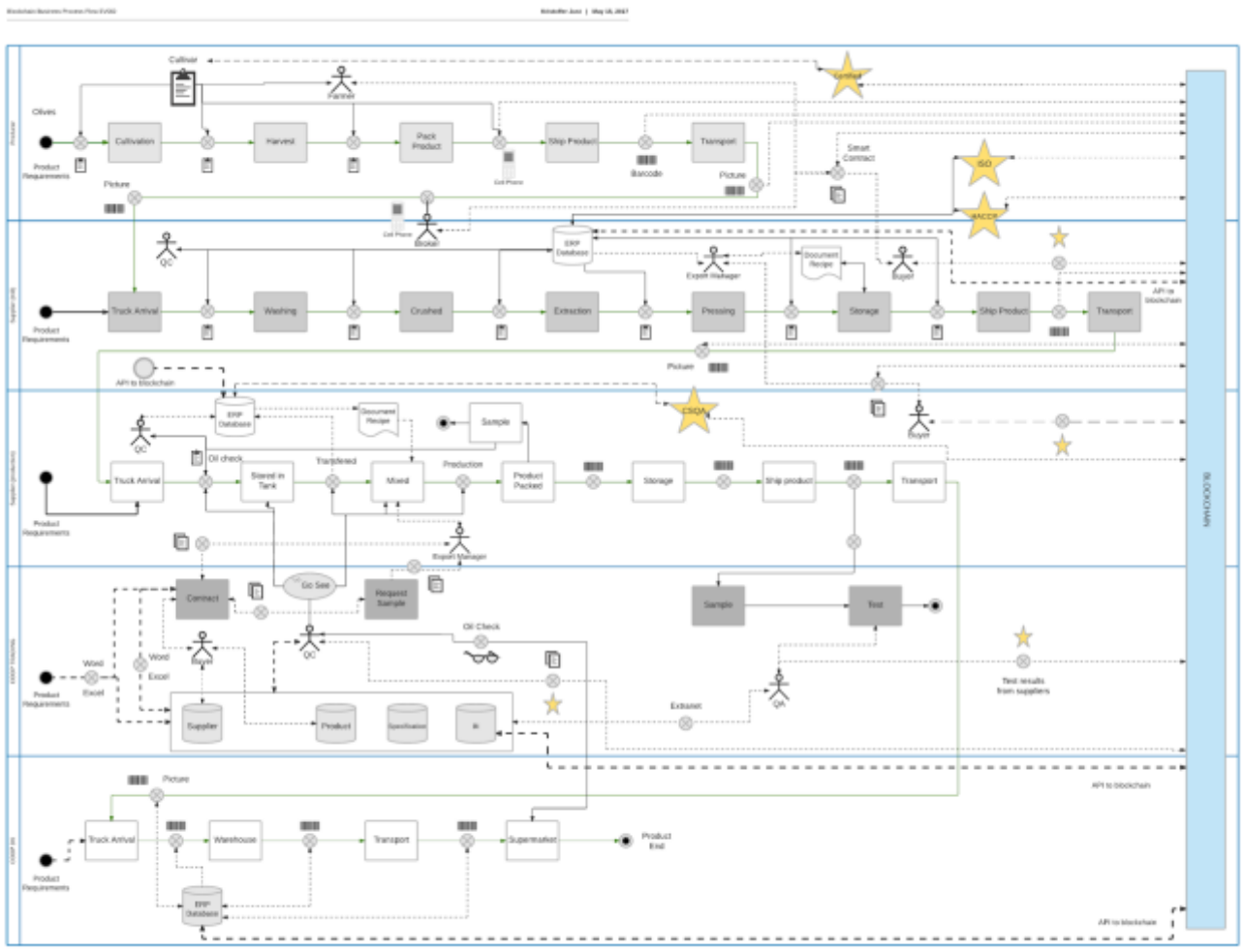

Figure 18

The conceptualization has been shaped by the PoC of Provenance, but has been developed from gathered data and blockchain literature.

At first, the use of certifications can act to verify that the information is correct, as they physically oversee processes to hinder garbage in, garbage out, all accessible through blockchain. But it would the intention in the end, that certification bodies will not be needed. When the product flows through its supply chain, each data point will be a block added to the blockchain, so the product is visible when transferring, for the intended participants to oversee or control/audit. If, as suggested in the conceptualization, combined with RFID technology to track and trace the product during transport,

COOP Tradings blockchain can contribute with stronger traceability, accurate and real-time information, and documentation sharing in as automated method as possible. Which can add value in numerous ways, creating business advantages, e.g. with a significant stronger ability to use storytelling. That the consumer knows and can “see” the whole process, from olive grove to shelf by a scan of the bottle.

But to be able to utilize the blockchain technology, requires an evaluation of ROI (Return On Investment). The thesis has not touched upon this, but as this is a crucial consideration for COOP Trading deciding to invest time and capital. There is a high buy in, so there is a high fixed cost, to design and develop to establish the platform. But in return COOP Trading get minimal variable costs, as the maintenance costs are very low. So in the end, costs to develop can be ignored, as the solution can run for many years.
So, it might be worthwhile, also regarding risk management costs, as this could be substantially lowered due to fewer public scandals, recalling of products and health treating cases. And it would not only be applicable for EVOO. EVOO can be used as a pilot for any other high risk product to be on a blockchain.
As with any new improvements it should sprout internally, teaching management of the possibilities, organizing internal meetings and identify other areas where technology can be applied in the future. Take time to do a simple test, gain knowledge and grow from there.

5.3 Future research

Based on my findings, there are many areas where future research can contribute to strengthen the findings or work further on similar aspects as touched upon.

In continuation of above, getting a live and operational blockchain to test its possibilities and hiccups. As I created a conceptualization, and not looked into the actual coding, coding of an application would be a step in the direction of creating a blockchain. Get data in the system to see that the possibilities

outbalance the challenges. This will also have the side effect of getting to know the spillover effects, to learn what to be vigilant of. Also by looking into if RFID solves the challenges with data quality, or if the investment is too great to bring enough economic value in return. It would be interesting to explore the financial aspects, by comparing costs of control, audit and risk management costs, to the blockchain and RFID investment. As companies like COOP Trading, and companies in general, will need a financial assessment of blockchain, before even considering looking to apply it.

Similarly, research on transaction costs affected by blockchain. If the implementation of blockchain will lower transaction costs as predicted, so the economy surrounding the handling of products becomes more efficient, and more capital and labour are freed to produce wealth on other matters.

Another factor to work further on is the legislation. Both about blockchain as a new radical innovation, but also all the legal implications that blockchain encounters along the supply chain. The thesis has not touched upon all the legislative actions that occurs along the supply chain, such as customs, bill of lading, port authorities and so forth. This will have a huge impact on a full application of blockchain solution, as there will be different demands from each entity, which needs to be accommodated. These different demands might result in individual blockchains for each party of the supply chain, which would be interesting to investigate.

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Appendix