UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Master Degree Project in Logistics and Transport Management

FruitChain Revolution?

Trustworthiness of information along the physical fruit supply chain for Swedish actors importing fresh fruit from outside Europe and how Blockchain provides potential solutions

Authors:

Christian Bremer & Carl-Philip Lindqvist

Graduate School

Master of Science in Logistics and Transport Management

Supervisor: Jonas Flodén

FruitChain Revolution?

Trustworthiness of information along the physical fruit supply chain for Swedish actors importing fresh fruit from outside Europe and how Blockchain provides potential solutions

By Christian Bremer and Carl-Philip Lindqvist

School of Business, Economics and Law, University of Gothenburg, Vasagatan 1, P.O. Box 600, SE 405 30 Gothenburg, Sweden

Department of Business Administration – Logistics and Transport

Contact: clindqvist@westmont.edu; christian.bremer@ewetel.net

Abstract

Background

Trust has been considered the foundation for trade and business relationships for centuries, especially in complex and fragmented Supply Chains. Blockchain technology claims to enable trustless transactions, which can benefit actors who do not trust the Supply Chain information they receive. In this case, the research revolves around the fragmented and highly fragile Fruit Supply Chain from outside Europe to Sweden. What kind of trust-related issues do Swedish fresh fruit importers perceive to have and how does blockchain offer potential usage to overcome these issues?

Methodology

Due to the low level of research within the field of blockchain technology in a Supply Chain context, the study takes an exploratory research approach. Therefore, the main trust-related Supply Chain challenges are identified through literature as well as qualitative semi-structured interviews with Swedish importers of non-European fruit. Further, the potential usage of blockchain to solve the identified trust-related challenges are discussed through qualitative semi-structured interviews with blockchain experts to develop an understanding of the practical benefits of blockchain.

Results & Conclusion

The study found divergent perceptions of trust-related challenges along Swedish Fruit Supply Chains amongst importers, experts and literature. From the importers' perspective, challenges exist at the point of origin, but are perceived to be limited upstream the Supply Chains. Experts claim that the highly fragmented and non-digital structure of Swedish Fruit Supply Chains limit the potential usage of blockchain technology. Nevertheless, experts and literature emphasize beneficial impacts of blockchain in a Fruit Supply Chain context, once Supply Chains are digitalized and trust regarding the initial data input can be established.

Keywords: *Blockchain technology, Trust, Fruit Supply Chain Management, Fruit Import*

Acknowledgement

We would like to acknowledge and thank anyone who has helped in carrying out the research. Firstly, we are appreciative of our supervisor Jonas Flodén for his guidance throughout the entire process of writing the thesis. We therefore wish to thank Jonas for his assistance and support, through which we have gained knowledge that influenced the content of the study. Secondly, we would like to express our gratitude to the Programme Master of Science in Logistics and Transport Management at the School of Business, Economics and Law, University of Gothenburg, for giving us the opportunity to engage in this research study.

Also, we are deeply appreciative of all the interviewees who participated in this study for taking the time to be a part of this thesis and for contributing with their valuable insights. It would not have been possible to carry out this project without their help as the thesis is built on the information received from the participating interviewees.

Lastly, we would like to thank our families and friends for supporting us in various ways throughout the entire writing process.

Gothenburg, 23th of May, 2019

______________________________ ______________________________

Christian Bremer Carl-Philip Lindqvist

Table of Contents

List of Figures

List of Tables

1 Introduction

The following chapter will introduce the background and purpose of the thesis. It will provide insight about the importance of the field of research. Further on, the Research Question and two Sub-Questions are presented, which will be analyzed and discussed during the thesis. Lastly, the Research Delimitations are introduced, and a Disposition of the thesis is provided.

1.1 Background

For centuries, the foundation of relationships and trade for industries and businesses has been built on the premises of trust between multiple actors. Even though standards and controls have been implemented to improve the main weak points of Supply Chains, initiatives have mainly focused on the improvement of internal processes, data sharing and transparency. However, inter-organizational processes have been left rather unattended, causing inefficiencies in the areas of external information traceability and transparency. (Kehoe et al. 2018) Despite the mentioned standards and controls, as well as developments in Digital Supply Networks (DSN), paper-based communication and documentation are still common practice in the world of logistics and transportation. Hence, trust in business partners regarding transactions is still the foundation for cooperation since fraudulent or accidental alterations to the documentation process are possible. (Kehoe et al. 2018; Wüst & Gervais, 2017)

Wüst & Gervais (2017) claim that blockchain has potential to change how society interacts, builds relationships and trades in the presence of distrust. At its core, blockchain is an open and distributed ledger that is able to verify and store incoming information in a permanent way. Contracts can be digitally stored and made transparent in a shared database, secure from fraudulent alterations, deletion and revision. In this shared database, processes, transactions, payments and agreements are validated and stored visibly for all other participants in the network, limiting the need for third parties and intermediaries. Instead, individuals, organizations, as well as smart objects or machines, collaborate with one another directly. (Iansiti & Lakhani, 2017) This especially is interesting for mistrusting business partners who have the possibility to create their own blockchain network not controlled by a third-party. Advocates of the blockchain technology believe that it offers the possibility of trust-free transactions of digital assets through a consensus driven, decentralized, distributed and inalterable network.

The ability to circumvent the need for trust in business transactions and obtain full traceability of any processes makes blockchain currently one of the most discussed subjects within Supply Chain Management (SCM). The increased use and interest in applications making use of the Internet-of-things (IoT) make blockchain technology a potential approach to simplify communication between actors and ensure trust, security and visibility along the Supply Chain. Kshetri (2018) Supply Chains such as food, textile and pharmaceutical Supply Chains, are often globally distributed and complex, with various stakeholders feeding into production lines that can stretch across continents (ElMessiry & ElMessiry, 2018; Challener, 2014; Dabbene et al. 2014). Supply Chain transparency, or the ability to see into the various stages along a Supply Chain, is essential in a modern business context due to regulations and standards as well as marketing strategies and the attestation of product origin, identity and quality (Challener, 2014; Dabbene et al. 2014). Complex Supply Chains suffer from a lack of transparency as there currently is not a single, globally utilized system with the ability to track and trace a product through a Supply Chain (ElMessiry & ElMessiry, 2018). Instead, current IoT-based traceability systems for Supply Chains are often interconnected in centralized infrastructures, which increases the risk of transparency- and trust-issues such as data breaches, tampering and single points of failure (Caro et al. 2018). Supply Chain enthusiasm around blockchain derives from the technology's alleged ability to provide a permanent and immutable record of every moment of a products trip throughout a Supply Chain, improving product transparency as well as product authenticity and legitimacy. However, current understanding of blockchain technology's potential to increase traceability and, therefore, trust remains limited. (Wang et al. 2018)

Although the Supply Chain interest in blockchain is quite general, the ability to take advantage of the technology is not present in all sectors. Blockchain can be beneficial for an industry with a complex Supply Chain with a high need for traceability and transparency. (ElMessiry & ElMessiry, 2018) This applies to the food industry in general for many different reasons, which includes the complexity of its Supply Chains, the necessity of effective sanitary measures, compliance with mandatory standards and regulations as well as the documentation of product identity, origin and quality (Dabbene et al. 2014). More specifically, it applies to the Swedish Supply Chains, as the Country Councils and Regions have identified public procurement of food as a high-risk environment when it comes to issues regarding traceability and transparency.

Similarly, Martin & Servera[1] describe that all food commodities with the potential for added monetary value are high risk products when it comes to food fraud. Fresh fruit are among the commodities that have been identified has challenging regarding traceability, transparency and, thus, trust. (Kempe et al. 2018) The lack of research into the potential usage of blockchain for Swedish fruit importers with the perspective of increased trust in information indicates that more knowledge is needed.

Currently, there is a hype regarding the ability of the blockchain technology to provide society with the ability to perform trust-free transactions through various applications and, therefore, solve trust issues along various Supply Chains (Xu 2017; Nakamoto, 2008; Warburg, 2016; Swan, 2015). Despite the hype, others express concern regarding blockchains ability to live up to the high expectations associated with the technology (Hawlitschek et al. 2018; Notheisen et al. 2017). While there are obvious technological advantages to the blockchain technology (Etwaru, 2017; Warburg, 2016; Swan, 2015), the technology is nonetheless in its infancy and struggling to overcome technical issues (Fremont & Gideon, 2018). In addition, most research on blockchain is focused on the technical aspects of the technology (e.g. design and features) as well as the legal aspects (Nakamoto, 2008; Alzahrani & Bulusu, 2018; Xu, 2017). A study by Yli-Huumo et al. (2016) reveals that 80% of blockchain related academic literature is on the Bitcoin system while the remaining 20% focus on other blockchain applications such as smart contracts and licensing. In practice, the financial sector currently develops the most blockchain applications, but the shipping, transportation, health-care and entertainment sectors are also introducing blockchain applications (Beck et al. 2017). Despite significant blockchain activity in practice, less academic research is focused on the implication of the technology on organizations and little is known about the effects of blockchain in practice in a business context (Beck et al. 2017; Fremont & Gideon, 2018). Research into the ramifications of blockchain in an organizational context could increase the comprehension of the technology's implications.

The lack of knowledge regarding the possible impact of blockchain technology on the trust issues of Swedish Fruit Supply Chains makes it an important area of study. In fact, the absence of

---

[1] Sweden’s leading restaurant and catering specialist - https://www.martinservera.se/

practical blockchain technology cases indicates that there is a need for further research regarding the topic from the perspective of Swedish importers of fruit.

1.2 Research Purpose

The purpose of the study is to provide knowledge of the use of blockchain technology in practice, especially in a SCM context, by applying it to the Swedish fruit import sector. This is accomplished by examining if and how the blockchain technology can reduce the effect of trust issues regarding information along the physical Supply Chain for Swedish actors importing fresh fruit from outside Europe. The study focuses on non-European import of fruit to Sweden due to the complexity, difference in food standards and regulations as well as the lack of transparency and traceability associated with global fruit Supply Chains.

By successfully fulfilling the purpose of the study, the study will provide knowledge regarding the practical ability of the blockchain technology to increase Supply Chain transparency and traceability to reduce the effect of trust issues between actors along Supply Chains. Studies as well as academic literature express a general lack of knowledge regarding the applicability of blockchain among Supply Chain actors. Thus, the practical significance of this thesis is to fill an existing knowledge gap in SCM.

Additionally, the thesis will contribute to academic literature by providing knowledge about whether and how blockchain technology can be used to reduce trust issues in Supply Chains, thus closing a research gap that currently exist. The thesis will provide a theoretical contribution by compiling and structuring existing literature concerning Supply Chain trust issues.

1.3 Research Question

Based on the background and the purpose of this thesis, the paper will focus on the following Research Question und Sub-Questions:

- **What is the potential usage of blockchain technology for Swedish importers to reduce trust-related issues along the physical Supply Chain when importing fresh fruit from outside Europe?**

- *Which Supply Chain "trust issues" exist regarding information along the physical Supply Chain for Swedish actors importing fresh fruit from outside Europe?*
- *Can, and if so how, the blockchain technology reduce the effect of "trust issues" regarding information along the physical Supply Chain for Swedish actors importing fresh fruit from outside Europe?*

1.4 Delimitations

The research concentrates on the aspect of trust-related challenges along Fruit Supply Chains from outside Europe to Sweden from an importer perspective. Therefore, the study focuses on the Supply Chain from farmer to importer, while the retailer and end-customer is not considered due to time and space limitations. Since Fruit Supply Chain configurations and processes do not differ significantly when importing from outside Europe, the research does not focus on fruit imports from a specific region, but rather "from outside Europe". The research concentrates on fruit that is transported by ship as it is the dominating transport mode. Other transport modes are not considered, except road transportation from the European Port of Entry to Sweden. Since only a few importers are involved in the import of fruit to Sweden, the limitation to the Swedish market provides a comprehensive understanding of trust-related challenges the in the Swedish fruit sector.

The paper does not revolve around blockchain technology implementation strategies for importers, but rather whether there is a potential use of blockchain solutions based on trust levels. Financial aspects, like Bitcoin and other cryptocurrencies, are not considered due to space and time limitations.

1.5 Disposition

The research paper follows the following outline and is briefly presented in the overview below.

Figure 1 - Thesis Outline

The Literature Review introduces the reader to the theoretical background of the study. Firstly, the Concept of Trust is described to provide an understanding of the most important aspects of trust in a business context. Further on, blockchain technology is described in general and put into a Supply Chain context. Following, the aspect of Fruit Supply Chain Management (FSCM) and the Concept of Transparency is introduced. Lastly, trust-related challenges in FSCM are presented, building the foundation of the research framework.

The Methodology provides the reader with an overview of the Research Strategy, Design, Method and Quality.

The Empirical Findings present all findings during the primary data collection within the Theoretical Framework. Firstly, the findings from the Importer interviews are described. Secondly, the content of the Expert interviews is presented.

The Analysis combines the findings from the Literature Review and Empirical Findings. Each category of the Theoretical Framework is analyzed separately to provide a clear and relevant discussion.

The main findings from the analysis are concluded, answering the Research Questions presented in the Introduction. Lastly, the paper suggests starting points for Future Research and Limitations of the study.

2 Literature Review

In the first place, the Concept of Trust in a Business context is explained. Since the Concept of Trust is a central aspect of the research, this section is necessary to introduce the different components and aspects that lead to trustworthy business relationships. Further on, the blockchain technology is explained and the idea of FSCM is introduced. Lastly, the main trust-related Supply Chain challenges are identified, which also represent the theoretical framework for the thesis.

2.1 Concept of Trust in Business Context

Working across organizations often involves an interdependence, where individuals depend on others to fulfil personal and organizational goals. Interdependence then raises the issue of trust or distrust, which is the foundation of interorganizational relationships. (Mayer et al. 1995) Nguegan & Mafani (2017) found that lack of buyer-supplier trust has a measurable negative effect on efficiency regarding the Supply Chain flows and Key Performance Indicators.

Zaheer et al. (1998) and Schoorman et al. (2007) point out the conceptual challenge to translate the individual concept of trust to an organizational level. While an organization does not trust itself, it is the individuals as members of organizations who place trust. Consequently, trust in the business context is viewed from two perspectives: Interpersonal and Interorganizational Trust, which is visualized in *Figure 2*.

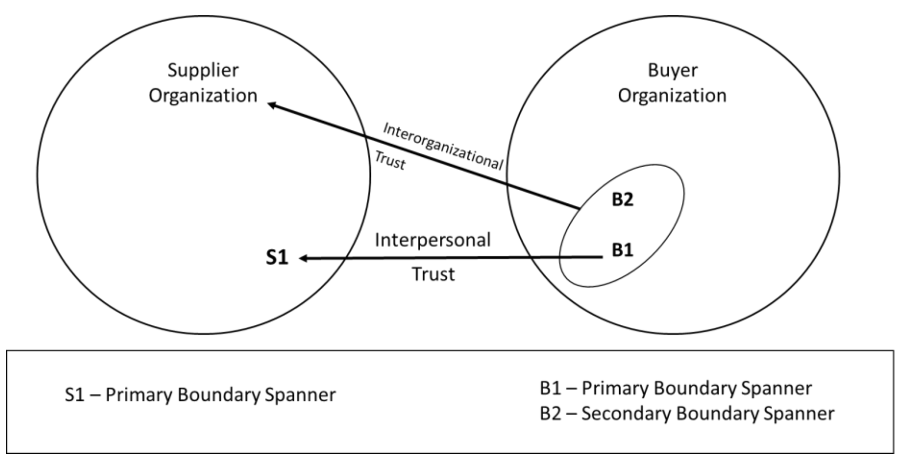

Figure 2 - Interpersonal and Interorganizational Trust (Zaheer et al. 2018)

Interpersonal trust can be described as level of trust amongst two individuals (S1, B1) in two different organizations (Supplier, Buyer), who interact with each other in a business context. *Interorganizational* trust is the level of trust placed in an organization (Supplier) from a group of members in the partner organization (Buyer). (Zaheer et al. 1998; Liu, 2015, Schoorman et al. 2007) From the angle of a buyer-supplier relationship, Lindgreen (2003) classified trust into System Trust, Personality-based Trust and Process-based Trust. System Trust is purely based on written regulations and contracts, while Personality-based Trust is related to interpersonal trust, which depends on the level of trust between two individuals in two organizations. System-related Trust is the result of repeated interactions between two individuals and organizations, which can develop over time. In addition to the versatile nature of trust, literature regarding trust theories revolve around the identification of aspects that influence and contribute to the level of trust amongst individuals and organizations. Mayer et al. (1995) and Parris et al. (2016) point out that high levels of trust can only be reached if three characteristics are given: Ability, Benevolence and Integrity. Ability can be described as the skill set and competencies which are necessary to have positive influence. Benevolence can be defined as goodwill, while integrity relates to a set of common principals. (Mayer et al. 1995) Additionally, Zaheer et al. (1998) complements these characteristics with the elements of predictability and confidence in the actions of a business partner. Overall, the main characteristics that lead to trust can be summarized as the predictability and confidence in the abilities, benevolence and integrity of a business partner, both on individual and organizational level. (Mayer et al. 1995; Parris et al. 2016; Liu, 2015; Zaheer et al. 1998).

Further on, Mayer et al. (1995), Schoorman et al. (2007) and Parris et al. (2016) emphasize that to reach high levels of trust in the described aspects, either positive experiences over time and/ or transparency of processes are the foundation. *"Transparency should serve as a foundational tool for addressing stakeholders' distrust and improving responsible management practices of organizations"* Parris et al. (2016, p. 223).

Parris et al. (2016, p. 224) illustrates the relationship between trust and transparency. In an organizational context, *"trust is an antecedent and consequence of transparency"*. To create trustworthiness, transparency is therefore the foundation for any trustful relationship. Consequently, trust on an interpersonal and interorganizational level can be built by sharing relevant information and communicating openly. However, since trust can also be understood as antecedent of transparency and not exclusively as consequence, transparency and trust need to be developed by creating relevant learning opportunities on an interpersonal level. By increasing transparency and therefore trust continuously, all involved actors can benefit from the willingness to trust in the abilities, benevolence and integrity of the business partners. (Parris et al. 2016; Mayer et al. 1998; Zaheer et al. 1998) Personality-based and System-related Trust then accumulate to an overall Process-based trust between buyers and suppliers (Lindgreen, 2003).

2.2 Blockchain Technology

2.2.1 What is a Blockchain?

A blockchain can essentially be defined as a public ledger of assets and transactions stored in cryptographically connected datasets called "blocks" across a peer-to-peer network (Nakamoto, 2008; Warburg, 2016; Xu, 2016). Simplified, a blockchain is a public registry of ownership of digital assets and the transaction history of these digital assets (Warburg, 2016). The assets and transactions stored in a blockchain are secured through a cryptographic fingerprint called a "hash" (Nakamoto, 2008; Kshetri, 2018). Over time, the transaction history of the digital assets is locked in chronologically and linearly linked blocks of data. This creates an immutable, unalterable record of all the transactions across the network (Warburg, 2016). Each network user maintains an identical copy of the public ledger, which means that a blockchain is completely distributed, unlike a centralized database controlled by a central authority (Xu, 2016). Warburg (2016) believes that blockchain is closest to the description of the Wikipedia concept, which at its core is an open platform, or infrastructure, that stores data such as words or images as well as changes to this data. Similarly, blockchain is an open infrastructure capable of storing the history of custodianship, ownership and location of different digital assets such as a title of ownership, a certificate, a contract, real world objects or even personal identifiable information.

As shown in *Figure 3*, each block in a blockchain ledger contains a unique hash, the hash of the previous block (parent), a time stamp and the relevant transaction data (Nakamoto, 2008; Kshetri, 2018; Lisk, 2019). The first block in the ledger is unable to contain the hash of a previous block and is therefore referred to as the "genesis block" (Nofer et al. 2017). A hash is an arithmetically generated code from data within the block and is considered the cornerstone of the technology. Hashes represent the current state of a blockchain as it contains information about previous blocks in the chain as well a data regarding new transactions that occur. The transaction history is stored within the block in the form of a checksum or, in the case of blockchain, a hash sum. Additionally, every block contains the hash sum for the entire blockchain. (Nakamoto, 2008; Kshetri, 2018; Lisk, 2019).

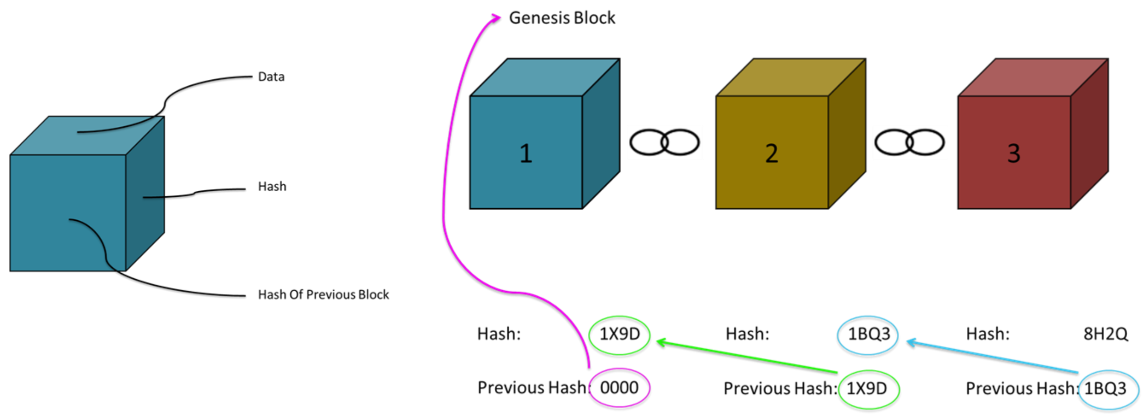

Figure 3 - Blockchain Ledger (inspired by Savjee, 2018)

2.2.2 Trust aspect of Blockchain

The fundamental idea of, and the need for, the blockchain technology revolve around interpersonal and interorganizational trust problems within trade markets (Etwaru, 2017; Xu, 2016; Van Waarden, 2012). Van Waarden (2012) defines markets as sub-societies populated by people which are exposed to social issues such as risk and uncertainty. Such social problems follow trade markets as they create distrust between potential trading partners. Society has traditionally relied on political and economic institutions, such as governments, corporations and banks, to lower risks and uncertainties involved in market transactions. (Warburg, 2016) Transactions between two untrusting parties, on individual and organizational level, are often recorded and stored in databases controlled by these central intermediaries (Warburg, 2016; Xu, 2016). Thus, the integrity of the information in a traditional database depends on the dependability and capability of the responsible intermediary (Xu, 2016).

With blockchain technology, the role of these trusted third parties, or middlemen, can be substituted by a decentralized and distributed consensus ledger (Prinz & Schulte, 2018; Casino et al. 2018; Warburg, 2016). Each transaction in the blockchain is verified and validated collectively by the users of the network themselves, thus eliminating the need of a central authority. This eliminates trust issues between potential trading partners, as the distributed and public nature of the blockchain means that transaction history is openly available for the entire network. (Xu, 2016) In fact, blockchain advocates argue that the implementation of the blockchain technology enable human society to lower transaction uncertainties and increase trust between parties with technology alone (Warburg, 2016). In essence, blockchain technology overcomes contemporary trust issues in markets by enabling trust-free transactions. As illustrated in *Figure 4*, a network's community of miners examines and verifies new transactions. If a transaction is verified, a new block containing the new transaction is added to the blockchain and all the individual copies of the blockchain are refreshed and updated simultaneously to achieve a consensus. (Xu, 2016)

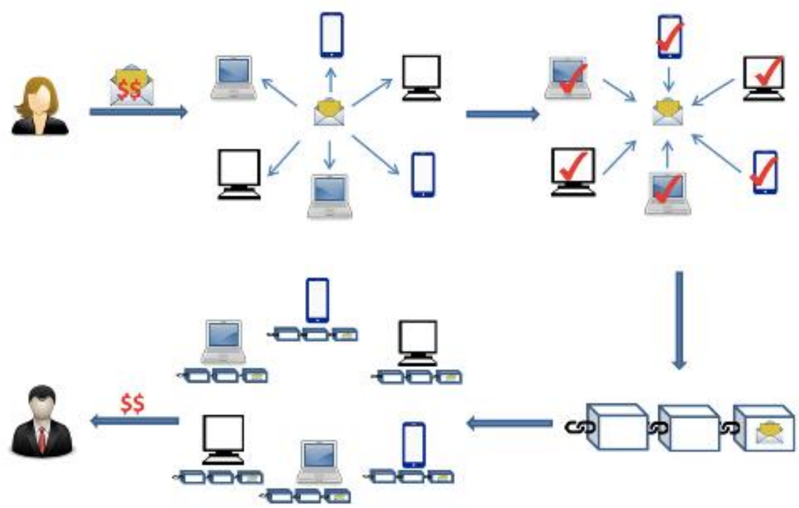

Figure 4 - Blockchain Transaction Process (Xu, 2016)

Central aspects of user trust in the blockchain are derived from the technologies' ability to offer transactions across a decentralized and distributed peer-to-peer network. Decentralized means that, unlike traditional databases, the blockchain technology network is not controlled or owned by a single actor. Instead, users of the network collectively own the blockchain technology network. Every actor is cooperatively responsible for the operability and performance of the ledger, making the network decentralized. Distributed means that, unlike a traditional database, every actor in the network secures the information in the blockchain by owning a copy of the ledger. (Nakamoto, 2008) Consequently, malicious users are unable to insert fraudulent blocks into the public ledger, as any fraudulent attempt to tamper with the blocks would be noticed by the users of the network (Xu, 2016).

Another vital element of the trustworthiness of the blockchain technology is the immutability of the data records (Nakamoto, 2008; Hofmann et al. 2017). As previously mentioned, every record in a blockchain ledger is secured with its own unique cryptographic hash as well as with the cryptographic hash of the previous record (Nakamoto, 2008). This makes the data stored in the blocks improbable to be maliciously manipulated without being noticed, as the reference value of the hash would cease to fit with the referenced data block (Hofmann et al. 2017). Thus, as the miners validate the transactions by connecting the blocks in the chain, the data within effectively becomes irreversible and immutable (Nakamoto, 2008). Essentially, this means that data recorded in the blockchain cannot be tampered with or manipulated after being accepted by the blockchain (Hofmann et al. 2017). Since every node has an updated copy of the blocks, manipulations are detected quickly. (Nakamoto, 2008; Lisk, 2019) Consequently, situations in which the trustworthiness of a blockchain is impacted by malicious attacks can be eliminated. (Wüst & Gervais, 2017)

The blockchain technology can offer trustless transactions through its use of consensus protocols (Nakamoto, 2008; Alzharini et al. 2018; Lisk, 2019). A consensus protocol can be defined as a set of rules on how data is communicated and transmitted between electronic devices, or nodes, including the structure of the information as well as how each node will send and receive it (Nakamoto, 2008; Lisk, 2019). In blockchain technology, a consensus protocol guarantees that all the nodes approve the validity of a new block and the transaction within it (Alzharini et al. 2018; Lisk, 2019). A consensus is reached when all nodes agree on the same version or state of a blockchain, even when single nodes fail to validate the input (Lisk, 2019). Essentially, the consensus protocol ensures that information added to the blockchain is reviewed and confirmed as correct (Alzharini et al. 2018; Lisk, 2019). A consensus protocol also ensures that the participants responsible for maintaining the operability of a network remain incentivized by being offered rewards. In blockchain, these rewards often come in the form of cryptocurrencies or digital tokens. (Lisk, 2019)

In essence, the blockchain technology enables trustless transactions of digital assets in a decentralized, distributed, immutable, consensus driven network. Swan (2015, p. 1) describes blockchain as a technology that enables records to be "*shared by all network nodes, updated by miners, monitored by everyone, and owned and controlled by no one*". Etwaru (2017) believes that blockchain has the potential to close the trust gap that exists in today's economy in the same way that the printing press closed the knowledge gap and the engine closed the power gap. Distrust prevent transactions in industries sensitive to fraudulent activities, whether from hackers, customers or even trusted partners (Derebail, 2017).

2.2.3 The Blockchain Technology and Fruit Supply Chain Management

A growing amount of recent research identify SCM as one of the most interesting fields for blockchain applications since value creating business partners, between whom performance agreements exist, need technology capable of ensuring secure products, information and financial flows (Prinz & Schultz 2018; Petersen et al. 2018; Tan et al. 2018; Yiannas 2018; Kempe et al. 2018). Current information systems are often centralized and most Supply Chains require its actors to trust one single organization with valuable and sensitive information. Consequently, low levels of Supply Chain transparency and traceability can cause strategic and competitive issues. (Saberi et al. 2018) For example, the 2017 multi-state salmonella outbreak caused by papayas were complicated due to a lack of transparency and traceability across the involved companies Supply Chains as the cause of the outbreak could initially not be identified (Saberi et al. 2018; Tan et al. 2018). These incidents reveal transparency and traceability to be an urgent necessity in Supply Chains, especially within the agricultural food industry (Tan et al. 2018). Abeyratne, & Monfared (2016) state that blockchain can enhance trust through increased traceability and transparency within any transaction of data, goods or financial resources.

When goods or documents pass between actors in a Supply Chain, items are exposed to the risk of counterfeiting (Fransisco & Swanson, 2018) Yet, paper records still dominate the food industry, although they run the risk of being tampered with (Yiannas, 2018). Trusted information regarding key product traceability information such as origin, eco-label claims, temperature, lead-time, product documentation and labor conditions at production site is therefore not always available (Yiannas, 2018; Kshetri, 2018). Through blockchain, actors can have more confidence in the information they receive as no entity can change the information within the blockchain (Fransisco & Swanson, 2018). Information such as product travel path, temperature and duration as well as various food audit certificates can therefore be secured within a blockchain by tracing back information flow to specific verified data points (Yiannas, 2018; Kshetri, 2018).

Another promise of blockchain is to create transparency throughout Supply Chains through its decentralized and distributed characteristic (Petersen et al. 2018; Abeyratne, & Monfared, 2016; Yiannas, 2018). Today, the use of centralized information systems mean that most actors do not have access to information from second or third tier partners and have therefore only limited insight (Abeyratne, & Monfared 2016). Petersen et al. (2018) emphasis that blockchain can ensure that every actor along a Supply Chain have access to the same data, providing a single point of truth, as each actor has an identical copy of the ledger. This level of transparency in a network makes transactions, operations and activities highly visible, thus reducing the need for trust between Supply Chain actors (Abeyratne, & Monfared 2016).

It is important to remember that the blockchain technology needs to be combined with complementing technologies to verify input data to be useful in a Supply Chain context. It is possible to collect real-time data of goods from their origin to the end-consumer through Internet-of-things (IoT), Radio Frequency Identification (RFID) tags, sensors etc. (Kshetri, 2018). The International Telecommunication Union (ITU) defines IoT as "*a global infrastructure for the Information Society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies*" (ITU, 2015). In this regard, blockchain can be used to confirm identities in IoT applications to securely know who is preforming what actions, as well as when and where these actions are performed. (Wortmann & Flütcher, 2015) From a SCM perspective, data collected from IoT devices such as drones or Unmanned Aerial Vehicles (UAV) can be securely stored within a blockchain (Ferro et al. 2018). Similarly, it is possible to combine blockchain and IoT devices with satellite images in order to receive information on fraudulent activities such as ecological farmers not following requirements or packages being broken during transportation (Oddman, 2018)

2.4 Concept of Fruit Supply Chain Management

The following section introduces the idea of FSCM. Two of the most important aspects in a FSCM context are the concepts of transparency and traceability, which are defined and explained during this section.

Within the past decade, the increasing awareness of consumers regarding their diet, as well as a generally higher income, lead to a significant increase in the European fruit consumption. Even though the requirements of matching supply and demand, variety, quality, safety and convenience increased simultaneously, the concept of SCM has been found rather young in the context of the agricultural food industry. During the past 10 to 12 years, particularly the fresh fruit sector has started to apply SCM as a key concept for its competitive advantage. (Soto-Silva et al. 2016; Verdouw et al. 2010) Due to the products perishability, fluctuations in demand and prices, dependency on climate conditions, as well as the increasing awareness for food safety and quality, fresh fruit Supply Chains appear to be highly complex in comparison to others. (Negi & Anand, 2015)

Today, highly regulated and controlled fruit markets make SCM one of the most critical aspects of the value chain from grower to the end-customer. It composes of steering flows of information, products, services and financial aspects up- and downstream the value chain. (Kehoe et al. 2018; Weimert et al. 2018 The regulation landscape increasingly forces actors to provide full traceability over all Supply Chain processes. (Kehoe et al. 2018) This requires research and investments into technologies which can adapt to new needs for real-time tracking and complete transparency over their operations. (Kehoe et al. 2018; Weimert et al. 2018; Negi & Anand, 2015)

In highly fragmented Fruit Supply Chains, continuous and complete information is important to ensure a trustworthy documentation process. Once a product is released into a Supply Chain, any information gaps or misleading information will not only influence safety and quality aspects of the produce, but also further decision-making regarding storage and handling and processes upstream the Supply Chain. With an increasing number of actors in the value chain and longer throughput times, the vulnerability of Supply Chains towards the described phenomenon increases. (Burbridge, 1989; Goldratt, 1997) Generally, measures to close information gaps and avoid incorrect information include minimizing throughput times to move information and products quicker through the Supply Chain and therefore, reduce the potential of distortion and uncertainty along the chain (Negi & Anand, 2015; Weimert el al. 2018).

To ensure complete, correct and trustworthy information along the Fruit Supply Chains, transparency has been discussed as the largest influence towards a fully trusted Supply Chain *(see Chapter 2.1)*.

Concept of Transparency

The concept of "Transparency" concerning SCM, or Supply Chain Transparency (SCT), can be defined as the communication between the main stakeholders regarding the history of a product, as well as the visibility of current process steps along the Supply Chain. (Morgan et al. 2018; Weimert et al. 2018). Even though transparency is seen as one of the main pillars of SCM, the concept of SCT is still relatively new (Morgan et al. 2018). A study described by Wieland et al. (2016) showed that even though SCM is seen as an important theme, the field of transparency is considered the fourth most understudied topic in the research about SCM.

The strategy behind the concept of transparency is explained as "*planning a project or relationship on the basis of what needs to be shared and in what manner, at what time, for what purpose to be achieved and potential (or latent) value to be realized"* (Lamming et al. 2004, p. 302). Additionally, SCT provides the market and stakeholders with the possibility to assess compliance with regulations and laws. Therefore, companies can evaluate their suppliers and business partners not only based on the final product or material they receive or consume, but based on the whole process of development, production and transportation. (Morgan et al. 2018, Parris et al. 2016)

Overall, the concept of SCT rests on the concept of traceability and can be described as the tool leading to a transparent Supply Chain. (Morgan et al. 2018; Weimert et al. 2018; Parris et al. 2016) Hence, the following section will expand on the elements of traceability.

Concept of Traceability

Traceability can be described as a system that keeps record, identifies and tracks products, including its transportation, and ingredients from point of origin to the final customer (EC, 2019a; FAO, 2017). Generally, it comprises the ability to trace products and components in two directions: backwards and forwards. Tracing backwards comprises the ability to comprehend the path of a product downstream the Supply Chain. Forward traceability, on the other hand, describes the ability to follow the product along the Supply Chain in real-time. Therefore, forward traceability in the literature is also described as "Tracking", whereas backward traceability is often referred to as "Tracing". Internal traceability considers processes within a company, while external traceability includes tracking a product or component through the whole Supply Chain. (Jakkhupan et al. 2015; Olsen & Borit, 2018; Shamsuzzoha et al. 2013) Traceability systems should be able to cover the entire Supply Chain, including transportation and middlemen. (Kehoe et al. 2018) The following *Figure 5* visualizes the concepts of tracking and tracing, as well as internal and external traceability.

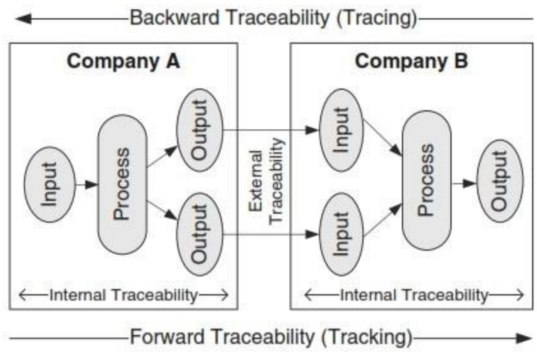

Figure 5 - Tracking & Tracing in the Supply Chain (Jakkhupan et al. 2015)

Jakkhupan et al. (2015) and Olsen & Borit (2018) describe three issues that are fundamental to the success of traceability systems: 1) compatibility, 2) data standardization, as well as 3) the definition of a traceable resource unit. Compatibility in the first place is necessary to communicate and transmit data efficiently between the actors along the chain. Secondly, standardized systems are required to preserve the identity of the product, as well as all information regarding handling, processing and storage. Lastly, a traceable unit must be defined and efficiently adapted to each process step along the Supply Chain. (Jakkhupan et al. 2015; Olsen & Borit, 2018)

It has been shown that trust-related issues along the Supply Chains exist. These will be discussed in the following section.

2.5 Trust-related Challenges in Fruit Supply Chain Management

While demand for fresh fruit within Europe has been stable in times of economic fluctuations, the demand characteristics changed significantly. The growing demand for exotic fruits, ample product choice, nutrition, and organic products of high-quality challenge the fruit industry. In this kind of business environment, a high quality of the Supply Chains and logistical aspects is required. (Goedhals-Gerber et al. 2017) The following section provides an overview and introductory description of the identified challenges global Fruit Supply Chains face.

2.5.1 Product Identification

2.5.1.1 Product Origin

Identity preservation is an important aspect that adds economic value to a product (Dabbene et al. 2014). Origin is one of the process attributes that are difficult to perceive and detect but still add value for the consumer (Dabbene et al. 2014; Wognum et al. 2011; Bitzios et al. 2017; Charlebois et al. 2016; Aung & Chang, 2014) Buyers and end-users are increasingly concerned with product origin due to safety aspects, perceived quality aspects and the risk of a product being sold under false pretenses, which can impact both the safety and quality of a product (Wognum et al. 2011; Bitzios et al. 2017). Product origin is especially important if the proclaimed source of origin is associated with higher food safety or quality (Aung & Chang, 2014). These concerns are addressed in legislation, as the European *General Food Law* requires registration of the origin of all food products in all stages of production (Wognum et al. 2011). Yet, the relative difficulty of detecting the origin of a product means that cases of false product origin occur (Bitzios et al. 2017). Misrepresentation of the origin of products is most common when highly valuable products can be substituted, partially or entirely, with cheaper products. Suppliers may also alter the country of origin of products to promote local products or region, despite having a different origin. (Charlebois et al. 2016; Aung & Chang (2014) highlight the need of a traceability system capable of tracing the origin.

2.5.1.2 Harvesting Date

The harvesting date is an important aspect regarding the freshness and quality of a product. While certain products are more sensible to decay after the point of harvest (e.g. bananas, strawberries), others do not show signs of decay immediately (e.g. pineapples, apples, pears). (De Winter, 2015; Smithers, 2018) Nevertheless, the harvesting date for less sensible goods is still an indicator for quality, shelf life, and therefore price. Even though customers are not exposed to direct health risks in case of decayed fruits, compared to fish or meat, according to EU Regulation No 1169/2011 the customer must be able to make buying decisions regarding quality and price based on the expiry or Best-Before date. (De Winter, 2015; CGSO, 2019) Therefore, actors along the Fruit Supply Chains are obliged to hold information regarding the harvesting date of perishable produce and can be hold accountable for failing to do so, creating trust issues regarding the correct labeling downstream the Supply Chain (De Winter, 2015). Since the exact harvesting date is difficult to determine once the fruit products enter the Supply Chain, wrongful labeling regarding the harvesting date occurs due to financial motivations at the point of origin (Bitzios et al. 2017; Karp, 2018).

2.5.1.3 Eco-Labelling

Research indicates that organic foods is subject to food altercation such as mislabeling and mixing due to financial reasons as well as the relevant ease of substitution (Song et al. 2016; Shears, 2010; Capuano et al. 2012). Organic products are often sold at a premium price compared to conventional products and therefore susceptible to food fraud (Capuano et al. 2012). Another factor is that fraud is often difficult to detect regarding organic food (Shears, 2010; Capuano et al. 2012; Song et al. 2016). Shears (2010) expresses that, apart from field visits, there is no infallible way to check that a product has been produced organically as there are so many different criteria, where most are challenging to verify scientifically. For example, synthetic fertilizers are banned on organic farms but almost impossible to detect (Shears, 2010). Further, Capuano et al. (2012) state that even reports from field reports are susceptible to fraud. Most organic products today are verified through paper trail-based traceability systems that can be falsified. Although, it is important to note that supermarkets and large retailers are less vulnerable compared to small shops as their organic products can more easily be ascertained. (Capuano et al. 2012)

Organic fruit is among the products that are vulnerable to food altercation (Song et al. 2016; Vincent et al. 2018). Song et al. (2016) estimate that the need to protect organic apples from mislabeling is high as the non-organic variety is vulnerable to high levels of pesticide contamination. Vincent et al. (2018) state that organic apples are on average 43% more expensive than their non-organic counterparts and therefore susceptible to mislabeling and mixing. In line with Capuano et al. (2012), Song et al. (2016) express that the availability of a traceability system suitable for field use and which can reliable detect organic products from non-organic would be beneficial in the Fruit Supply Chain sector.

2.5.2 Product Movement

2.5.2.1 Cold Chain

When it comes to the most significant characteristics of fruits in the eye of the importer, cost and quality are the determining factors regarding purchasing choice. (Nielsen, 2015) The cold chain is considered as a key factor to ensure high quality of the fruits. It can be defined as temperature-critical and temperature-controlled Supply Chain which allows for trade with perishable products such as fruits. To meet product-specific temperature requirements during delivery, the cooling chain must be maintained through the entire Supply Chain, starting from point of production, packaging, loading, shipping, handling, storage and/ or ripening. (Goedhals-Gerber et al. 2017, Rodrigue, 2017). If the cold chain is maintained according to standards, fruit deterioration, maturation as well as microbial decay can be prevented, and an optimal shelf life can be achieved (Berry et al. 2015). Temperature abuse, on the other hand, can be defined as *"unacceptable deviation from the optimal temperature or setting for a given food product for a certain time period"* (Ndraha et al. 2018, p. 3) It has been shown that temperature breaches along temperature-controlled Supply Chains during the transportation and storage of fresh fruit from non-European countries to Europe occur repeatedly. Reason is found to be mainly non-compliance to temperature specifications due to poor design of refrigerated storage facilities. (Ndraha et al. 2018) According to Goedhals-Gerber et al. (2017), 81% of the temperature breaks in fruit reefer containers last longer than 90 minutes while 30% of the produce experiences repeated temperature breaches during sea transport alone. Mercier et al. (2017) points out that temperature breaches are not evenly distributed along the cold chain, but rather are subject to critical points. Apart from the beforementioned breaches during sea transport by Goedhals-Gerber et al. (2017), two further critical points before reaching the importer are discussed by Mercier et al. (2017) – Precooling and Ground Operations during Transportation. Precooling describes the process after harvesting and before transportation, where core temperatures need to be lowered to create a lasting cooling effect during transportation and to take off pressure from the remainder of the cooling chain. Inefficiencies regarding Ground Operations mainly appear before and right after sea transportation. Due to a lack of cooling infrastructure and waiting time for the units to be loaded onto the vessel, temperature breaches are common. On the other hand, temperature breaches occur at the Port of Entry caused by waiting times due to customs and veterinary control, as well as consolidation for further transport. (Mercier et al. 2017; Goedhals-Gerber et al. 2017) Additionally, Goedhals-Gerber et al. (2017) points out that personnel along the Supply Chain often does not record or react to irregularities, resulting in improper actions or non-actions upstream the Supply Chain.

Overall, Mercier et al. (2017) describes the cold chains as seemingly well documented. Nevertheless, some steps in the Supply Chain still rely on manual data entry, which undermines the effectiveness and usefulness of the recordings. Additionally, the awareness regarding the importance of constant cold chains is often not given, resulting in inefficiencies along the Supply Chains and inappropriate handling of the produce. (Mercier et al. 2017; Goedhals-Gerber et al. 2017)

2.5.2.2 Lead-Time

In the context of sensible and perishable cargo like fruits, the time that passes between harvesting and arrival to the importers facilities plays a significant role. Apart from the importance of temperature *(see Chapter 2.5.1.1)*, Lead-Time determines the quality and shelf life of the produce due to its short date of expiry. (Pagani et al. 2016, Mercier et al. 2017) While each product starts with a certain quality level, depending on the produce itself and growing conditions, quality decreases during transport and storage while moving through the Supply Chain network (De Keizer et al. 2017).

Nguegan & Mafani (2017) point out that the threat of disruptions along time sensible Supply Chains remain as a challenge, caused by either internal factors of the Supply Chain, or external environmental circumstances, e.g. natural disasters, political and economic developments, changing regulations and the ability to respond to technological trend. While the later are not in the control of the Supply Chain, internal factors are subject to improvements.

The major challenge found regarding the Lead-Time of fresh fruits when importing from outside Europe is the downtime during transportation (Wyman et al. 2018; Nguegan & Mafani, 2017). *"With each logistics operation product quality decreases depending on the operational characteristics and the decay rate of the product"* (De Keizer et al. 2017, p. 537). Four critical operational steps are described in the literature, from the harvesting to the moment the importer receives the goods. Mercier et al. (2017) points out in its study that the first step in the Supply Chain, from harvesting location to the packaging station, is a time critical phase. Fruits are collected on site and transported to the cleaning/ packaging station once they reach a sufficient volume. Lead-Time, in combination with temperature, plays a significant role. At this point, documentation is described as poor, leading to a lack of trust regarding the Lead-Time before the first official registration. (Mercier et al. 2017) Secondly, the produce needs to wait for loading at the port facilities. On average, containers have a downtime of approximately 24 hours before they are loaded onto the ship, which reversely leads to a reduced shelf life. (Wyman et al. 2018) Once the ship reaches the Port of Entry to Europe, the documentation assessment as well as the customs and veterinary control is at risk to slow down the Supply Chain (Descartes, 2019). Mercier et al. (2017) emphasize at this point that uncertainty arises from a lack of knowledge about the completeness of necessary documentation and the duration of the controls. Lastly, importing from outside Europe to Sweden by the mean of sea transportation often adds 2-3 days of Lead-Time due to an additional step of road or sea transportation from the Port of Entry (Netherlands, Germany) until the produce reaches Sweden (UPS, 2019; DHL, 2019).

Overall, Lead-Time challenges occur distributed along the Supply Chain. While the Lead-Time increases until the fruits leave the Port of Origin, the customs procedure and additional transportation step to reach Sweden adds Lead-Time on the European side. (Wyman et al. 2018; Nguegan & Mafani, 2017; Descartes, 2019) Additionally, network designs influence the durations and conditions of the produce (De Keizer et al. 2017).

2.5.3 Import Regulation Compliance & Process

3,8 billion tons of cargo are handled at European ports every year. Due to these high volumes, especially in Rotterdam (NL) and Hamburg (GER), the inspection of all containers and the assurance that contained products comply to European standards and regulations is described as a major challenge in the field of shipping and trade. (Massy-Beresford, 2017; Bakshi et al. 2011; EC, 2019b; Orphan et al. 2009; CBO, 2016) Additionally, the importing process and requirements for documentation is often found to be a major inefficiency along Fruit Supply Chains (CBI, 2018; Descartes, 2019).

Major European Port of Entries for sea cargo in Rotterdam and Hamburg strive for scanning 100% of the container reaching and leaving the port facilities. Apart from RFID and X-Ray scans, additional devices check for radioactive signs. (CBO, 2016; Massy-Beresford, 2017) Even though it contributes to the identification of a container unit, preventing smuggle and potential terroristic attacks, other food safety aspects are not covered. Unattended aspects revolve around contamination of fruit products, e.g. level of pesticides, fertilizers, vermin infestation, as well as economically motivated frauds, e.g. alterations of labels regarding the origin of produce or fraudulent use of Eco-Labels. (Davidson et al. 2017; Massy-Bereford, 2017) To detect these issues, containers need to be subject to physical inspections. Bakshi et al. (2011) and Orphan et al. (2009) describe that 5-6% of the containers at ports are inspected physically, leaving most of the produce unchecked regarding compliance to import regulations and European standards.

On the other hand, the import documentation and process can be described as a Supply Chain bottleneck (Descartes, 2019). Due to strict regulations regarding documentation on food safety, quality and business compliance, containers without full documentation of Bill of Lading, phytosanitary certificate, packing list, custom documentation and traceability code for fruits will not be allowed to enter Europe (CBI, 2018). Since documents are often of physical nature, delays mainly occur due to incomplete documentation. (EC, 2019b; Descartes, 2019)

Due to increasing global trade, Ringsberg (2014) emphasizes that improvements in communication between producers, transporters, customers and authorities are necessary to build fully transparent and traceable Supply Chains, to ensure product safety and quality.

2.5.4 Labor Conditions

Agriculture seems subject to dangerous working environments, with exposure to pesticides, musculosketal disorders, accidents and child labor as prevalent problems (Human Right Watch (HRW), 2011) Yet, information transparency regarding labor conditions at production sites is an issue in the Fruit Supply Chain sector (Weng et al. 2015; HRW, 2011). Pesticides are an important aspect to achieve high agricultural productivity in todays farming. However, researchers have shown that unintentional exposer to pesticides remain a health hazard for farm workers all around the world. (Weng et al. 2015) Robinson (2010) reports that banana-plantation workers in Costa Rica are frequently exposed to highly toxic chemicals when fungicides and pesticides are applied by airplanes and aerial spraying. Yet, the responsible supermarket groups and large transnational producers claim that it is impossible to monitor all the farms managed by their supply base and they can therefore never guarantee the provenance of each consignment of fruit (Robinson, 2010). Also, findings from Thetkathuek et al. (2017) show that musculosketal disorders are common among Cambodian fruit farm workers due to unnatural body movements, heavy manual lifting and repetitive movement. HRW (2011) report that fruit farm workers in South Africa often fail to receive proper treatment and are habitually forced to work after sustaining a work-related accident. However, this issue often goes unnoticed as labor inspection capacities are too low to monitor all workplaces (HRW, 2011). Another labor issue in fruit farming is child labor, as the International Labor Organization (ILO) estimate that 60 percent of all child laborers work in agriculture. Yet, it is difficult to receive information regarding child labor due to minimal enforcements and regulations as well as ingrained attitudes about the roles of children in farming. (ILO, 2019)

2.5.5 Overview: Literature

Issues	Specification	Discussed by
Product Identification		
Origin of Products	*How trustworthy is the information about the origin of products?*	Aung et al. 2014; Bitzios et al. 2017; Charlebois et al. 2016; Dabbene et al. 2014; Wognum et al. 2011
Harvesting Date	*How trustworthy is the information about the harvesting date of the products?*	Bitzios et al. 2017; CGSO, 2019; De Winter, 2015; Karp, 2018; Smithers, 2018
Eco-Labelling	*Are the Eco-labels reliable? Can sustainability claims be trusted?*	Capuano et al. 2012; Shears, 2010; Song et al. 2016; Vincent et al. 2018
Product Movement		
Cold Chain	*How trustworthy is the information about the Cold Chain, including storage, transportation and disruptions?*	Berry et al. 2015; Goedhals-Gerber et al. 2017; Mercier et al. 2017; Ndraha et al. 2018; Nguegan & Mafini, 2017; Nielsen, 2015; Rodrigue et al. 2017
Lead-Time	*How trustworthy is the information about the Lead-Time, including storage, transportation and disruptions?*	Descartes, 2019; DHL, 2019; De Keizer et al. 2017; Mercier et al. 2017; Nguegan & Mafani, 2017; Pagani et al. 2016; UPS, 2019; Wyman et al. 2018
Import Regulation Compliance & Process		
Compliance to Import Regulations, EU-Standards, as well as Importing Process	*Can suppliers claim of compliance to import regulations be trusted? E.g. use of fertilizers, pesticides, Irrigation, hygienic-sanitary, etc.*	Bakshi et al. 2011; CBI, 2018; CBO, 2016; Davidson et al. 2017; Descartes, 2019; EC, 2019b; Massy-Beresford, 2017; Orphan et al. 2009; Ringsberg, 2014
Labor Conditions		
Labor Conditions	*Can suppliers claim of compliance to Human Rights Laws be trusted? E.g. worker health, safety and welfare*	HRW, 2011; ILO, 2019; Robinson, 2010; Thetkathuek et al. 2017; Weng et al. 2015

Table 1 - Literature Overview: Trust-related Supply Chain Challenges

3 Methodology

The following chapter will provide a detailed overview of methodology aspects chosen in this study, covering the Research Strategy, Design, Method, Analysis Method and the Quality of the Research. This chapter will therefore provide all relevant information about methodic approaches and decisions to display a transparent process.

3.1 Research Strategy

This study is conducted as an exploratory research due to the unexplored nature of the subject. The objective of exploratory research is to understand the topic that is being researched (Sreejesh, 2014). The intention of the study is not that the results should be used for organizational decision making as it should rather provide insight into a specific situation, which is in line with exploratory research. Exploratory research often includes elements such as reviewing existing literature and qualitative interviews. Descriptive and causal research is not used throughout the study as these alternatives are more quantitative and conclusive in nature. (Bryman & Bell, 2015)

A qualitative research strategy is used throughout the study to enable a detailed analysis of the insights and opinions of the participants. A qualitative strategy serves the purpose of the study as Bryman & Bell (2015) underlines it as the superior research strategy when there is a lack of knowledge as well as a high degree of uncertainty regarding the research topic. To fulfill the objective of understanding trust issues along the Swedish Fruit Supply Chains and possible blockchain-enabled solutions to these trust issues, it is necessary to analyze the knowledge and perception of both the Supply Chain actors and the blockchain experts. This is in line with the qualitative strategy approach of this paper as the study takes an epistemological position described as interpretivist. This means that, in contrast with the natural science model approach in quantitative research, the emphasis is on understanding the topic through the examination of the interpretation of the topic by the study's participants. The natural science model, on the other hand, is a schematic view of the pattern of advances in natural science and often include elements such as experimentation and hypothesis testing, skepticism, and empiricism. Further, the study uses semi-structured, qualitative interviews, a principal research method associated with a qualitative strategy, as the primary data collection approach to explore the experience and perception of the participants regarding the research topic. Qualitative, semi-structured interviews enable the participants to give rich and detailed answers to a specific list of questions, but also to depart from the interview guide to give insight into what the interviewee perceives as relevant or important. This is in line with the exploratory nature of the study. Bryman & Bell, 2015)

Additionally, the study employs abductive reasoning regarding theory to overcome the weakness of inductive and deductive reasoning. Abduction, like inductive and deductive reasoning, is as a form of logic that is used to build theories and make logical interferences about the world (Bryman and Bell, 2015). In more detail, Eriksson & Kovalainen (2008) defines abduction as the process of moving from the descriptions and perceptions given by people, to categories and concepts that create the basis of an understanding or an explanation of the phenomenon described. Further, abduction can be described as a way to combining deductive and inductive reasoning (Eriksson & Kovalainen, 2008). This study initially employs deductive reasoning by reviewing relevant literature as a mean to compose characteristics and categories regarding trust issues along Fruit Supply Chains as well as possible blockchain solutions for these issues. The composed characteristics and categories are used as a framework while collecting the qualitative data. The study then takes an inductive approach by combining and expanding upon the qualitative data and existing literature to create an analysis model capable of answering the research questions. The fundamental benefit of abductive research for this study is that it, unlike deductive and inductive, can be used for the creation of new knowledge and insight, which is in line with exploratory research (Kolko, 2011).

3.2 Research Design

This study has an exploratory research design. An exploratory research design approach helps in evaluating and understanding critical issues associated with problems and should not be used in cases where a define result is desired. Instead, an exploratory research design is used to obtain relevant information and to establish a foundation for subsequent research to attain results for a problem situation. More specifically, an exploratory research design can typically be divided into three main aspects; to analyze a problem, to evaluate alternatives and to discover new ideas. (Kolko, 2011)

The study takes an exploratory approach by initially collecting secondary data from existing literature as well as primary data from semi-structured interviews to create the foundation for the analysis model. In more detail, the interviews in the study are conducted with both Supply Chain actors and blockchain experts. The data collected from the actors is used to identify trust issues along the Swedish Fruit Supply Chains while the data from the experts is used to identify possible blockchain solutions to the mentioned trust issues. Further, the study combines and extends upon existing literature and the interview data to build an analysis model. The analysis model includes themes from the secondary and primary data and is used to examine the trust issues as well as the blockchain solutions. The study does not seek to provide definite results, but instead attempt to build a foundation for future research in a relatively new field.

3.3 Research Method

3.3.1 Primary Data Collection

For the study, the primary data collection was based on a semi-structured interview approach. Throughout the interviews, two different groups were consulted. Firstly, interviews with representatives from four Swedish fruit importers were conducted. In a second step, Blockchain experts with diverse backgrounds were interviewed. According to Bryman & Bell (2015) the approach of semi-structuring the interview provides the researchers with the opportunity to explore a topic and benefit from expert insights, while still following a rough structure. The process can be described as flexible, as the focus lies on what the interviewee considers important. Due to the exploratory and abductive approach of the research, the semi-structured interview approach was considered appropriate, since the subject required openness for new information. During the first step it was necessary to gain insights into Supply Chain challenges when importing fruit from outside Europe to Sweden, including different products, origins and configurations, as well as defining areas where trust issues exist. In the second step, the blockchain experts elaborated on if and how the trust issues in the identified case can be solved. A structured approach would have potentially undermined the exploratory character and leave blind spots.

3.3.1.1 Interviewee Selection

Within the limitations of time and access, it is necessary to achieve a level of data which can picture the topic of the research to a sufficient extent. (Bryman & Bell, 2015) The selection of fruit importers to Sweden was limited by the nature of the market. Firstly, the study focused on Swedish companies located in Sweden. Two of Sweden's largest general fruit importers were interviewed, as well as one importer specialized on bananas and pineapples and one importer who focus on a small range of organic produce. The main selection criterion for the smaller importer was the independence from the market leaders, hence, the organization of imports from outside Europe on its own behalf. On the other hand, blockchain experts were chosen from diverse backgrounds, including academia, consultants, and representatives from start-up companies. Overall, seven experts were interviewed to gain a diverse perspective on the research topic.

In the first place, Swedish fruit importers were identified by internet investigation and consultation with the study supervisor. In the following, the companies were contacted by e-mail, giving them a brief overview of the study background, its purpose, expectations from the interview with a representative of the company and how the interview can contribute to the study *(see Appendix 1)*. The aim was to identify active representatives and managers who have a deep insight into the Supply Chain of the company and are aware of challenges along the Supply Chain. Even though the interest of the study lied in the blockchain technology, it was made clear that at this stage no knowledge regarding blockchain was needed and the focus clearly lies on trust-related aspects. An overview of the importer interviewees can be found in *Chapter 3.3.1.3, Table 2*.

As the importers, the blockchain experts were identified by Internet investigation and consultation with the study supervisor. A special focus lied on contributions in form of articles regarding blockchain solutions for the Food Industry, or even the Fruit Industry. Additionally, Supply Chain experts with research interest in blockchain were considered. Like the importers, experts were contacted by e-mail *(see Appendix 1)*. All interviewed experts were either located in Sweden, the UK or the Netherlands. An overview of the expert interviewees can be found in *Chapter 3.3.1.3, Table 3*.

The interviews followed the same order. Firstly, importers were interviewed, followed by the identified experts. In general, this approach was chosen to achieve a clear division into two parts. Like this the study avoided unintentional premature evaluation and influencing the interviews with the importers. The experts were then interviewed to address specific challenges and trust issues that arise from the previous interviews.

3.3.1.2 Interview Guidelines

For the interviews, two individualized guidelines needed to be created, one directed to the group of importers and the other one to the experts. Both guidelines can be found in *Appendix 2*. Since the interviews with the import company representatives were conducted earlier in time, the guideline was created first. According to Bryman & Bell (2015), a guide for a semi-structured interview needs to be less strict in comparison to a structured guide. It can rather be referred to as a list of memory which areas need to be covered. However, since time was a critical aspect to the research and the importers representatives alike, the interview was guided to some extent.

The first interview guideline initially intended to discover the challenges the importers perceive to have from their perspective, as well as more fact-based information about the importer's areas of interest and Supply Chain structures. This part mainly was conducted to establish a valid case within the topic of Fruit Supply Chains. Secondly, categories were created which capture the most significant challenges along food Supply Chains *(see Table 1)*. These categories were based on a literature review and discussed with the supervisor of the study. This approach was chosen to be able to ask importers for trust issues in specific categories, which is the main goal of the first phase of the interviews.

The second interview guideline, focusing on specific approaches and solutions in the means of blockchain technology, was based on the results from the first phase of the interviews. Therefore, the questions were based on the most significant challenges which are identified during the interviews with the importers. The experts were confronted with the findings from the first phase to capture specific approaches to solve the trust issues, if possible.

For both interviews, the study took an iterative approach. This approach allowed the study to adjust the questions throughout the process of interview phase one and two, which is necessary in timely restricted researches where there is only a highly limited number of interview rounds possible. (Bryman & Bell, 2015) However, to maintain comparability between the interviews, the main framework and questions were not changed throughout the process. The approach was rather used to discover areas of interest brought up by the interviewees, also contributing to an open room for discussions.

Before the interviews, the interview guideline was not sent out to the interviewees. Whilst the interviewees received an overview of the study, the interview guidelines were not sent out to the interviewees. That approach contributed to capture spontaneous answers based on the interviewee's experiences, rather than prepared and internally pre-discussed answers.

3.3.1.3 Interview Overview

According to Bryman & Bell (2015), direct face-to-face interviews increase the understanding and engagement of the interviewees. Therefore, face-to-face interviews were conducted with every participant possible. However, the study did not only encounter internal time restrictions, but also limited time of the interviewees. Therefore, Skype and phone interviews were considered as the main approaches. All interviews were transcribed afterwards to eliminate the errors regarding wrong memories and to have better access to the qualitative data for the analysis.

Before the interviews, it was made clear that all interviews can be conducted anonymously, since the identities of the interviewees are not significant to fulfil the purpose of the research. Even though some interviewees accepted the usage of their names, the paper anonymized all participants to avoid bias and potentially higher influence of the statements made by non-anonymized interviewees.

List: Swedish Fruit Importers			
Importer	Shortcut	Description	Date & Duration
Swedish Importer 1	IMP1	*Head of Quality*	13.03.19 – 60 min. *(Phone)*
Swedish Importer 2	IMP2	*Head of Purchasing, Fruits*	18.03.19 – 60 min. *(Phone)*
Swedish Importer 3	IMP3	*Purchasing Manager, Fruits*	04.03.19 – 60 min. *(Phone)*
Swedish Importer 4	IMP4	*Head of Trade and Business Development*	14.03.19 – 60 min. *(Phone)*

Table 2 - List: Swedish Fruit Importers (Interviewees)

List: Blockchain and Supply Chain Experts			
Expert	Shortcut	Description	Date & Duration
Academic Expert1	EXP1	*PhD, Senior Researcher,* in the field of SCM, Logistics and recently blockchain at one of the biggest Technological University in Sweden.	19.03.19 – 60 min. *(Skype)*

Consultant	EXP2	*Director of Blockchain Services* in Sweden and the Nordics at one of the major advisory companies in Sweden and Europe.	20.03.19 – 30 min. *(Phone)*
Business Manager1	EXP3	*CEO, Founder and Research Scientist* in the field of big data analytics, space-related technology and blockchain.	21.03.19 – 60 min. *(Phone)*
Business Manager2	EXP4	*Project Leader* for Swedish research foundation around the exploration and evaluation of blockchain technology in the food industry.	22.03.19 – 30 min. *(Phone)*
Academic Expert2	EXP5	*PhD, Professor,* in the Department of Computer Science and Engineering at one of the biggest Technological University in Sweden.	22.03.19 – 30 min. *(Face-to-Face)*
Academic Expert3	EXP6	*PhD, Senior Researcher,* in the field of Applied IT, software development and blockchain technology.	29.03.19 – 45 min. *(Skype)*
Business Manager3	EXP7	*Co-Founder* and blockchain solution architect in the field of logistics and trade.	01.04.19 – 45 min. *(Phone)*

Table 3 - List: Blockchain and Supply Chain Experts (Interviewees)

3.3.2 Secondary Data Collection

The purpose of the secondary data in this study is to provide the researchers with additional information regarding the researched topics. The benefit for this study to collect secondary data from existing literature include the opportunity to receive high-quality data for a fraction of the time it takes to collect primary data (Bryman & Bell, 2015). Thus, the secondary data in this study is used as a complement to the primary data to answer the research questions. More specifically, the researchers initially used the secondary data as a mean to define the research questions. This process included the use of various databases as well as search engines such as Google Web and the Super Search function on the website of University of Gothenburg to establish a research topic. As the research questions were established, the existing literature was reviewed in a more systematic manner. Bryman & Bell (2015) encourages the use of a systematic review of literature to compile a complete review of the chosen research topic. In this study, the systematic literature review was performed by examining academic articles and equivalent (i.e. books, articles) posted in the library of University of Gothenburg as well as in established databases such as EBSCO, Emerald Insight, Science Direct, Scopus, Taylor & Francis and SpringerLink.

Inclusion criteria

The following inclusion criteria for literature were chosen to achieve the objective of describing trust-related challenges in Fruit Supply Chains and exploring if/how the blockchain technology is suitable to reduce trust issues between the importers of fruit in Sweden and their suppliers.

- Peer-reviewed articles
- Articles published in academic journals (or in sources of equivalent status)
- Reports from corporate bodies
- Newspaper publications

Exclusion criteria

The following exclusion criteria were chosen to avoid irrelevant and unrelated information in the literature review.

- Articles published in unreliable sources, e.g. not trusted databases or equivalent
- Articles in other languages than English, Swedish or German
- Articles on the financial aspects of blockchain, e.g. Bitcoin and other cryptocurrencies, as well as purely technical/ mathematical papers

3.4 Analysis Method

The study includes a thematic data analysis, which is one of the most common ways of approaching qualitative data analysis (Bryman & Bell, 2015). The thematic analysis approach does not have a universal definition, but Braun & Clarke (2006, p.79) define it as *"a method for identifying, analyzing and reporting patterns (themes) within data".* Coding is the primary method for structuring captured data when conducting a thematic analysis. In line with this, data from the interviews with the importers as well as the blockchain experts were coded based on the Supply Chain trust challenges identified in the literature review to make the data understandable, coherent and structured. (Bryman & Bell, 2015) Also, the interviews were coded based on the trust categories, as the objective of the interviews was to take part of the participants' perspective regarding specific Supply Chain trust issues. Both authors conducted the transcriptions and coding individually to reduce the impact of personal opinions on the end-result. By using the thematic analysis approach, the answers from the interviews with the importers and the experts could be classified and compiled into the predetermined categories. The results from the interviews are presented in the empirical findings *(see Chapter 4)* of the study. Further, the results from the interviews with the importers and the experts are combined with literature in the analysis *(see Chapter 5)* to understand the potential usage for blockchain technology for each specific trust issue.

3.5 Quality of the Research

In the context of business research methodology, the quality of the research is generally determined by three research criteria, which can be divided into reliability, validity and replicability. (Bryman & Bell, 2015) Therefore, each criterion will be discussed in the following sections to assess the quality of the research.

3.5.1 Reliability

The criterion of reliability in general refers to the question whether the results of a research are repeatable, if an identical approach to the study is carried out in the future. (Bryman & Bell, 2015) In other words, reliability can be described as measure for stability and consistency of the conclusions drawn from the research. According to Bryman & Bell (2015), the criterion of reliability is divided into two categories – external reliability and internal reliability.

External reliability describes the degree to which a study can be replicated with results similar to those found in the original study. Thereby, the purpose of external reliability is to present the used methodology in order for another researcher to be able to replicate the study. (Bryman & Bell, 2015) As described by Yli-Huumo et al. (2016), the research around practical implications of blockchain technology is considered rather underdeveloped. However, research in business context is expected to increase rapidly. Additionally, knowledge and adoption amongst the Swedish fruit importers may develop as people are not static measurements. Nevertheless, the study measures the current level of trust in certain Supply Chain aspects and how the current state of technology can counter these challenges. Hence, the study can lay the foundation for future research and is therefore considered a relevant field of study. Additionally, all relevant research process steps are displayed in order to provide full transparency of the research. Consequently, researchers who replicate the study are expected to receive similar results.

On the other hand, internal reliability is a measure for alignment within the researcher team. In other words, given that there is more than one researcher, it ensures that the members of the research team agree on observations or interpretations. (Bryman & Bell, 2015) To ensure internal reliability, an interview guideline was prepared in close collaboration to ensure clarity and avoid unambiguity regarding the meaning and expectations of the questions. Both authors participated in the interviews with import companies, as well as blockchain experts, to prevent exertion of influence during the interviews and avoid biased interpretations. For the same reason, all interviews were held in English, since the research members do not have the same native language. However, this might cause complications regarding understanding and expression of the interviewees. Eventually, all transcribing was done separately and counter-checked with the interviewees, whilst the content of the analysis was discussed jointly.

3.5.2 Validity

In general terms, the validity of a research refers to the integrity of the conclusions which are drawn from the research. In the context of qualitative business research, validity can be divided into two categories – internal validity and external validity. (Bryman & Bell, 2015)

According to Bryman & Bell (2015), external validity revolves around the question whether the results of a research can be generalized and applied to contexts other than the specific research. To increase external validity and allow for generalization the main fruit importers in Sweden are interviewed. On the other hand, blockchain experts from different backgrounds are consulted. However, time and access limit the number of interviewees, especially on the side of the importers. Since the research covers some of the main fruit importers of Sweden, as well as two niche importers, the study covers the Swedish import market to a significant extent. Consequently, results can be generalized on an industry level. However, due to highly diverse trust-related challenges in different industries, findings and results are not generalizable across different industries.

Internal validity defines the causality between empirical findings and conclusions. (Bryman & Bell, 2015) In the research, internal validity is improved by measures taken regarding the documentation of the interviews. Interviews were transcribed and validated with the interviewees to avoid incorrect interpretations or other mistakes. Additionally, each category measuring trust were summarized by a single question, which the interviewees were asked to rank between "Low, Medium, High”. This allows the research to validate the answers given by the importers and experts beforehand and exclude contradictions.

3.5.3 Replicability

Even though replications in the context of business research are not common, research has to allow for future replication. Consequently, the procedure during the research needs to be documented in detail to allow future researchers to apply identical methods. (Bryman & Bell, 2015) For the purpose of replicability, the study describes the literature review, the interview settings, the procedure and rational of coding the qualitative data and the analysis model as detailed as possible to increase the possibility to replicate the study. Additionally, purposes and rationales are explained in each step. According to Bryman & Bell (2015) clarity in qualitative research is the most important aspect to assure replicability.

4 Empirical Findings

In the first step, the Supply Chains are generically described according to each importer and a generic Fruit Supply Chain from outside Europe to Sweden is compiled. Following, the chapter will present the Empirical Findings from the Importers, as well as Expert interviews. An overview of all abbreviations can be found in Chapter 3.3.1.3.

4.1 General Information about the Supply Chains

Swedish Importer 1 (IMP1)

IMP1 describes itself as one of the biggest importers of fresh fruit in northern Europe. The company sources a wide variety of products from across the world, including South American countries (Ecuador, Peru, Chile, Argentina, Costa Rica, DR), but also from Asia (Thailand, Vietnam, China, India) and Africa (Morocco, Kenya, South Africa). The company generally does not rely on long-term contracts, but rather on short-term supply agreements. Even though it owns a small number of producers, the focus of the company is sourcing directly from independent farmers. While fruits are mainly bought on a weekly basis, volumes are covered with purchases from the European spot markets. Most of the produce is shipped in containers from their origin to the port of Rotterdam, where the products are consolidated and sent to Sweden via ships or trucks.

Swedish Importer 2 (IMP2)

IMP2 can be described as a 100% subsidy of a Swedish food retailer. While the import of fruit from Southern Europe is strong, sources outside Europe are mainly located in South America (Chile, Argentina, Brazil, Peru, Columbia, DR, Costa Rica), Asia (China, India) and Oceanica (Australia, New Zealand) and Africa (South Africa). To reduce risks, IMP2 sources various products from different European and non-European countries alike. According to IMP2, the company relies on a network of long-term partners in their network, which however are evaluated on a weekly and monthly basis regarding performance, quality, and price. To assure product availability at any given time, products are also bought on the European spot markets.

Swedish Importer 3 (IMP3)

As subsidy of a banana and pineapple producer, the company is responsible for importing to Sweden as well as the ripening process. The yearly volume is broken down into 52 weeks, consisting of 2,3 million boxes of bananas per year and 44.000 boxes per week. While 50% of the produce is ordered from the owner, mainly produced in Ecuador and Costa Rica, IMP3 also imports from the Dominican Republic (DR). In DR, the fruits come from Associations which consist of 10-20 independent farmers and plantations. Additionally, fruits are bought from the spot market to complement the production and supplier capacities. The Supply Chain is described by IMP3 as lean: The harvested fruit reaches the port after 1-2 days and is shipped to Sweden, either directly (DR – 2 weeks) or through the port of Rotterdam (Costa Rica – 3 weeks, Ecuador – 4 weeks). IMP1 describes the core business in Sweden being the ripening of green bananas in its facilities in Stockholm and Helsingborg.

Swedish Importer 4 (IMP4)

IMP4 is a Swedish importing company focusing on biological and organic produce. According to IMP4, the company therefore concentrates on a small product portfolio, mainly including bananas, pineapples, mango and ginger. Due to long-term business relationships and contracts with the producers, IMP4 sources primarily from the Dominican Republic and secondarily from Ecuador, Peru and Costa Rica. 90% of the volume is sourced from small growers and cooperatives, while the other 10% is bought on the spot market. IMP4 describes that 70-80% are FairTrade labelled products, while the other 20-30% are regular products. Volumes are forecasted and ordered on a yearly basis, broken down into 52 deliveries per year. On average, IMP4 receives 10-15 containers of bananas and one container of pineapples per week, as well as two containers of mango per week depending on the season. Ginger is a sporadically imported product.

Description of a generic Fruit Supply Chain from outside Europe to Sweden

According to the importers, the configuration of Supply Chains from farmer to importer does not differ significantly between regions and countries. Hence, a generic Supply Chain is presented in *Figure 6*. Independent farmers or producers harvest the produce at the plantation, where it is either picked up or transported to the packing station. After cleaning, if necessary, goods are packaged, precooled, stored in a cooling container and transported to the Port of Origin. The duration of Sea Transportation depends on the location, varying between 14 and 21 days on sea. The containers are then scanned and/ or inspected at the Port of Entry, consolidated if necessary and loaded onto the next ship or truck. Eventually, the produce arrives at the importers facilities.

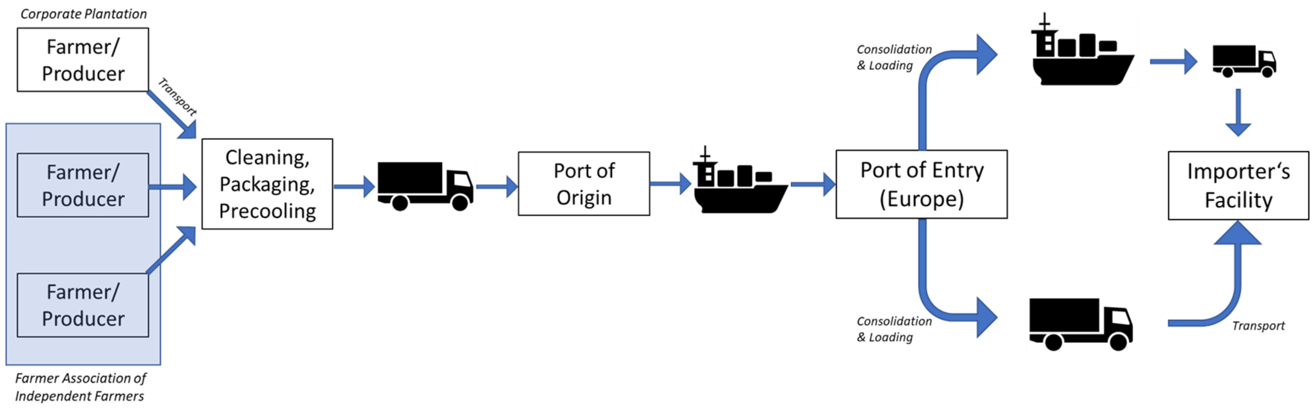

Figure 6 - Generic Fruit Supply Chain

4.2 Importer Interviews

The following sections present the findings from the importers interviews. During the interviews, importers were asked to evaluate upon specific areas where Supply Chain challenges exist and how they perceive the trust relationship downstream the Supply Chain regarding those identified challenges.

4.2.1 Product Identification

4.2.1.1 Origin of Products

All four companies express high trust in the information they receive about the origin of fruits. IMP1 and IMP2 state that product origin is of somewhat importance to them as quality issues as well as political and social issues can mean that products from certain regions are unwanted. Issues such as modern slavery and child labor, seasonal needs as well as a perceived difference in quality level between countries matter when it comes to information on product origin (IMP1; IMP2). The origin of fruit also matters when customers question why products are sourced from far-away destinations, according to IMP1. However, IMP1 and IMP2 regard origin of fruit to be of low risk for food fraud due to the lack of monetized incentives to cheat. Also, both importers express a high level of confidence in the information they receive from their suppliers regarding product origin due to long-term contracts with their suppliers as well as frequent supplier visits. For example, the suppliers of IMP2 need to upload certain information on IMP2s website, such as the location of their packing stations, the certificates of these packing stations as well as certificates of the growers connected to the packing station. IMP2 states that Peru is considered to be a risk country when it comes to information in general, but still express full trust in the suppliers in Peru when it comes to product origin, partly due to a lack of monetized incentive to "cheat".

"There is very low risk for food fraud because the risk that suppliers putt Peru or Brazil on apples from Argentina is low as there is not a lot of money to earn by doing that" (IMP2)

Perceptions of IMP3 and IMP4 differ from IMP1 and IMP2 in that the origin of the product is not of importance to their customers. For IMP3, it is the color and the size that is of interest because that is what IMP3 believes that its customers are interested in. IMP4 believes that origin of the product is important as their customers pay for the label on the products and therefore also information about the origin of the product.

"If you build up a family name, a future for you and your family, invest your money in a good plantation, take care of the plantation, give the right salary to your workers, then you are there to stay. Not just to develop, take a share and leave the island" (IMP3)

Similarly, IMP1 and IMP2, IMP3 and IMP4 state that food fraud is not an issue when it comes to origin of the product. IMP3 believes that suppliers do not want to risk their reputation by not being visible and transparent. Comparably to IMP2, IMP3 says that information on fruit origin from Dominican Republic generally carry more risk than information from Ecuador and Costa Rica, but IMP3 express full confidence in the origin of the products as the company have full trust in their suppliers. Concerning the labeling, IMP4 mentions that products are at times labeled wrong at the packing stations and fruit from farmer A can therefore be sold as fruit from farmer B. However, this is not of concern to IMP4 as the farmers are often a part of a cooperative that IMP4 trusts due to an established long-term relationship. The opinions of the importers are summarized in *Table 4*.

"So, if the banana in the end comes from Farmer A or B does not really interest us, as long as the country of origin is correct and the product doesn't show any quality issues" (IMP4)

	Low	Medium	High
Origin of Products			IMP1, IMP2, IMP3, IMP4

Table 4 - Importer Results: Origin of Products

4.2.1.2 Harvesting Date

IMP3 and IMP4 express that the harvesting date is of importance while discussing the confidence in information regarding the harvesting date. IMP3 says that the harvesting date is interesting from a quality perspective as delays or problems along the physical Supply Chain can cause quality issues. IMP4 says that harvesting date is a rather important factor when it comes to seasonal products like mangos and pineapples as the flow of these products are not as constant as other products.

Regarding the confidence of the harvesting date, both IMP3 and IMP4 state that they have full trust in the information they receive. In the case of IMP3, this trust originates from the fact that the company educates both the IMP3 farms and the sub-contractors. Also, the sub-contractors are obliged to inform IMP3 of any issues and they are contracted to keep up with all the specifications given by IMP3. IMP3 specifies that trust issues regarding the harvesting date occurs, but it is easily identified by the weight, size, and color of the products. Therefore, there is no incentive for the suppliers to “cheat” as suppliers who repeatedly fail to provide fruit of acceptable weight, size, and color lose their certificates from IMP3. Similarly, IMP4 states that suppliers who regularly try to deceive the company will not remain in its supplier portfolio. In more detail, IMP4 explains that the small cooperatives the company conducts business with are so dependent on selling their fruit to exporters and IMP4, which means that there is no incentive to jeopardize the relationship with the buyers.

““Monkey business” absolutely happens, but if it happens too often, you are not certified. And then you’re standing there with the fruit you can’t sell, except on the spot market” (IMP3)

IMP2 and IMP1, on the other hand, are more interested in the shelf life of the products then the actual harvesting date. Both importers state that they do not receive information regarding the actual harvesting date but instead receive information about the packaging date. The packaging date is considered to be important by IMP2 and IMP1. Also, IMP2 and IMP1 both describe the complexity of information regarding the harvesting date as the date can differ considerably depending on the product. IMP2 explains that harvesting date is essential for a product like lettuce due to short shelf life while it is not as essential for a product like apple that can be harvested during a one to two-week period and moved into long-term storage. Similarly, IMP1 expresses that the harvesting date is of greater importance when it comes to products with short shelf life compared to products with longer shelf life.

IMP2 and IMP1 have different viewpoints regarding the trustworthiness of the information about the harvesting date. IMP2 is focused on how external factors, such as weather conditions, impact the shelf life of the products and therefore also the information the company receives. For example, IMP2 describes that unusually warm weather can affect the sugar levels of the crop and therefore shorten the shelf life of products. IMP2 receives constant information from its suppliers regarding the condition of the crops but it can still be difficult to estimate the quality of products throughout the season. Considering this, IMP2 expresses medium to high trust regarding the information about the harvesting date.

IMP1, on the other hand, is more concerned about the lack of directness when it comes to the information about the harvesting date. IMP1 says that it can be difficult to link a batch or box of products to the information the company receives. Additionally, the trustworthiness of the information also depends on the region from which the products are sourced, as certain countries, such as Egypt, are perceived to be less trustworthy then others. However, IMP1 clarifies that the company has trustworthy suppliers in Egypt. All in all, IMP1 experiences medium trust when it comes to information about the harvesting date. The opinions of the importers are summarized in *Table 5*.

	Low	Medium	High
Harvesting Date		IMP1, IMP2*	IMP2*, IMP3, IMP4

Table 5 - Importer Results: Harvesting Date

** IMP2 express medium to high level of trust regarding information about the harvesting date*

4.2.1.3 Eco-Labelling

All the importers express that the labeling of organic products is of importance to them and all the importers test the organic products frequently to ensure its status. The importers also work closely with certifiers, such as the National Food Agency, Krav and Fair Trade, to verify the status of the organic products.

The importers describe slightly different levels of trust when it comes to the trustworthiness of information regarding organic products. IMP3 and IMP2 both describe that pesticides have been found in organic products when the organic product comes from regions where conventional and organic farms are located close to each other. IMP3 says that it is not uncommon that conventional farms and organic farms are located close to each other in Latin America while IMP2 says that pesticides can sometimes, although quite rarely, be found in organic products as a result of wind carrying pesticides from conventional to organic production fields. Yet, IMP3 express full confidence in their suppliers as IMP3 perceives these issues to be a result of accidents rather than trust issues between buyer and seller. IMP2, on the other hand, is more concerned regarding the trustworthiness of information from suppliers in general as it would surprise IMP2 if "cheating" did not occur regarding eco-labelling due to the monetary incentives to commit fraud as organic products have higher value than conventional products. However, IMP2 stresses that the company are confident about the truthful information they receive from their own suppliers.

IMP1 also expresses medium to high confidence in the trustworthiness of information regarding eco-labelling and identify organic products as an area impacted by the risk of fraudulent behavior from suppliers. In more detail, IMP1 expresses concerns when it comes to situations where buyers go from buying large volumes of conventional products to instead buy large volumes of organic products. For example, IMP1 describes that buyers in Sweden switched from buying conventional bananas to organic bananas seemingly overnight about ten years ago. It is during similar circumstances that IMP1 sees a potential risk regarding fraudulent behavior due to a monetized incentive to cheat. Yet similarly to IMP2, IMP1 stress full confidence in its own suppliers as the company only works with suppliers that are certified according to organic systems.

IMP4 also expresses some concern regarding issues with organic labels and state that every now and then there are cases where certified producers do not comply with the labeling rules. A typical issue can be that the producers use the wrong kind of pesticides. IMP4 says that it is demanding for the suppliers to meet the standards of the certifiers and it is often the suppliers that can adapt quickly to issues pointed out by the certifiers that survive as most will come across issues at some point. IMP4 also identifies bananas from Ecuador as particularly sensitive when it comes to fraudulent activities regarding eco-labelling. While expressing some concern for the trustworthiness of eco-labels, IMP4 still says that the company have trust in their suppliers and especially in the certifiers that they work closely with. In fact, suppliers who engage in fraudulent activates are often caught quite quickly and lose their certificate as a result. The opinions of the importers are summarized in *Table 6*.

"Some farmers do better, some do worst. But in my experience, almost every farm come across some issues with the certifiers at some point" (IMP4)

	Low	Medium	High
Eco-Labelling		IMP1*, IMP2*, IMP4	IMP1*, IMP2*, IMP3,

Table 6 - Importer Results: Eco-Labelling

** IMP1 and IMP2 express medium to high level of trust regarding information about eco-labels.*

4.2.2 Product Movement

4.2.2.1 Cold Chain

The constant cooling chain is considered as a crucial aspect by all importers when transporting fresh fruit from outside Europe to Sweden. The cold chain affects the ripening process of the produce as well as the eventual shelf life. (IMP1, IMP2, IMP3, IMP4) Especially for the transport of bananas and mango fruits the temperature needs to be stabilized at 13,3-13,9 Celsius, since the ripening process is disrupted during the shipment (IMP3, IMP4). For other produce, e.g. apples, pears and berries, the precise temperature does not play a primary role as long as a defined temperature range is not exceeded during transportation.

"Even if a product can take either higher or lower temperatures […], the change in temperature is what stresses the product and effects the quality directly" (IMP1).

According the importers, most of the produce that travels from outside Europe to Sweden is imported by ship (IMP1, IMP2, IMP3, IMP4). Products are either shipped directly from the port of origin to Sweden, mainly accounting for bananas from the Dominican Republic (IMP3, IMP4), or the shipment reaches Europe in Rotterdam (Netherlands), is consolidated and further distributed to Sweden by road transportation or feeder services (IMP1, IMP2). Air transportation is only used in small volumes by IMP1, however is fractional in comparison to shipped products. Throughout the interviews, IMP1, IMP3 and IMP4 point out a substantial issue when it comes to importing fruit from outside Europe. Due to climatic requirements of growing exotic fruits, countries of origins rather lie in regions averaging high temperatures, e.g. in Latin America (Dom. Republic, Costa Rica, Ecuador, Peru, Argentina), in Africa (South Africa, Morocco) or Asia (Thailand, Vietnam). Therefore, moving the produce from the plantations to the packaging and cooling units quickly is important. Cooling down the produce to adequate temperatures is the most critical point in the Supply Chain. Further on, assuming the cooling units in the container work throughout the transport to the port and during transportation, IMP4 considers the import process at the port of entry to Europe as critical. Due to high documentation requirements, which are mainly of physical nature, and the lack of personnel of legal authorities, the importing process is considered as a second risk point along the Supply Chain. Other influences, e.g. shipment delays due to weather conditions at sea or dense traffic in the final stage of the Supply Chain to Sweden, is considered an issue but cannot, however, be influenced (IMP1, IMP4)

All importers have expressed the ability to access full traceability records of the cold chain. Temperature sensitive systems (e.g. SensiTech[2], IMP1) capture the temperature and humidity within the transport unit, record it and make it available for the importer. However, none of the importers receive real-time information about the climatic conditions during transportation. (IMP1, IMP2, IMP3, IMP4) The information is then used to assess and react to the shelf life by adapting storage times in their warehouse, if the product is not already considered food waste (IMP1, IMP4). As described by IMP3 and IMP4, the temperature recording usually starts after the produce has been packed at the packing stations. Beforehand, a temperature record might exist, however *"it is mostly entered manually"* and therefore cannot be trusted (IMP4). IMP1 also expresses concerns how the produce was stored and transported before it reaches the packaging stations. IMP4 supports this concern by pointing out a lack of awareness regarding the temperature sensitivity before the products reach the packaging station. Considering the climatic circumstances, the lack of awareness during the first mile can have a significant impact on the quality at a later stage in the Supply Chain. The opinions of the importers are summarized in *Table 7*.

	Low	**Medium**	**High**
Cold Chain		IMP1, IMP4	IMP2, IMP3

Table 7 - Importer Results: Cold Chain

4.2.2.2 Lead-Time

The Lead-Time from the origin to the importer in Sweden is overall seen as a critical and relevant issue by the importers when importing goods from outside Europe (IMP1, IMP2, IMP3, IMP4).

[2] Supply Chain Visibility Specialist (https://www.sensitech.com)

IMP1 and IMP4 point out that a loss in Lead-Time directly translates to a decrease in shelf life, which eventually is the critical parameter they will be evaluated upon.

Examples regarding the Lead-Time revolve around the transport of produce from South America as well as Central America. When importing from Ecuador, Peru or Costa Rica, IMP3 and IMP4 estimate the lead time to be 4 days from the point of harvest to the port, including the packaging stations, 21 days for shipping to Rotterdam (NL) or Hamburg (GER), and 2-3 days for off-loading, scanning, consolidation and transportation to Sweden. From the Dominican Republic, both importers use direct shipping lines to Sweden. Therefore, IMP3 and IMP4 count 3-4 days from the point of harvest, to the packaging station and the port. From there the Lead-Time to Sweden is approximately 12-13 days.

When asked about the most critical stages along the Supply Chains influencing the overall Lead-Time, IMP1 states that the customs procedure is a hurdle and cause for delays. Apart from labor strikes, the workload exceeds the personnel's capacities at the port which often leads to delays. On the other hand, IMP4 points out that the very first stage and the last stage in the Supply Chain can be critical. Firstly, getting the produce from the harvesting point to the packaging station and the port is difficult to manage and oversee. Secondly, the trucking to Sweden causes issues due to consolidation, traffic and driver regulations. IMP3 emphasizes that the location of Sweden is a challenge itself, since additional transportation always adds 2-3 days to the Lead-Time and therefore reduces shelf life. Otherwise, *"there is always a risk on board of the vessel"* (IMP1), which is supported by IMP3 and IMP4. This risk involves non-functioning cooling units or external influences, e.g. weather conditions. Lastly, IMP1, IMP2 and IMP4 point out an information gap regarding the Lead-Time from point of harvest until the produce is packaged and registered.

"*We do not really know how long the produce needs to reach the packaging station or how long the produce actually stays in the packaging station. So, there might be a gap of knowledge or trust, if you like"* (IMP4).

Also, IMP2 shows concern in this regard, *"If the packaging station has too many orders, they might package the products a little bit earlier than we know"*. Nevertheless, IMP1, IMP2 and IMP4 mostly trust their suppliers, since it is in their interest that any kinds of interruptions or added Lead-Time is reported. The opinions of the importers are summarized in *Table 8*.

"*If something happens regarding lead-time, the producer is interested in telling us, so we actually can react to it and treat the fruit accordingly. [e.g. bring them out to the retailer as quickly as possible]. Is that a product I can keep in storage for a couple of days more? Or should it leave to the retailer right away? They know, if I have an issue with the product, it will fall back on them. So, there is no reason to hide information*" IMP4

	Low	Medium	High
Lead-Time		IMP1, IMP2*	IMP2*, IMP3, IMP4

Table 8 - Importer Results: Lead-Time

** IMP2 expresses medium to high level of trust regarding information about eco-labels.*

4.2.3 Import Regulation Compliance & Process

Compliance to EU Standards and import regulations is seen as crucial, especially when importing from outside Europe. However, importers emphasize that they are not directly responsible for the compliance to these regulations. (IMP1, IMP3, IMP4) Once the product enters the European Union (EU), containers and batches are checked by the customs control as well as the veterinary inspection office. Once the products pass the inspections, there is no reason for distrusting the information regarding the compliance, as stated by IMP1 and IMP4.

"If the import authorities find e.g. rotten goods, insects or if they measure too high residuals in their samples, the products are rejected and are not going through" (IMP4).

Nevertheless, IMP3 and IMP4 agree that violations against standards and regulations exist, whilst IMP4 says that it is possible that products that do not comply to regulations reach Sweden in rare occasions. Apart from the product itself, these non-compliances often arise from packaging, e.g. when untreated wooden boxes are used for transport, which are more likely to parasite infestation than other packaging materials. (IMP1) In the end, the inspection relies on human judgements, which can be subject to errors. However, IMP1, IMP2 and IMP3 mention that detected errors always fall back on the exporter, the packaging station and eventually the farmer.

Further on, IMP4 describes another issue the company comes across on a regular basis. Whilst the compliance of the products to import regulations and standards is one issue, the importing process itself raises problems.

“For our products to enter the EU in the first place, all of the documentation needs to be present and complete” (IMP4).

Since documentation is still largely of physical nature, documents get lost along the Supply Chain. *“It happens regularly during a month that containers are not allowed to leave the port due to missing documents […]”* (IMP4). This does not only reduce the shelf life, but also risks that whole loads need to be discarded eventually. The opinions of the importers are summarized in *Table 9*.

	Low	Medium	High
Import Regulation Compliance & Process		IMP1	IMP2, IMP3, IMP4

Table 9 - Importer Results: Import Regulation Compliance & Process

4.2.4 Labor Conditions

According to all importers, labor conditions and production sites and the certification of “good working conditions” is considered a critical point, which is difficult to monitor constantly and 100% reliably. Since monitoring labor conditions itself is a time and resource consuming process, the importers mainly rely on third party audits, e.g. the FairTrade certification. (IMP1, IMP2, IMP3, IMP4) Additionally, the importers visit farms themselves to picture the facilities and working conditions.

IMP1 describes a situation in which their auditors encountered child labor in Egypt and Thailand, but also emphasizes that inappropriate working conditions also appear in Sweden.

“Labor conditions are quite tricky; you need to be very sharp to find and notice it. You must know the regulations in every country, because workers should not be paid under the legal level according to the country” (IMP1).

IMP2 came across inappropriate working conditions in Egypt, India, and other parts of Asia at the plantation site as well as the packaging station, including underpayment and physical threats against the employees. IMP3 comes across comparable issues in South and Central America, where “*a lot of people are not getting the right conditions”.* Their highest concerns revolve around the Dominican Republic, where field workers are found to be not paid on a regular basis. This is supported by IMP4 who claims that the working conditions in the Dominican Republic from a European perspective are *“tough”*.

“Probably you would not find these working conditions in Europe. […] Even though farms might be certified by FairTrade, I know farms which […] might be quite questionable if they would be located within Europe”. (IMP4)

Overall, all importers found issues regarding labor conditions in different parts outside Europe, as well as within Europe. The importers are not directly responsible for the certification of the labor conditions but include site visits in their CSR policies. However, officially and formally they rely on third party audits. (IMP1, IMP2, IMP3, IMP4) Since all importers still found different kinds of issues despite the certification, “*this is kind of a field where many importers maybe are too soft and have to close an eye to some extent*” (IMP4). The opinions of the importers are summarized in *Table 10*.

	Low	Medium	High
Labor Conditions		IMP1, IMP3, IMP4	IMP2

Table 10 - Importer Results: Labor Conditions

4.3 Expert Interviews

After summarizing the findings from the Importer interviews, the following section presents the Empirical Findings from the Expert interviews. While the Importer interviews are focused specifically on trust-related issues regarding information along the Supply Chains, the Expert interviews are now focusing on if and/ or how blockchain technology can provide potential usage to encounter the trust issues found in the previous chapter.

4.3.1 Product Identification

4.3.1.1 Origin of Products

EXP1, EXP2, EXP4 and EXP6 express similar thoughts about the possibility of blockchain to provide trustworthy information regarding the origin of products. EXP1 says that the blockchain technology secures the information that is put into the blocks through the design of the blockchain itself. It is therefore possible to trust that information put into the blockchain has not been tampered with. Basically, it is not possible to lie within a blockchain, according to EXP1. Yet, EXP1 believes that a major factor when it comes to the trustworthiness of information in a blockchain is the ability for other stakeholders to control the information entered into the blockchain. Someone must register the information into the system and the blockchain technology, just like any other technology, is not able to detect human errors or malicious activities. EXP2 express comparable concerns by describing the blockchain technology as a ledger technology that is only helpful if the right people construct it in the right way. Similarly, EXP4 says that blockchain could enable better access to real time information but a challenge is to ensure that the information entered into the blockchain is accurate and trustworthy. EXP6 also conveys concerns regarding the input of information into the blockchain by describing a problem called "Reality Fit". The reality fit problem is that the information put into the blockchain is controlled by certain correspondents along the Supply Chain and can therefore not be fully trusted.

"Blockchain is another technology which is great, but the technology needs to go hand in hand with people and behavior and blockchain will have to push change in behavior and that is the most difficult part" (EXP4)

Considering this, EXP2 states that blockchain together with other technologies can be leveraged to prove origin of goods. However, it depends on if trust issues exist and whether there is a strategy that supports the investment to build an ecosystem that is using a new trust mechanism. Otherwise, blockchain is not useful, according to EXP2. EXP1, on the other hand, states that it is difficult to predict if blockchain is fit for data sharing in Supply Chains. Also, EXP1 only sees a need for blockchain regarding more expensive fruit such as Pomelo, which costs five times more a kilo than apples or oranges, compared to more common commodities such as apples as the need for customers to know the origin of products is greater for more valuable commodities. EXP4 believe that blockchains ability to provide trustworthy information regarding product origin is medium as it is just one tool that needs to fit in the environment of so many other parameters.

EXP3, EXP5 and EXP7 are more positive when it comes to blockchains ability to provide trust when it comes to the origin of products. In the fruit context, EXP3 identifies mangos, grapes and avocados as products that are sensitive to fraud regarding origin. Also, EXP3 believes that the blockchain technology is the only technology capable of providing trustworthy information regarding product origin. EXP5 points out that it is possible to change information about the origin of products in the databases used today without any trace of the change. However, the blockchain technology enables everyone in the database to see if anyone is tampering with the data. For example, it would be possible see if anyone change the sticker on a banana box during the transport from Africa to Europe and therefore possible to understand that the information on the banana box cannot be trusted.

"It is the only technology that could provide trustworthy information. Obviously, it is a question of implementation, but I cannot think of a different technology that can provide the level of trust that blockchain can for the fruit chain" (EXP3)

EXP7 believes that a major aspect when it comes to the blockchain technology is its ability to provide decentralized information with the help of IoT sensors. The two main aspects to track the origin of products is data validation and IoT integration, according to EXP7. EXP7 state, similarly to EXP3, that blockchain is the only technology capable of integrating decentralized applications in form of IoT devices and keep the information received from these devices secured. EXP7 says that the suitability of blockchain to provide trustworthy information regarding the origin of products is high, especially in situations where people or organizations do not necessarily trust each other. The opinions of the experts are summarized in *Table 11*.

	Low	Medium	High
Origin of Products		EXP1, EXP2, EXP4, EXP6	EXP3, EXP5, EXP7

Table 11 - Expert Results: Origin of Products

4.3.1.2 Harvesting Date

Some of the experts are confident that the blockchain technology is suitable to provide trustworthy information regarding the harvesting date of products. EXP3 emphasizes that the harvesting location and the harvesting date of products are currently often recorded through a GPS coordinate by a GPS device. It is not uncommon that suppliers tamper with these devices, according to EXP3. EXP3 explains that the blockchain technology can be combined with satellite technology to ensure the correctness of the harvesting date by capturing real time data from the production fields through satellite images and securely storing the information in the tamper proof blockchain ledger.

EXP2 and EXP7 express a similar perspective but stress the difficulty of guaranteeing the trustworthiness of information through the technology alone. For example, EXP2 says that it is possible to secure harvesting information by capturing data from the production fields through drone technology as well as IoT. In more detail, a drone can provide real-time data about the production fields and this information can be encrypted and verified through a protocol. Also, harvesting machines can be connected to the network though sensors and thus be able to record the actual time of harvest, according to EXP2. EXP7 describes a comparable project in the Netherlands where a drone is used to record data from an orange orchard. This drone is capable of registering data regarding quality aspects such as the temperature on the field. The information from the drone and the sensors can be verified and securely stored in a blockchain and thus increase quality of prediction when it comes to aspects regarding the quality of the crop such as the harvesting date, according to EXP7.

However, EXP3 and EXP2 emphasize that information about the harvesting date cannot be trusted if the initial data entry is not reliable. Comparably, EXP1 and EXP5 both state that the blockchain technology can ensure harvesting date if the stakeholders agree upon the date that is put into the blockchain. EXP6 seconds that blockchains ability to provide trustworthy information boils down to information is entered onto the blockchain. However, EXP6 believes that the suitability of blockchain to provide trustworthy information is low as something else need to increase trust in terms of what enters the blockchain. The opinions of the experts are summarized in *Table 12*.

	Low	Medium	High
Harvesting Date	EXP6	EXP2, EXP7	EXP1, EXP3, EXP5

Table 12 - Expert Results: Harvesting Date

** EXP4: Not knowledgeable to answer the question*

4.3.1.3 Eco-Labelling

EXP1, EXP3, EXP4 and EXP5 all express high confidence that the blockchain technology can provide trustworthy information regarding Eco-Labelling. EXP3 brings attention to the issue that certifiers of today have limited resources and can therefore not guarantee that all organic producers fulfil the required criteria by visiting them separately. Instead, the certifiers select a limited number of farms each year for inspection. EXP3 believes that this is not the optimal way of capturing valid data, arguing that the blockchain technology, combined with other technologies such as sensors or satellite images, enables stakeholders to receive real time data about the requirements of organic production. For example, information regarding requirements such as use of fertilizers, preservation of wildlife and proper crop cultivation can be captured through satellite images and secured in the blockchain, according to EXP3. EXP4 describes trust in eco-labels through blockchain in a similar sense by highlighting that food fraud exist with regards to organic products due to the price premium of these products. The blockchain technology could help to ensure that conventional products are not sold as organic products by registering the actual volume of organic products at production sites to make sure that the volumes of organic products do not increase along the Supply Chains, according to EXP4.

"I think that blockchain can really provide value with respect to certifications because today certifiers are heavily dependent on audits and field visits and I think that Blockchain could really provide an added value in helping verifying labels" (*EXP4)*

EXP1, EXP5, EXP2 and EXP6 are more focused on the trustworthiness of the information that is put into the blockchain. EXP1 says that it is possible to create an information category about eco-labels within the blockchain to secure the trust of organic products, but it is essential to have the right parameters. EXP5 says that blockchain can provide a trustworthy platform for information regarding organic products if there is a system in place that can ensure the correctness of the information put into the blockchain. EXP2 is more skeptical regarding the potential of blockchain to verify eco-labels. Like EXP1 and EXP5, EXP2 acknowledge that blockchain is a technology that is capable of recording and remembering data in a sufficient manner. However, EXP2 stress that blockchain is not a smart technology and that it is only capable of recording what the stakeholders want it to record. Also, EXP2 emphasizes that blockchain is heavily dependent on other technologies, such as IoT and AI, to be of any use to a Supply Chain. Yet despite the limitations of blockchain, EXP2 believes that blockchain can be provide trust in eco-labels if it is combined with the appropriate technology for a Supply Chain that lacks trust. EXP6 is the only expert that express low confidence that blockchain can provide trustworthy information regarding eco-labelling. EXP6 specify that this is because, just as with harvesting date, something else need to ensure trust regarding what enters the chain.

EXP7 is more interested in blockchains ability to provide dominant Supply Chain stakeholders, such as importers, with more transparent information regarding the ecological status of products. Today, the problem is that dominant Supply Chains members usually have a legal contract with first level suppliers but not with second or third level suppliers (EXP7). It is therefore not possible for the dominant members to receive direct information (e.g. eco-certificates) from second or third level suppliers. Also, the first level suppliers are reluctant to share this information with the dominant actors due to the first level suppliers status as intermediaries. EXP7 says that the anonymity aspect of blockchain can be used for second and third level suppliers to ensure directly to the dominant members that they have all the proper credentials for production of ecological products. It will not be necessary to know an organization to verify the authenticity of certificates and this will increase the transparency and trustworthiness of information regarding eco-labels, according to EXP7. The opinions of the experts are summarized in *Table 13*.

	Low	Medium	High
Eco-Labelling	EXP6		EXP1, EXP3, EXP2, EXP4, EXP5, EXP7

Table 13 - Expert Results: Eco-Labelling

4.3.2 Product Movement

4.3.2.1 Cold Chain

The maintenance of the cold chain and the correct recording of the data is pointed out as an issue by EXP1, EXP2, EXP3 and EXP4 in terms of the transportation of fresh fruits. EXP1 emphasizes that the perfect cool Supply Chain does not exist. Despite the fact that an unbroken cooling chain is required to preserve perishable products, EXP1 raises the concern of imprecise measurability. Even though the packaging of a product might be exposed to higher temperatures, the product temperature itself is often not considered. EXP2 raises the issue of the complexity of Fruit Supply Chains. *"[…] There are 237 intermediaries involved in getting a kiwi fruit from South America to Sweden",* only partly being digitalized and still relying on physical documentation. EXP2 and EXP5 point out that if a product moves off the blockchain and transforms from being digitalized back to its physical nature, blockchain technology becomes "*useless".* Even though temperature recorders exist and provide information on temperature changes, EXP3 and EXP4 state that responsibilities are not clear when it comes to temperature breaches.

"*The transportation company tells you a story, the packaging station another one. Now, which one can we trust? Who is going to pay for that?"* (EXP3).

All importers believe in the potential usage of blockchain technology to provide trustworthy information regarding about the cold chain. However, they also point out that blockchain itself does not have the capability to solve these issues. (EXP1, EXP2, EXP3, EXP4, EXP5, EXP6, EXP7)

"*If you make sure that the data has not been tampered at the capture point [the potential] is high"* (EXP3).

EXP2 describes a necessary process to eliminate as many points of contact as possible along the Supply Chain to minimize the potential that temperature data is tampered with. Further on, data needs to be captured reliably, which can be ensured by IoT sensors. The aspect of IoT is crucial since it creates *"one single source of truth"* and therefore is adding value to the Supply Chain (EXP7). Once these sensors are interconnected with a blockchain, where information regarding temperature, humidity, etc. is stored continuously and automatically, vulnerable points of manual access can be eliminated. (EXP2, EXP3, EXP7) Nevertheless, the possibility of tampered temperature sensors itself will remain (EXP6).

Once a Supply Chain is that transparent, it does not only clarify the responsibilities, but also allows for an optimization of the Supply Chain. (EXP 2, EXP3, EXP5) *"You can see that certain regions, routes, transport modes or companies are not doing their job"* (EXP3) Additionally, alarm systems can be put in place which allow for real time information about the cold chain. It can open up possibilities to react faster to malfunctioning cooling units to reduce quality risk. (EXP5) The opinions of the experts are summarized in *Table 14*.

	Low	Medium	High
Cold Chain		EXP6	EXP1, EXP2, EXP3, EXP4, EXP5, EXP7

Table 14 - Expert Results: Cold Chain

4.3.2.2 Lead-Time

Even though the two aspects of the cold chain and the Lead-Time are subject to two different categories and are discussed separately with the importers, EXP5 and EXP7 point out that technically there is no difference in capturing data regarding the temperature or Lead-Time. *"The [RFID] chip can also measure temperature, time, humidity, GPS and other signals"* (EXP5)

EXP3 states that to ensure trustworthy information about the Lead-Time in general, the data source at the capture point needs to be trustworthy. For the information to be trustworthy, there needs to be a standardized and automatized system that collects relevant information and stores it on the blockchain. Only then can trusted information be distributed to actors along the Supply Chain. (EXP3, EXP4) EXP6 points out that one of the most interesting use cases along the Supply Chain is the importing process. The opinions of the experts are summarized in *Table 15*.

Here, *"Blockchain can definitely help to cut down the Lead-Time during the importing process due to its transparent nature – maybe even cut down completely"* EXP6.

	Low	Medium	High
Lead-Time		EXP6	EXP1, EXP2, EXP3, EXP4, EXP5, EXP7

Table 15 - Expert Results: Lead-Time

4.3.3 Import Regulation Compliance & Process

The trustworthiness of information regarding the compliance of products entering the EU depends largely on the personnel of the authorities which are responsible for verifying the compliance to European regulations and standards (EXP 2, EXP3). EXP3 describes a situation in which the customs and veterinary control at the Port of Entry to Europe do not have the workforce to be able to check every product entering the EU. Consequently, *"there is a lot going through that does not meet the importer regulations of the EU"* (EXP3). Further on, EXP3 sees complications due to highly bureaucratic processes when importing goods to Europe. Since 50% of European ports are still paper based and do not operate with ERP systems, bureaucratic efforts slow down the importing process and the Supply Chains overall. That does not only cause delays and a reduced shelf life, but also endangers the European customer with products that do not comply to regulations. (EXP2, EXP3, EXP6)

To simplify and optimize the process of importing and therefore create a more secure and trustworthy environment, EXP2 stresses that ensuring a digital environment needs to be a preliminary step to implementing a blockchain. If only half of the Supply Chain is digitalized while the other half is of a physical nature, the blockchain ledger does not add security or transparency to the Supply Chain and hence, is *"a waste of resources"*. *"Why is Bitcoin so powerful? It is born digital; it is traded digital [...]"* EXP2. Therefore, Supply Chains need to be designed leaner and shorter, to drive and enhance a complete digitalization of the chains more efficiently. *"People are trying to solve way too complex things that have not been solved before. Blockchain is not going to help that. We need to evolve how it is used"* (EXP2).

However, once these issues are overcome, blockchain has the potential to create a more efficient and safer importing process. (EXP1, EXP3, EXP5) *"You reach levels of automation that have not been there before. In the past people where just transferring their own version of the truth to the* *next silo"* (EXP7). If the information that is saved in the blockchain is certified, verified and trusted, import authorities like custom and veterinary control would have the possibility to find all relevant information in the blockchain, instead of relying on several non-standardized sources. (EXP1, EXP3, EXP5) EXP7 describes it as *"a single source of the validated truth"*. After all, *"you can use blockchain technology to enhance information sharing between authorities, businesses, and customer"* (EXP1). However, it needs to be evaluated if alternative technologies already exist, which might be even more suitable to ensure transparent information for the importing process (EXP6). The opinions of the experts are summarized in *Table 16*.

	Low	Medium	High
Import Regulation Compliance & Process			EXP1, EXP2, EXP3, EXP4, EXP6, EXP7

Table 16 - Expert Results: Import Regulation Compliance & Process

EXP5: Not knowledgeable to answer the question

4.3.4 Labor Conditions

"We have come across child labor, inequal conditions, discrimination of women, farmers not being allowed to organize themselves in syndicates, […] dangerous working conditions, overexploitation – these are quite a lot of issues at the point of origin" (EXP3).

It is difficult to constantly follow up on the conditions at production site. *"That is no longer a problem of tracing [a product], it is about how [the product] was produced"* (EXP4). EXP2, EXP3 and EXP5 point out that if reliable data can be captured, blockchain can provide trustworthy information about labor conditions at the site of production.

According to EXP3, certifiers nowadays face the challenge of not having the right capacities to ensure that their label is valid at any given time and point of origin. To ensure that trustworthy information enters the blockchain, it needs to be clearly defined what kind of sources the Supply Chain actors are willing to trust. This can be IoT systems or a trusted certifier which has the capacities to check farms on a regular base. (EXP2, EXP3) One approach is to link a digital record of absent days and sick days of a farm to a blockchain. This does not allow for 100% trustworthy certificates but can create a sense of alertness regarding suspicious farms. (EXP2) On the other hand, EXP5 suggests a mobile application which registers movements on the plantation, working time and allows for anonymous employer ratings. If the conditions are found to be acceptable, a certificate is issued automatically and saved on the blockchain. Otherwise, the use of satellite imagery of farms that are suspected to exert working conditions under a defined standard is tested by EXP3. By analyzing the configuration of buildings and measuring flows into and out of the building, EXP3 can detect unusual movements. This data can then be used to either certify a farm as "compliant" to set standards, or to issue a personal audit. To its benefit, satellite images are already available and therefore can be used by third parties (EXP6).

Overall, *"the connection of working with humans and their behavior"* is challenging (EXP5). While blockchain will provide untampered information upstream the Supply Chain, the challenge is how to capture the data and whom to trust. (EXP1, EXP2, EXP3, EXP4, EXP5) Additionally, privacy concerns need to be considered when capturing data, e.g. by satellite or mobile phone. *"You need to be careful what you actually store on the blockchain in terms of personal information"* (EXP6). The opinions of the experts are summarized in *Table 17*.

	Low	Medium	High
Labor Conditions	EXP4	EXP1, EXP5, EXP6, EXP7	EXP2, EXP3,

Table 17 - Expert Results: Labor Conditions

5 Analysis

After presenting relevant Literature (see Chapter 2) and the Empirical Findings from the Importer and Expert Interviews (see Chapter 4), the findings and results are analyzed and discussed in the following section. Each category presented in Chapter 2.5 will be analyzed separately, following Research Sub-Question 1 ("Which Supply Chain "trust issues" exist regarding information along the physical Supply Chain for Swedish actors importing fresh fruit from outside Europe?") and Research Sub-Question 2 ("Can, and if so how, the blockchain technology reduce the effect of "trust issues" regarding information along the physical Supply Chain for Swedish actors importing fresh fruit from outside Europe?").

5.1 Product Identification

5.1.1 Product Origin

Most of the importers say that the origin of the product is of importance to them due to quality (IMP2), political and social issues (IMP1; IMP2), value added-labelling (IMP4) and sourcing-related questions from customers (IMP1). This is in line with research as the literature state that product of origin is important due to perceived quality aspects (Wognum et al. 2011; Bitzios et al. 2017) and because it brings added economic value to the customers (Dabbene et al. 2014). Also, end-buyers increasing concern for the risk of a product being sold under false pretenses (Wognum et al. 2011) corresponds with the importers concerns regarding sourcing-related questions as well as political and social issues. Only one importer (IMP3) expresses that origin of the fruit is not of importance, as it is only the color and the size of the products that matter to the end-customers.

However, all the importers express high trust in the information they receive regarding fruit origin due to established long-term relationships and frequent supplier visits. The most important trust factor appears to be the lack of monetized incentive to falsify information (IMP1; IMP2). Based on the literature, the reasons for the lack of monetized incentive to misrepresent information can be that no or few production regions are associated with high fruit quality (Aung et al, 2014), that highly valuable fruits cannot be substituted with cheaper fruits and/or that there is no supplier incentive to promote local fruits by altering the country of origin (Charlebois et al, 2016). In fact, this is in line with IMP2 comments that it is difficult for a supplier to add value to a fruit by altering country of origin. Some trust issues do exist when it comes to fruit origin, as IMP4 says that fruit from Farmer A is sometimes sold as fruit from Farmer B. Similarly, IMP3 expresses that information on fruit origin from Dominican Republic is not as trustworthy as information from Costa Rica or Ecuador while IMP2 says that information from Peru is generally not as trustworthy. Yet, these issues are of minor significance, as all importers trust their suppliers when it comes to information on fruit origin. In fact, the importers highlight long-term relationship with suppliers as the foundation for trust. This corresponds to literature, as research indicate that positive experiences over time is an essential element to reach high levels of trust (Mayer et al. 1998; Schoorman et al. 2007; Parris et al. 2016).

Some of the blockchain experts (EXP3, EXP5, EXP7) perceive that blockchain is the only technology that can provide trustworthy information regarding fruit origin. Information in the databases used today can be tampered with while information entered into the blockchain can be cryptographically secured. This is in line with literature, as the research indicate that a vital element of the trustworthiness of the blockchain technology is the immutability of the data records (Nakamoto, 2008; Hofmann et al. 2017). Blockchains are therefore of particular interest for Supply Chains with little or no trust between the actors (EXP7). Experts (EXP1, EXP2, EXP4, EXP6) and literature (Etwaru, 2017; Xu, 2016; Van Waarden, 2012) agree that information regarding fruit origin will be securely stored in the blockchain once it is entered but the experts express concern regarding the Supply Chain actors' control over the information that enters into the blockchain. In fact, the actors along the Fruit Supply Chain need be certain that the information that enters the blockchain is correct as the technology itself cannot detect human errors or malicious activities *("the Reality-Fit Problem" EXP6)* (EXP6).

The Swedish importers do not appear to have this information control, as they simply trust their suppliers to provide the correct information. This is evident by the fact that fruits from a certain farm are sometimes sold as fruit from another farm (IMP4) or by the fact that the importers ensure the trustworthiness of suppliers through frequent visits (IMP2). IMP4's issues could potentially be reduced by blockchain in combination with an IoT device as the farmer himself/herself could enter the information into the blockchain to increase transparency (Kshetri, 2018; Yiannas, 2018; Petersen et al. 2018). Also, experts (EXP3; EXP5) and literature (Abeyratne, & Monfared, 2016) agree that the blockchain technology could make it possible to trust information on fruit origin without frequent supplier visits. In fact, blockchain could make it easier to trade in high-risk countries such as Peru (IMP2) or Dominican Republic (IMP1) as it would limit the need to trust the suppliers within these countries. However, experts and literature do not describe how to reduce the reality-fit problem when it comes to product origin. The authors therefore estimate blockchains suitability to provide trustworthy information to be medium.

Table 18 below summarizes the statements regarding the level of trust and potential usage of blockchain made by the importers and experts, respectively (*see Chapter 4.2.1.1*).

Importer \ Experts		Experts: Potential Usage of Blockchain		
		High Usage	Medium Usage	Low Usage
Importer: Level of Trust	Low Trust	EXP3, EXP5, EXP7	EXP1, EXP2, EXP4, EXP6	
	Medium Trust			
	High Trust	IMP1, IMP2, IMP3, IMP4		

Table 18 - Compiled Results: Product Origin

5.1.2 Harvesting Date

Two of the importers express full confidence in the information they receive regarding the harvesting date due to the education of production farms and sub-contractors (IMP3) as well as the perceived notion that the suppliers cannot afford to jeopardize the supplier-buyer relationship as the suppliers depend on the buyers (IMP4). However, neither IMP3 nor IMP4 specify if and how they receive information regarding the exact harvesting date. Instead, the two importers appear to rely on the notion that "cheaters" can be detect easily and discarded from the supplier portfolio. Thus, it appears as if IMP3 and IMP4 trust the consistency as well as the abilities and integrity of their suppliers, which are important elements of trust according to literature (Mayer et al. 1995; Parris et al. 2016; Liu, 2015; Zaheer et al. 1998)

The other two importers (IMP1; IMP2) agree with literature (De Winter, 2015; CGSO, 2019; Smithers, 2018) that harvesting date is important due to quality and shelf life of the fruit. Yet, they are skeptic regarding the harvesting date information due to the lack of directness of information (IMP1, IMP2), which corresponds to literature as research indicates that the transparency of processes is a foundation for trust between business partners (Parris et al. 2016). In more detail, IMP1 says that it is difficult to link a batch or a box of products to the information the company receives while IMP2 points out that it is difficult to estimate how external factors such as weather conditions affect the quality of the crop during harvesting. This is in line with research as the literature indicates that the exact harvesting date is difficult to determine once the fruit products enter the Supply Chain (Bitzios et al. 2017). Also, IMP1 and IMP2 only receive information on the packaging date and not the actual harvesting date. This is somewhat in contrast with literature, as actors along the Fruit Supply Chains are obliged to hold information regarding the harvesting date of perishable produce. In fact, lack of harvesting information can create trust issues regarding the correct labeling downstream the Supply Chain. (De Winter, 2015)

The experts agree with literature (Kshetri, 2018; Ferro et al. 2018) by highlighting the need to combine blockchain with IoT devices to capture and trust relevant data. The necessity of this integration is displayed by the fact that EXP2 and EXP7 stress the difficulty of guaranteeing the trustworthiness of harvesting information through technology alone while EXP6 emphasizes that something else is needed to increase trust in terms of the input of the initial data. This is in line with literature, as Kshetri (2018) state that IoT devices are essential for blockchains ability to display real-time data of goods. However, the positive aspects of the blockchain technology with respect to harvesting information are related to the importer's issues (IMP1, IMP2). EXP3 emphasis that satellite technology can be integrated with the blockchain technology to ensure the correctness of the harvesting date by capturing real time data from the production fields through satellite image while EXP2 stress that harvesting machines can be connected to the blockchain through sensors and therefore be able to provide the actual time of harvest. This corresponds to literature, as blockchain is believed to be able to instantly trace back information flow to specific verified data points along the Supply Chain (Yiannas, 2018; Kshetri, 2018). Thus, there appear to be a potential for blockchain to provide the directness of information that IMP1 desires.

The experts (EXP7) and literature (Yiannas, 2018; Kshetri, 2018) agree that blockchain can be integrated with drone technology to register data regarding quality aspects such as the temperature on the field. This information can be verified and securely stored in a blockchain and thus dramatically increase quality of prediction when it comes to shelf-life. Blockchain can therefore prove beneficial for importers (IMP2) who believe that it is difficult to estimate how external factors such as weather conditions affect shelf-life.

Table 19 below summarizes the statements regarding the level of trust and potential usage of blockchain made by the importers and experts, respectively (*see Chapter 4.2.1.2*).

Experts / Importer		Experts: Potential Usage of Blockchain		
		High Usage	Medium Usage	Low Usage
Importer: Level of Trust	Low Trust	EXP1, EXP3, EXP5	EXP2, EXP7	EXP6
	Medium Trust	IMP1, IMP2*		
	High Trust	IMP2*, IMP3, IMP4		

Table 19 - Compiled Results: Harvesting Date

** Interviewees expressed medium to high usage/ trust*

5.1.3 Eco-Labels

Most of the companies mention trust issues when it comes to eco-labels of fruit. In line with literature (Shears, 2010), IMP2 state that pesticides can be found in organic fruits when winds carry pesticide from conventional to organic production fields. Even the importer (IMP3) that expresses the highest trust in information on eco-labels admits that pesticide issues exist. Also, the literature (Capuano et al. 2012) and the importers (IMP1; IMP2) agree that organic fruit are at risk due to the ease of substitution with conventional products as well as a monetary incentive for suppliers to "cheat". IMP1 describe situations where a substantial number of buyers switch from buying conventional to organic fruit to be particularly risky. These trust issues can be related to a lack of transparency of information (Parris et al. 2016) as well as a perceived lack of benevolence and integrity among general fruit suppliers (Mayer et al. 1995).

The importers rely on tests and certifiers to ensure the correctness of the eco-labels. IMP4 states that most farms come across some sort of issue when it comes to eco-labels, but eco-labels can still be trusted due to the certifiers. This corresponds with the literature as research (Shears, 2010) display that the only secure way of checking that a product has been produced organically is to conduct field visits. Although the importers agree that trust issues exist, all of them still emphasize that they trust the eco-labels provided by their own suppliers. Yet, the smallest importer (IMP4) is the importer that trust the eco-labels the least. The reason for this, according to literature (Capuano et al. 2012), might be that large retailers are less vulnerable to fraud when it comes to eco-labels. All in all, the authors estimate that Swedish importers of fruit experience medium trust regarding information on eco-labels, based on the answers by the importers and complementing literature.

Almost all the blockchain experts believe that blockchain has the potential of providing trustworthy information regarding eco-labels, although most of them (EXP1; EXP2; EXP5 and EXP6) still emphasize the need to control the initial input of information. In correspondence with the importers and the literature (Shears, 2010), EXP3 and EXP4 acknowledge that certifiers, and thus Supply Chains, are heavily dependent on audits and field visits but are unable to perform the adequate number of audits due to limited resources. Blockchain, in combination with data capturing technology, can provide real-time information on farms use of use of fertilizers, preservation of wildlife and crop cultivation and provide an added value in helping verifying labels (EXP3; EXP4; Yiannas, 2018; Kshetri, 2018). This correlate to literature, as Abeyratne, & Monfared (2016) believe that blockchain can enhance trust through increased traceability and transparency within any transaction of data. Also, EXP4 recognizes the price-premium problem described by IMP2 and describe that blockchain could potentially reduce this by registering the actual volume of organic fruit at production sites to ensure that the volume of organic fruit does not increase along the Supply Chain. This is in line with literature as Song et al. (2016) describe the potential benefit of a traceability system suitable for field use and which can reliable detect organic products from non-organic products.

The experts (EXP7) and the literature (Abeyratne, & Monfared, 2016; Petersen et al. 2018) agrees that blockchain can make it possible to eliminate the need of information from middlemen such as certifiers and instead receive information directly from the farmers. Todays use of centralized information systems mean that it is often not possible for dominant Supply Chain actors such as large importers to receive information from second or third tier suppliers such as small farmers (Abeyratne, & Monfared 2016), partly due to the lack of legal contracts between these parties (EXP7). The anonymity aspect of blockchain, in combination with IoT devices such as satellite images (EXP3), makes it possible for farmers to directly provide proof to the importers that they possess all the proper credentials for ecological production through a single point of truth as all actors have access to the same information (Petersen et al. 2018). Compatibly, blockchain literature (Prinz & Schulte, 2018; Casino et al. 2018; Warburg, 2016) emphasis that trusted third parties, or middlemen, can be substituted by a decentralized and distributed consensus ledger. This could prove valuable for the Swedish importers as it would eliminate the need to trust certifiers with eco-label information.

Table 20 below summarizes the statements regarding the level of trust and potential usage of blockchain made by the importers and experts, respectively (*see Chapter 4.2.1.3*).

Experts / Importer		Experts: Potential Usage of Blockchain		
		High Usage	Medium Usage	Low Usage
Importer: Level of Trust	Low Trust	EXP1, EXP2, EXP3, EXP4, EXP5, EXP7		EXP6
	Medium Trust	IMP1*, IMP2*, IMP4		
	High Trust	IMP1*, IMP2*, IMP3		

Table 20 - Compiled Results: Eco-Labelling

** Interviewees expressed medium to high usage/ trust*

5.2 Product Movement

5.2.1 Cold Chain

The consistency and maintenance of a fully temperature-controlled Fruit Supply Chain has been identified as a challenge by both literature and the importers. Quality, in this aspect, is the one most important characteristic from the perspective of importers (Nielsen, 2015; Berry et al. 2015). Therefore, the continuous cold chain from the start is a key factor, since temperature affects the ripening process as well as the eventual shelf life of the produce (Goedhals-Gerber et al. 2017; Rodrigue, 2017; IMP1, IMP2, IMP3, IMP4). While precise temperature and atmosphere is crucial for products like bananas and mangos, other produce like apples or pears is less sensible to higher or lower temperatures, but instead more sensitive to temperature fluctuations. (IMP1, IMP3, IMP4)

According to studies by Goedhals-Gerber et al. (2017) and statements by IMP1, IMP3, IMP4, temperature breaches occur regularly during transports from non-European countries to Europe. 30% of the produce transported in a Supply Chain, including sea transportation, experiences temperature breaches, while 81% of those temperature breaches last longer than 90 minutes (Goedhals-Gerber et al. 2017). Critical stages along the Supply Chain were found to be consistent amongst literature and importers.

Mercier et al. (2017) describes the precooling of the produce after harvesting and before transportation as critical. IMP1, IMP3 and IMP4 emphasize that fruits from outside Europe are mainly produced in regions averaging high temperatures, e.g. Latin America, Africa or Asia. Therefore, temperatures need to be lowered to create a lasting cooling effect, since optimal core temperatures will not be reached even though container temperatures itself might be appropriate. IMP3 and IMP4 point out that temperature recordings start at the packaging stations when the produce is packaged and placed into the containers. Beforehand, temperature records might exist in manually documented state, which are vulnerable to alterations (Yiannas, 2018; Ndraha et al. 2018; Mercier et al. 2017; IMP4). However, the importers do not have information about how the produce was stored, transported and cooled beforehand (IMP1, IMP4). Ndraha et al. (2018) emphasize that at this point in the Supply Chain poor cooling facilities in developing countries lead to undocumented temperature breaches, resulting in quality issues higher up the Fruit Supply Chains. Additionally, Goedhals-Gerber et al. (2017) and IMP4 describe the lack of awareness about the necessity of strict cooling chains at packaging stations and along the Supply Chain as a challenge. Personnel is often not schooled to detect irregularities and does not react when temperature breaches occur.

Further on, research by Mercier et al. (2017) and Goedhals-Gerber et al. (2017) point out inefficiencies within ground operations. Temperature breaches at the Port of Entry to Europe are caused by waiting times due to customs and veterinary controls, as well as consolidation for further transport. IMP1, IMP3, and IMP4 recognize waiting times at European ports as issue regarding temperatures, however, at this point full visibility of the cold chain is provided. This allows for actions, e.g. reducing warehouse times once the produce reaches Sweden.

Overall, IMP2 and IMP3 show high level of trust regarding the information they receive regarding the cold chain. They state that temperature recordings are always fully available in digital nature when fruit batches arrive in Sweden. Even when temperature breaches occur, e.g. due to waiting times at the Port of Entry or prolonged shipping times, importers can react according to the recordings. This transparency leads to trust in this aspect (Parris et al. 2016). IMP1 and IMP3 share that point of view, however, state that they have medium trust in the information they receive. The medium rating is reasoned with most critical point in the Fruit Supply Chains – what happens between harvesting and packaging. While all importers have full visibility and trust in the information they receive regarding the container temperature, IMP1 and IMP3 point out trust issues regarding the precooling and handling of the produce. At this point, information regarding temperature is not trustworthy since temperature data is often documented manually and personnel often is less aware about the importance of quick precooling measures (IMP1, IMP3, IMP4).

From the perspective of blockchain experts, correct and complete transparency regarding temperature data is pointed out and approved as a challenge and critical aspect along Fruit Supply Chains (EXP1, EXP2, EXP3, EXP4).

As Ndraha et al. (2018), Mercier et al. (2017) and IMP4 point out, in parts of the Fruit Supply Chain temperatures are not manually documented. EXP2 and EXP5 emphasize the issue of not having fully digitalized Supply Chains. They argue, if any contact point along the Supply Chain is not digitalized, blockchain as a ledger technology is not able to generate trustworthy information (EXP2; Yiannas, 2018). Based on statements by IMP3, IMP4, Mercier et al. (2017) and Ndraha et al. (2018) this can be applied to the situation at the point of origin. Since information about the temperature of the fruit batches is not available or vulnerable to alterations due to manual documentation, a blockchain ledger would not be able to capture trustworthy information on which further decisions can be made. In support, EXP1 stresses that measurability of precise temperature information along the chain is challenging. Sensors capture the temperature and humidity within the container, however, not the critical core temperatures of the produce (Ringsberg, 2014). Since information about the path between harvesting, precooling and storage in cooling containers is often not given, information regarding the temperature along the Supply Chains might not be accurate and trustworthy. In addition, EXP2 states that the high number of middlemen included in Fruit Supply Chains magnify the issue. To create a fully digital Supply Chain in the first place, contact points along the Supply Chains need to be eliminated to create a manageable chain to exclude most possible steps in which data can be potentially tampered (EXP2).

The interviewed experts and literature states that blockchain technology alone is not able to create trustworthy information regarding the cold chain (EXP1, EXP2, EXP3, EXP4, EXP5, EXP6, EXP7; Kshetri, 2018; Ferro et al. 2018). To provide trustworthy information with blockchain technology upstream the Supply Chain, it is necessary to create *"one single source of truth"* (EXP7). Described issues at the point of origin need to be transformed to a digital nature, which can be achieved by IoT devices linked to the blockchain, where data is transferred automatically stored and distributed (Kshetri, 2018; Ferro et al. 2018; EXP2, EXP3, EXP7). Consequently, high level of suitability of blockchain technology to provide trustworthy information regarding temperature is given, in case data can be captured reliably (EXP1, EXP2, EXP3, EXP4, EXP5, EXP7). However, the risk of tampered sensors and IoT still exists, which in the eyes of EXP6 leads to a medium suitability.

Table 21 below summarizes the statements regarding the level of trust and potential usage of blockchain made by the importers and experts, respectively (*see Chapter 4.2.2.1*).

Experts / Importer		Experts: Potential Usage of Blockchain		
		High Usage	Medium Usage	Low Usage
Importer: Level of Trust	Low Trust	EXP1, EXP2, EXP3, EXP4, EXP5, EXP7	EXP6	
	Medium Trust	IMP1, IMP4		
	High Trust	IMP2, IMP3		

Table 21 - Compiled Results: Cold Chain

5.2.2 Lead-Time

In the context of perishability of fruit produce, literature and importers agree on the importance of correct and trustworthy information regarding the Lead-Time. Like the influence temperature has on quality and shelf life, Lead-Time is critical due to its short date of expiry (Pagani et al. 2016; Mercier et al. 2017; IMP1). Especially when importing from outside Europe, facing higher distances and comparably slower sea transportation, each additional step and minor disruption along the Supply Chain decreases quality and shelf life (De Keizer et al. 2017; IMP1, IMP2, IMP3, IMP4). Apart from the long sea transportation itself, which accumulates to approximately 21 days from Ecuador, Peru or Costa Rica, the geographical location of Sweden in Northern Europe adds 2-3 days of transportation time – a challenge that emphasizes the importance of correct information regarding Lead-Times. (IMP3, IMP4, UPS, 2019; DHL, 2019)

Apart from external disruptions, e.g. natural disasters, regulations or political and economic developments, Nguegan & Mafani (2017), Wyman et al. (2018) and De Keizer et al. (2015) state that internal factors like downtime during transportation is the main reason for prolonged Lead-Times. IMP1 describes that downtimes at the port of origin, waiting to be loaded onto the ship, and the port of entry can be time critical. The documentation assessment as well as the customs and veterinary control at the port of entry cause risk regarding prolonged Lead-Times (Descartes, 2019; Mercier et al. 2017). However, IMP1, IMP2 and IMP4 state that even though the risk of extended controls and Lead-Times exist, the information is fully transparent to the importer and leaves no reason for trust issues, as status updates are shared frequently. This allows the importer to react accordingly, e.g. decreasing warehouse times in Sweden, leading to trusted relationships according to Parris et al. (2016) and Mayer et al. (1998). On the other hand, trust issues might arise from the first steps along the Supply Chain – the Lead-Time from the point of harvest until the produce is packaged and registered (IMP1, IMP2, IMP4). Mercier et al. (2017) and IMP4 emphasize that physically and manually documented or no information is provided during these steps, which can lead to trust issues regarding the actual Lead-Time before registration. Due to disruptions at the plantations itself, where produce waits for further transportation, or inefficiencies in the packaging stations Lead-Times might be added without the knowledge of the importer (IMP2).

Therefore, IMP1 expressed a medium level of trust and IMP2 medium to high level of trust due to blind spots in the first steps along the Supply Chain. IMP3 and IMP4, on the other hand, expressed high trust in the information regarding Lead-Times they receive. IMP1, IMP2, and IMP4 state that if complications along the Supply Chain regarding prolonged Lead-Times occur, producer or exporter have an interest in forwarding this information, since issues regarding quality and shelf life fall back on them eventually.

According to EXP1, EXP2, EXP3, EXP4, EXP5 and EXP7 the suitability of blockchain technology to reduce the effect of the identified trust issues is high. EXP5 and EXP7 point out that technically there is no difference between capturing temperature related data, humidity, GPS and time. Since data capturing technology is already in place, the potential for blockchain technology implementation to provide trustworthy information regarding Lead-Lime is high Weimert et al. 2018; EXP6). On the other hand, IMP1, IMP2 and IMP4 describe a situation in which the information regarding Lead-Time along the Supply Chain is visible and trusted, which makes blockchain technology obsolete (EXP2). The issues raised by the importers, the lack of visibility from harvesting to first registration of the produce, are based on trust issues regarding the data entry. EXP3 points out that the data source at capture point needs to be standardized and compatible, which is supported by Jakkhupan et al. (2015) and Olsen & Borit (2018). Once a standardized and automatized data capture takes place, and one trusted data source is defined by all stakeholders in the Supply Chain, blockchain can distribute trustworthy information regarding Lead-Time.

Table 22 below summarizes the statements regarding the level of trust and potential usage of blockchain made by the importers and experts, respectively (*see Chapter 4.2.2.2*).

Importer \ Experts		Experts: Potential Usage of Blockchain		
		High Usage	Medium Usage	Low Usage
Importer: Level of Trust	Low Trust	EXP1, EXP2, EXP3, EXP4, EXP5, EXP7	EXP6	
	Medium Trust	IMP1, IMP2*		
	High Trust	IMP2*, IMP3, IMP4		

Table 22 - Compiled Results: Lead-Time

5.3 Import Regulation Compliance & Process

The process step of importing at the Port of Entry to Europe is considered as important bottleneck of the Fruit Supply Chains from outside Europe to Sweden (IMP1, IMP3, IMP4; Belt & Kok, 2018). Not only is it subject to time inefficiencies due to high volumes that arrive at Europe's main ports for international trade in Rotterdam or Hamburg, but also is an important product security layer for fruits entering the EU. (Massy-Beresford, 2017; Bakshi et al. 2011; EC, 2019b; Orphan et al. 2009; CBO, 2016)

Regarding the compliance to European import regulations and standards of fruits, one can observe diverse points of view of importers and relevant literature. While the importers have high interest in delivering fruit that complies to European health and security standards to their customers, they are not directly responsible to assure that fruits comply with regulations (IMP2, IMP3, IMP4). Nevertheless, IMP2, IMP3 and IMP4 place high levels of trust in the information regarding product compliance. IMP1, placing medium trust in the information regarding product compliance, points out that high trust only could exist when the process step is in its own hand. Even though violations exist according to IMP3 and IMP3, once a product enters the EU there is no reason to distrust (IMP1; IMP2). Literature, on the other hand, stresses the inability of import authorities to assure that 100% of the goods that enter the EU also comply to its health and safety regulations. While scanning devices can identify container and detect foreign elements, on average 5-6% of all containers are subject to physical inspections. This leaves 95-96% of all produce entering the EU unchecked regarding compliance to import regulations. (Massy-Beresford, 2017; Bakshi et al. 2011, EC, 2019b; Orphan et al. 2009; CBO, 2016). EXP2 and EXP3 support the issue, stating that product safety and health highly depends on the capacities of authority personnel at the Port of Entry, which are often not sufficient to assure 100% compliance. At this point IMP1, IMP2 and IMP3 rely on their Supply Chain power and place medium and high trust in the respective information since detected non-compliance falls back on the exporter, packaging station and eventually the farmer.

In close relation to the lack of authority personnel at the European Ports of Entry, IMP4 describes time inefficiencies due to inspections and missing documentation. As literature describes (Descartes, 2019; CBI, 2018; EC, 2019b), full documentation of Bill of Lading, phytosanitary certificate, packing list, custom documentation and traceability code for fruits need to be present for the produce to enter the EU. However, EC (2019b), Descartes (2019) and Yiannas (2018) claim that documentation is often not digitalized and of physical nature, causing delays due to missing documents on a regular base (IMP4). While IMP4 places high trust in the product compliance itself, the importer raises trust issues regarding information about the completeness of documentation. Descartes (2019) supports the importers concern, stating that there is few information about what kind of documents are present until the container arrives at the European port.

EXP2, EXP3, EXP6, IMP4 and Descartes (2019) point out that around 50% of European ports do not operate with ERP systems, but rather with physical documentation. This does not only result in a bottleneck along Fruit Supply Chains and puts European customers at risk due to lack of control what produce enters the EU, but also challenges the idea of a blockchain solutions for the beforementioned issues (EXP2; Ringsberg, 2014; Belt & Kok, 2018). As long as Fruit Supply Chains are not fully digitalized, EXP2 and Belt & Kok (2018) do not see any use for blockchain solutions. To construct digital Fruit Supply Chains, the complexity needs to be broken down into its essentials to reconstruct leaner and shorter Supply Chains. As a consequence, enhancing and driving the digitalization of Fruit Supply Chains can work more efficiently (EXP2; Ringsberg, 2014, Belt & Kok, 2018).

EXP1, EXP3 and EXP5 state that once Fruit Supply Chains are digitalized, blockchain provides the opportunity of safer and faster importing processes. According to EXP7, currently every actor transfers its own version of truth to the next Supply Chain step. Once stakeholders compromise on one single source of truth, information that is saved in the blockchain is certified, verified and trustworthy (EXP1, EXP3, EXP5, Belt & Kok, 2018; Petersen et al. 2018). The compromise about one single source of truth might include which entity or technology provides the necessary certified information, e.g. about the origin, harvesting date, Eco-Labels, temperature, Lead-Time and working conditions (EXP2; EXP3; EXP5; Kshetri, 2018; Ferro et al. 2018). On the one hand, the full transparency of information puts pressure on all actors to produce and act according to regulations. On the other hand, transparency provides import authorities with trustworthy documentation to improve the importing process at the Port of Entry. (EXP1, EXP3; Belt & Kok, 2018) Consequently, most of the experts state that blockchain technology is suitable to solve trust related issues raised by importers and literature (EXP1, EXP2, EXP3, EXP4, EXP6, EXP7). EXP5 stays beyond judgement.

Table 23 below summarizes the statements regarding the level of trust and potential usage of blockchain made by the importers and experts, respectively (*see Chapter 4.3.3*).

Importer \ Experts		Experts: Potential Usage of Blockchain		
		High Usage	Medium Usage	Low Usage
Importer: Level of Trust	Low Trust	EXP1, EXP2, EXP3, EXP4, EXP6, EXP7		
	Medium Trust	IMP1		
	High Trust	IMP2, IMP3, IMP4		

Table 23 - Compiled Results: Import Regulation Compliance & Process

5.4 Labor Conditions

In an agricultural context, importers and literature agree that inappropriate working conditions at fruit plantations outside Europe exist. Human Rights Abuse (2011), Weng et al. (2015) and Thetkathuek et al. (2017) describe conditions in which workers are exposed to pesticides and fungicides, high risks of work-related accidents and long-term body damages, as well as child labor. Even though conditions are known to be critical from a European perspective in many regions, information transparency regarding labor conditions at production sites is often not given (Went et al. 2015; HRW, 2011). All importers describe situations in which they encountered described conditions. However, they claim that monitoring labor conditions at production site is not possible due to capacity limitations. Consequently, they rely on third party audits, e.g. the FairTrade certifications. (IMP1, IMP2, IMP3, IMP4) Even though certifications are well accepted by the customers in Europe, HRW (2011) and IMP4 claim that certifiers do not have enough capacities to verify conditions at plantations on a regular basis. Even though importers are aware of the conditions, IMP2 describes a high level of trust in the information about labor conditions at the country of origin. IMP1, IMP3 and IMP4 place medium trust in the information, since work condition breaches are reported at recurring level.

EXP3, EXP4 and EXP5 support the findings stated by HRW (2011), Weng et al. (2015) and Thetkathuek et al. (2017) and point out the difficult connection of working with humans and their behavior. As HRW (2011) points out, there is a challenge to ensure that working conditions are appropriate at any given time. EXP2 claims that if the data entry is not digitalized and automatized, manual data entries into a blockchain ledger can be subject to alterations, limiting the use of the technology, supported by Yiannas (2018). EXP2 and EXP3 therefore point out that stakeholders within a Fruit Supply Chain need to agree on a single trusted source of truth when it comes to the certification of labor conditions at plantations, which can be based on a system combining IoT technology and trusted certifiers with the capacity to check farms regularly. EXP2 describes an alert system which directs the trusted certifying authority to suspicious farms, e.g. by evaluating absent and sick days. EXP5 describes an application which allows for movement and working time tracking via mobile devices to detect irregularities. EXP3 suggests tracking movements, growing patterns and building formations via satellite imagery to issue certificates directly, or direct authorities to plantations to verify working conditions.

While blockchain technology is suitable to provide untampered information upstream the Supply Chain, experts raise concerns regarding the data capture. Since the issue arises at data capturing point and is limited by verifying authority capacities, EXP4 claims that blockchain is not suitable to address the described issues. EXP1, EXP5, EXP6 and EXP7 rate suitability as medium, since data capturing remains unclear. Lastly, EXP2 and EXP3 claim that alert systems, with help of IoT and satellite imagery, can direct trusted authorities to suspicious farms, leading to more frequent and precise inspections of untrustworthy fruit plantations.

Table 24 below summarizes the statements regarding the level of trust and potential usage of blockchain made by the importers and experts, respectively (*see Chapter 4.3.4*).

<table>
<tr><th colspan="2" rowspan="2">Importer \ Experts</th><th colspan="3">Experts: Potential Usage of Blockchain</th></tr>
<tr><th>High Usage</th><th>Medium Usage</th><th>Low Usage</th></tr>
<tr><td rowspan="4">Importer: Level of Trust</td><td rowspan="2">Low Trust</td><td>EXP2, EXP3</td><td rowspan="2">EXP1, EXP5, EXP6, EXP7</td><td rowspan="2">EXP4</td></tr>
<tr><td></td></tr>
<tr><td>Medium Trust</td><td>IMP1, IMP3 IMP4</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>High Trust</td><td>IMP2</td></tr>
</table>

Table 24 - Compiled Results: Labor Conditions

5.5 Visualized Example of Blockchain Integration

The following *Figure 7* illustrates blockchain integration with a fruit supply chain from outside Europe to Sweden. Each data collection point along the supply chain requires the recording of certain information that is relevant for the successive steps, e.g. product origin, harvesting date, quantity and temperature. Once the transaction information is captured automatically through an IoT device, it is saved within a block. The process is repeated for each additional step, creating a chain of blocks. The blockchain is distributed to all the authorized actors and the information stored on the blockchain cannot be subjected to alterations or manipulations.

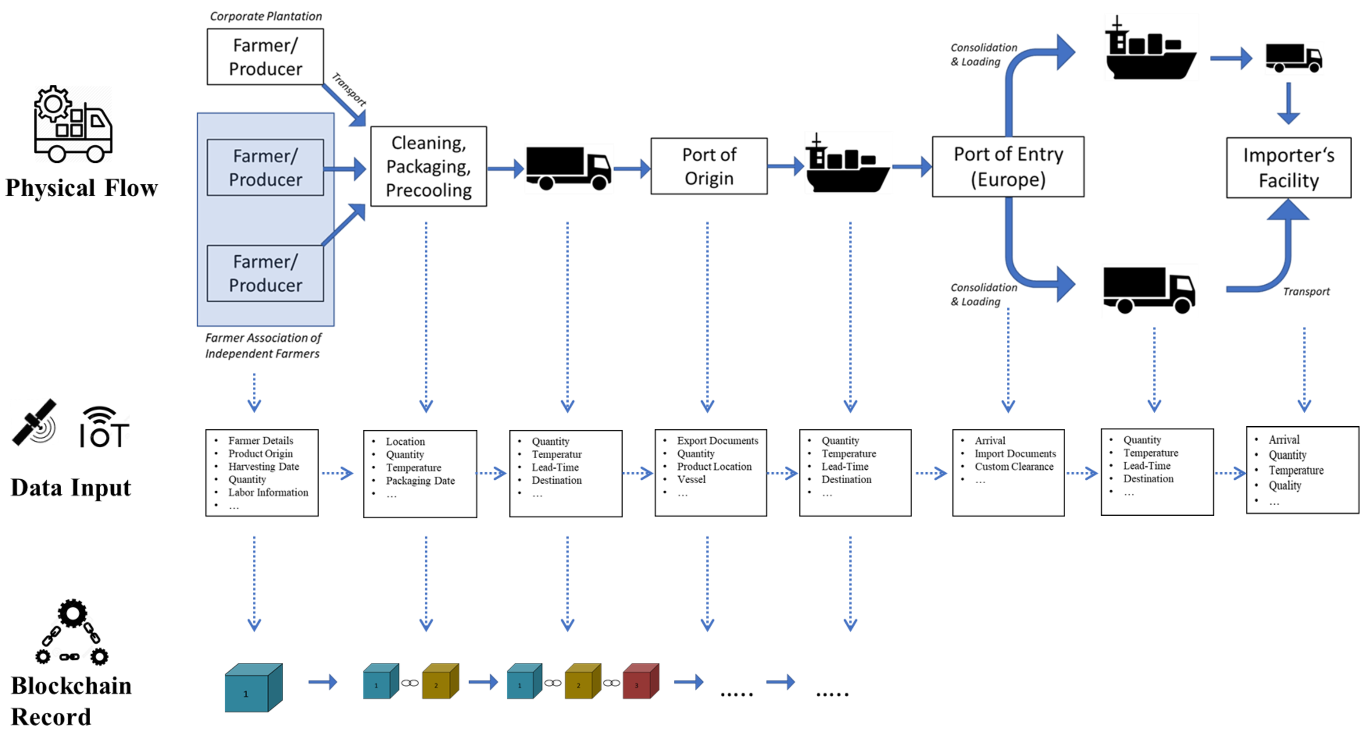

Figure 7 - Blockchain Integration in Fruit Supply Chain

6 Conclusion

In the following chapter the Research Questions will be answered. Therefore, the two Research Sub-Questions are concluded and answered, which lead to the conclusion of the overall Research Question. Further on, the Future Research and Limitations of the study are presented.

6.1 Answering the Research Questions

Throughout the process of researching and evaluating the findings from importer and expert interviews as well as literature, disagreement can be found regarding the existing trust issues researched in this study. All identified trust-related SC challenges were recognized as such from literature and experts. Importers agree that challenges in the identified areas exist, however, they mostly express high to medium trust in the investigated aspects of their Supply Chains. Since the aspect of trust needs to be understood as sensitive matter in a business context, answers from the importers are weighted and evaluated carefully against statements made by literature and experts.

The aim of the study is to investigate the potential usage of blockchain technology to reduce trust-related challenges for Swedish importers in a Fruit Supply Chain context. Therefore, the overall research question was defined as:

RQ: What is the potential usage of blockchain technology for Swedish importers to reduce trust-related issues along the physical Supply Chain when importing fresh fruit from outside Europe?

Based on this, two sub-questions were formulated which lead the discussion towards the overall research question:

1. *Which Supply Chain "trust issues" exist regarding information along the physical Supply Chain for Swedish actors importing fresh fruit from outside Europe?*

2. *Can, and if so how, the blockchain technology reduce the effect of "trust issues" regarding information along the physical Supply Chain for Swedish actors importing fresh fruit from outside Europe?*

Answer to Sub-Question 1)

The trust-related issues along Fruit Supply Chains from outside Europe to Sweden identified in the literature review were recognized as challenges and potential sources of trust-related problems by the importers. Even though the different identified categories are subject to inefficiencies regarding the information, importers generally place high to medium trust in the information they receive about Origin of the Products, Harvesting Date, Eco-Labelling, Temperature and Lead-Time, the Importing Process as well as the Labor Conditions at the place of origin.

The main reason for high trust in the information was found to be reliance on long-term contracts and relationships. As described in the literature and explained by the importers, high levels of trust were established over years of successful partnership. On the other hand, the importers Supply Chain power allows them to forward reoccurring issues down the Supply Chain, which puts actors downstream the Supply Chain in a position of dependence. If quality or compliance issues occur repeatedly, importers can change suppliers. This position of power, the reliance on long-term relationships, or the combination of both, results in high trust in the information the importers receive.

Nevertheless, importers described a lack of real-time information about the aspects covered in the theoretical framework. Since Supply Chains are often fragmented and of a non-digital nature, information is not able to flow directly to the importers for them to react to inconsistencies instantly. The issue causes lack of transparency at the point of origin, accumulating the potential risk in the beginning of the Fruit Supply Chain and resulting in deduction of trust. This view is supported by Experts and Literature, as both highlight fragmented and non-digital documentation as a major Supply Chain challenge. While importers obtain trust based on Supply Chain power and long-term business relationships, Experts and Literature stress the lack of transparency of Fruit Supply Chains. While the appropriate treatment of produce in the initial step of the Supply Chain is crucial for the quality and compliance to rules and regulations, complete visibility is not existent. Additionally, importers rely on the compliance to import regulations once the produce pass into the EU, not considering that limitations of personnel capacities do not allow for inspections at Port of Entry in 95% of the cases.

Overall, trust issues exist regarding the Origin of the Products, Harvesting Date, Eco-Labelling, Temperature and Lead-Time, the Importing Process & Compliance as well as the Labor Conditions at place of origin. Yet, it is important to recognize that these trust issues are perceived to be limited by the Swedish importers of fresh fruit from outside Europe.

Answer to Sub-Question 2)

Although limited, the existence of trust-related issues within the Fruit Supply Chains from outside Europe to Sweden mean that blockchain technology can be of use for the Swedish importers, as the technology is able to reduce, or even eliminate, trust issues in the long-term. However, substantial challenges need to be overcome beforehand.

Throughout the study it is made clear that certain parts of the Fruit Supply Chains provide digitalized information, e.g. regarding Temperature or Lead-Time, especially upstream the Supply Chain to Sweden. However, the industry faces highly fragmented and non-digitalized documentation structures downstream the Supply Chains, e.g. regarding harvesting date, eco-labelling and labor conditions. This means that no complete digital infrastructure is provided, limiting or even eliminating the effect of a blockchain in a Fruit Supply Chain context.

Another challenge is a lack of actor control or trust regarding the initial data input into the blockchain. Supply Chains actors who use blockchain need to either control the capturing of the data that is to be transferred into the blockchain and/or trust external actors to provide reliable information at the point of data entry. While information can be captured at the point of origin with IoT or satellite devices to overcome the visibility gap between harvesting and first registration, it is still crucial for Supply Chain participants to rely on trusted actors to provide the initial data entry in a trustworthy manner.

However, Supply Chain information can be securely stored on a blockchain if a trusted data capturing point is established and the Supply Chain is fully digitalized. From a Fruit Supply Chain perspective, blockchain technology can be combined with IoT or satellite devices to provide real-time information, which is wanted by the Swedish importers to reduce certain trust issues. In fact, blockchain has the potential to provide tamper proof, real-time data regarding relevant information such as fruit origin, the actual harvesting time and temperature at the production field, the accuracy of eco-labels, temperature transportation, as well as information regarding the working conditions, improving the importing safety and process. Thus, blockchain technology can increase transparency and traceability of the Swedish Fruit Supply Chains under the right circumstances.

Further on, it allows for the identification of unnecessary steps and actors along the Supply Chain, which can lead to the building of a leaner Supply Chain.

Overall, blockchain technology can reduce trust issues experienced by the Swedish importers of fruit from outside Europe. Once the Swedish Fruit Supply Chains are fully digitalized, blockchain can, in combination with other technologies, provide tamper-proof, real-time information regarding critical data points. Yet, blockchain technology will not solve the issue of manipulated data entry. It is important to recognize that the Swedish fruit importers need to overcome challenges such as a lack of control regarding initial data entry and an insufficient level of digitalization in the Supply Chains for blockchain technology to be useful.

Answer to the Research Question:

According to the authors and concluding Sub-Question 1) and 2), blockchain technology will not provide utility for Swedish fruit importers who import commodities from non-European countries. It is not possible for the importers to benefit from inalterable information along a blockchain due to the fragmented and non-digitalized nature of the Swedish fruit supply chains. Additionally, the Swedish importers lack control at the point of data entry, which is also one of the main reasons for reduced trust regarding product information. Yet, blockchain technology, in combination with the mentioned technologies, can enable real-time, tamper-proof flow of information. This allows Swedish importers to solve trust challenges related to a lack of directness of information, once the Supply Chains are fully digitalized and the initial data entry can be trusted. Consequently, the potential usage of blockchain to reduce trust issues along Swedish Fruit Supply Chains is limited nowadays but will enable a more transparent and trustworthy information flow in the future under the discussed circumstances.

6.2 Future Research

Blockchain technology is still a relatively new technology as well as an unexplored subject in academic literature. This thesis attempts to contribute to blockchain technology and SCM research by examining the potential usage of blockchain in a specific SCM sector. However, deeper and more specific studies are needed, especially when it comes to blockchains practical impact. Below are suggestions for future research about blockchain technology.

It is the attempt of the authors that the study specifically examines and discusses blockchain technology from the perspective of the Swedish fruit importers. Yet, the lack of studies about the blockchain technology's impact on related food sectors such as the meat or fish sector prove that further research is necessary in this regard. Research into processed products such as olive oil, fruit juice or wine could prove beneficial as well due to the difficultly of identifying these products and their relatively high economic value. In general, more research into the blockchain technology's potential impact on various food Supply Chains is needed to understand the practical implications of the technology.

The study is focused on the information flow as well as the physical flow of the Swedish Fruit Supply Chains. Thus, the financial flow is not considered in this paper. The authors therefore suggest that research into the impact of specific blockchain applications such as smart contracts on the financial flow of Swedish Fruit Supply Chains could be of interest. Especially as research into the financial aspects of blockchain could provide more practical knowledge about the potential implications of the blockchain technology.

Throughout the study, the authors found that many of the blockchain experts highlighted the potential benefits of blockchain for smaller actors, such as farmers, along a Supply Chain dominated by larger actors. The authors therefore suggest that future research focus on the implications of the blockchain technology for smaller actors and how it can impact business relationships with larger actors. Also, the study did not investigate the knowledge of blockchain among the Swedish fruit importers but instead focused on the importers trust issues. Research into the knowledge of blockchain in various business sectors could provide further information regarding the application of the blockchain technology.

6.3 Limitations

There are several limitations that can have affected the authors' ability to answer the research question in the most effective manner. Firstly, organizational trust can be viewed as a sensitive topic regarding supplier-buyer relationships. It is therefore possible that the interviewed importers did not answer certain questions completely transparently due to an unwillingness to expose their suppliers or their own company. Another aspect that can impact the result is that some of the requested importers chose to not participate in the study. Thus, the authors were not able to completely map the Swedish fruit import market, which might have an impact on the result. Thirdly, some of the participating blockchain experts have limited knowledge in SCM and might therefore have been unable to certain questions. Lastly, the study is heavily focused on the identified trust categories, which mean that other relevant aspects can potentially have been neglected.

Bibliography

Abeyratne, S., & Monfared, R. (2016). Blockchain ready manufacturing supply chain using distributed ledger. *5*(9), pp. 1-10.

Alzahrani, N., & Bulusu, N. (2018). Towards True Decentralization: A Blockchain Consensus Protocol Basedon Game Theory and Randomness. *Decision and Game Theory for Security* (pp. 465-486). Seattle: Springer.

Aung, M. M., & Chang, Y. S. (2014). Traceability in a food supply chain: Safety and quality perspectives. *Food Control, 39,* pp. 172-184.

Bakshi, N., Flynn, S., & Gans, N. (2011). Estimating the Operational Impact of Container Inspections at International Ports. *Management Science, 57*(1), pp. 1-20.

Beck, R., Avital, M., Rossi, M., & Thatcher, J. (2017). Blockchain Technology in Business and Information Systems Research. *Business & Information Systems Engineering, 59*(6), pp. 381–384.

Belt, A., & Kok, S. (2018). *A Reality Check for Blockchain in Commodity Trading.* Boston: BCG.

Berry, T., Griessel, H., Delele, M., & Opara, L. (2015). Geometric Design Characterisation of Ventilated Multi-scale Packaging used in the South African Pome Fruit Industry. *Agricultural Mechanization in Asia, Africa, and Latin America, 46*(3), pp. 34-42.

Bitzios, M., Jack, L., Krzyzaniak, S.-A., & Xu, M. (2017). Country-of-Origin Labelling, Food Traceability Drivers and Food Fraud: Lessons from Consumers' Preferences and Perceptions. *European Journal of Risk Regulation, 8*(3), pp. 541-558.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), pp. 77-101.

Bryman, A., & Bell, E. (2015). *Business Research Methods.* New York: Oxford University Press.

Burbridge, J. (1989). *Production Flow Analysis for Planning Group Technology.* Oxford: Oxford University Press.

Capuano, E., Boerrigter-Eenling, R., Van der Veer, G., & Van Ruth, S. (2013). Analytical authentication of organic products: an overview of markers. *Journal of the Science of Food and Agriculture, 93*(1), pp. 12-28.

Caro, M., Salek Ali, M., Vecchio, M., & Giaffreda, R. (2018). Blockchain-based traceability in Agri-Food supply chain management: A practical implementation. *2018 IoT Vertical and Topical Summit on Agriculture - Tuscany (IOT Tuscany)* (pp. 1-4). Tuscany: IEEE.

Casino, F., Dasaklis, T., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and Informatics, 36*, pp. 55-81.

Center for the Promotion of Imports (CBI). (2018). *What requirements should fresh fruit or vegetables comply with to be allowed on the European market?* London: Ministry of Foreign Affairs, U.K.

CGSO. (2019). *Consumer's Rights Regarding Expiry Dates.* Ferndale: CGSO.

Challener, C. (2014). Acute Need for Supply Chain Transparency. *Pharmaceutical Technology*, pp. 30-32.

Charlebois, S., Schwab, A., Henn, R., & Huck, C. (2016). Food fraud: An exploratory study for measuring consumer perception towards mislabeled food products and influence on self-authentication intentions. *Trends in food science & technology, 50*(2016), pp. 211-218.

Congressional Budget Office (CBO). (2016). *Scanning and Imaging Shipping Containers Overseas: Costs and Alternatives.* Washington: Congressional Budget Office.

Dabbene, F., Gay, P., & Tortia, C. (2014). Traceability issues in food supply chainmanagement: A review. *Biosystems Engineering, 120*(2014), pp. 65-80.

Davidson, R., Antunes, W., Madslien, E., Belenguer, J., Gerevini, M., Perez, T., & Prugger, R. (2017). From food defence to food supply chain integrity. *British Food Journal, 119*(1), pp. 52-66.

De Keizer, M., Akkerman, R. G., Jacqueline, B., Haijema, R., & Van der Vorst, J. (2017). Logistics network design for perishable products with heterogenous quality decay. *European Journal of Operational Research, 262*(2017), pp. 535-549.

Derebail, A. (2017). The trust factor: blockchain can help companies transform operations and fight fraud. *Best's Review, 118*(2), pp. 21-21.

Descartes. (2019). *Customs Information. Top Five Import Compliance Challenges Affecting International Trade*. Retrieved February 23, 2019, from https://www.customsinfo.com/industry-blog/top-five-import-compliance-challenges-affecting-international-trade

DHL. (2019). *Delivery Times for your Shipment*. Retrieved March 09, 2019, from https://www.dhlparcel.be/en/business/support/delivery/transit-times

ElMessiry, M., & ElMessiry, A. (2018). Blockchain Framework for Textile Supply Chain Management. In S. Chen, H. Wang, & L. Zhang, *Blockchain - ISBC 2018* (Vol. 10974, pp. 213-227). Cham: Springer.

Eriksson, P., & Kovalainen, A. (2008). *Qualitative Methods for Business Research.* London: Sage.

Etwaru, R. (Director). (2017). *Blockchain: Massively Simplified* [Motion Picture]. Retrieved March 16, 2019, from https://www.youtube.com/watch?v=k53LUZxUF50

European Commission (EC). (2019a). *Food Law General Requirements*. Retrieved March 12, 2019, from https://ec.europa.eu/food/safety/general_food_law/general_requirements_en

European Commission (EC). (2019b). *Trade Helpdesk. Tips on EU requirements*. Retrieved March 22, 2019, from http://trade.ec.europa.eu/tradehelp/tips-eu-requirements

Food and Agriculture Organization (FAO). (2017). *Food Traceability Guidance.* Santiago: United Nations.

Francisco, K., & Swanson, D. (2018). The Supply Chain Has No Clothes: Technology Adoption of Blockchain for Supply Chain Transparency. *Logistics, 2*(1), pp. 1-13.

Fremont, V., & Gideon, J. (2018). Can Blockchain Technology SolveTrust Issues in Industrial Networks? *BIR Short Papers, Workshops and Doctoral Consortium. 2218*, pp. 399-404. Stockholm: CEUR Workshop Proceedings.

Goedhals-Gerber, L., Stander, C., & Van Dyk, F. (2017). Maintaining cold chain integrity: Temperature breaks within fruit reefer containers in the Cape Town Container Terminal. *Southern African Business Review, 21*(2017), pp. 362-384.

Goldratt, E. (1997). *Critical Chain.* New York: North River Press.

Hawlitschek, F., Notheisen, B., & Teubner, T. (2018). The limits of trust-free systems: A literature review on blockchain technology and trust in the sharing economy. *Electronic Commerce Research*, pp. 50-63.

Hofmann, F., Wurster , S., Ron , E., & Böhmecke-Schwafert, M. (2017). The immutability concept of blockchains and benefits of early standardization. *ITU Kaleidoscope: Challenges for a Data-Driven Society* (pp. 1-8). Berlin: IEEE Conferences.

Human Right Watch (HRW). (2011). *Ripe with Abuse - Human Rights Conditions in South Africa's Fruit and Wine Industries.* New York: Human Rights Watch.

Iansiti, M., & Karim, L. (2017). The Truth About Blockchain. *Harvard Business Review, xx*(2017), pp. 118-127.

International Labor Organization (ILO). (2019). *Child Labor in Agriculture*. Retrieved March 16, 2019, from https://www.ilo.org/ipec/areas/Agriculture/lang--en/index.htm

International Telecommunication Union (ITU). (2015). *Internet of Things Global Standards Initiative*. Retrieved April 15, 2019, from https://www.itu.int/en/ITU-T/gsi/iot/Pages/default.aspx

Jakkhupan, W., Arch-Int, S., & Li, Y. (2015). An RFID-based traceability system. *Telecommunication Systems, 58*(2015), pp. 243-258.

Karp, D. (2018). *Most of America's Fruit Is Now Imorted. Is That a Bad Thing?* Retrieved April 03, 2019, from The New York Times: https://www.nytimes.com/2018/03/13/dining/fruit-vegetables-imports.html

Kehoe, L., Kai, G., Dalal, D., Andrzejewski, D., & O'Connell, N. (2018). *When two chains combine: Supply chain meets blockchain.* Deloitte. New York: Deloitte.

Kempe , M., Sachs , C., & Skoog , H. (2018). *Blockchain use cases for food traceability and control: A study to identify the potential benefits from using blockchain technology for food traceability and control.* Kairos Future. Stockholm: Kairos Future.

Kolko, J. (2011). *Exposing the Magic of Design: A Practitioner's Guide to the Methods and Theory of Synthesis.* New York: Oxford Scholarship Online.

Kshetri, N. (2018). Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management, 39*(2018), pp. 80-89.

Lamming, R., Caldwell, N., & Harrison, D. (2004). Developing the concept of transparency for use in supply relationships. *British Journal of Management, 15*(4), pp. 291-302.

Lindgreen, A. (2003). Trust as a valuable strategic variable in the food industry: Different types of trust and their implementation. *British Food Journal, 105*(6), pp. 310-327.

Lisk. (2019). *The Lisk Protocol*. Retrieved March 17, 2019, from https://lisk.io/documentation/lisk-protocol

Liu, Z. (2015). Trust between Organizations: A Review of Current Research and Recommendation for the Future. *Review for Contemporary Business Research, 4*(1), pp. 40-48.

Massy-Beresford, H. (2017). *Security. Beyond X-rays - the new inspection tool to thwart smugglers*. Retrieved March 23, 2019, from https://horizon-magazine.eu/article/beyond-x-rays-new-inspection-tools-thwart-smugglers.html

Mayer, R., Davis, J., & Schoorman, D. (1995). An Integrative Model of Organizational Trust. *The Academy of Management Review, 20*(3), pp. 709-734.

Morgan, T., Richey, R., & Ellinger, A. (2018). Supplier transparency: scale development and validation. *The International Journal of Logistics Management, 29*(3), pp. 959-984.

Nakamoto, S. (2008). Bitcoin: A peer-to-peer Electronic Cash System.

Ndraha, N., Hsiao, H., Vlajic, J., Yang, M., & Lin, H.-T. (2018). Time-temperature abuse in the food cold chain: Review of issues, challenges, and recommendations. *Food Control, xxx*(2018), pp. xx-xx.

Negi, S., & Anand, N. (2015). Issues and Challenges in the Supply Chain of Fruits & Vegetables Sector in India: A Review. *International Journal of Managing Value and Supply Chains, 6*(2), pp. 47-62.

Nguegan, C., & Mafani, C. (2017). Supply chain management problems in the food proessing industry: Implications for business performance. *Acta Commercii, 17*(1), pp. 1-15.

Nielsen. (2015). *We Are What We Eat. Healthy Eating Trends Around the World.* New York: Nielsen Company.

Nofer, M., Gomber, P., Hinz, O., & Schiereck, D. (2017). Blockchain. *Business & Information Systems Engineering, 59*(3), pp. 183-187.

Oddman, P. (2018). *Rymdteknik effektiviserar världens mat.* Retrieved March 18, 2019, from Affärsstaden: http://affarsstaden.se/esb-article/rymdteknik-effektiviserar-varldens-mat-2/

Olsen, P., & Borit, M. (2018). The components of a food traceability system. *Trends in Food Science & Technology, 77*(2018), pp. 143-149.

Orphan, V., Muenchau, E., Gormley, J., & Richardson, R. (2009). *Advanced Cargo Container Scanning Technology Development.* San Diego: Science Applications International Corporation.

Pagani, P., Epp, M., & Furmans, K. (2016). *An Exact Model to Determine the Lead-Time Distribution of Perishable Goods in a Kanban-Controlled Production System.* Karlsruhe: KIT.

Parris, L., Dapko, J., Arnold, R. W., & Arnold, D. (2016). Exploring Transparency: a new framework for responsible business manager. *Management Decisions, 54*(1), pp. 222-247.

Petersen, M., Hackius, N., & von See, B. (2018). Mapping the sea of opportunities: Blockchain in supply chain and logistics. *Information Technology, 60*(5-6), pp. 263-271.

Ringsberg, H. (2014). Perspectives on food traceability: a systematic literature review. *Supply Chain Management: An International Journal, 19*(5), pp. 558-576.

Robinson, P. (2010). Responsible Retailing: The Practice of CSR in Banana Plantations in Costa Rica. *Journal of Business Ethics, 91*(2010), pp. 279-289.

Rodrigue, J. P. (2017). *The Geography of Transport Systems.* New York: Routledge.

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2018). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research, 57*(7), pp. 2117-2135.

Savjee (Director). (2018). *Blockchain - Simply Explained* [Motion Picture]. Retrieved April 03, 2019, from https://www.youtube.com/watch?v=SSo_EIwHSd4

Schoorman, D., Mayer, R., & Davis, J. (2007). An Integrative Model of Organizational Trust: Past, Present and Future. *Academy of Management Review, 32*(2), pp. 344-354.

Shamsuzzoha, A., Ehrs, M., Addo-Tenkorang, R., Nguyen, D., & Helo, P. (2013). Performance evaluation of tracking and tracing for logistics operations. *International Journal of Shipping and Transport Logistics, 5*(1), pp. 31-54.

Shears, P. (2010). Food fraud – a current issue but an old problem. *British Food Journal, 112*(2), pp. 198-213.

Smithers, R. (2018). *Tesco to axe "confusing" best before dates on its fruits and vegetables.* Retrieved March 20, 2019, from The Guardian: https://www.theguardian.com/business/2018/may/21/tesco-best-before-dates-fruit-avegetables-food-waste

Song, W., Wang, H., Maguire, P., & Nibouche, O. (2016). Differentiation of organic and non-organic apples using near infrared reflectance spectroscopy - A pattern recognition approach. *2016 IEEE Sensors* (pp. 1-3). Newtownabbey: IEEE Explore.

Soto-Silva, W., Nadal-Roig, E., González-Araya, M., & Pla-Aragones, L. (2016). Operational research models applied to the fresh fruit supply chain. *European Journal of Operational Research, 251*(2), pp. 345-355.

Sreejesh, S., Mohapatra, S., & Anusree, M. (2014). *Business Research Methods: An Applied Orientation.* Cham: Springer.

Swan, M. (2015). *Blockchain: Blueprint for a new economy* . Sebastopol : O'Reilly Media .

Tan , B., Yan , J., Chen , S., & Liu , X. (2018). Smart Blockchain. *First International Conference, SmartBlock 2018* (pp. 167-177). Tokyo: Springer.

Thetkathuek, A., Meerpradit, P., & Sa-ngiamsak, T. (2017). A cross-sectional Study of Musculosketal Symptoms and Risk Factors in Cambodian Fruit Farm Workers in Eastern Region, Thailand. *Safety and Health at Work, 9*(2018), pp. 192-202.

UPS. (2019). *Finding Rates and Delivery Times*. Retrieved March 25, 2019, from https://www.ups.com/se/en/help-center/shipping-support/rates-and-times.page?

van Waarden, F. (2012). The Governance Of Markets: On Generating Trust in Transactions. *The Oxford Handbook of Governance*, 1-14.

Verdouw, C., Beulens, A., Trienekens, J., & Wolfert, J. (2010). Process modelling in demand-driven supply chains: A reference model for the fruit industry. *Computer and Electronics in Agriculture, 73*(2), pp. 174-187.

Vincent, J., Wang, H., Nibouche, O., & Maguire, P. (2018). Differentiation of Apple Varieties and Investigation of Organic Status Using Portable Visible Range Reflectance Spectroscopy. *Sensors, 18*(6), pp. 1708-1721.

Wang, Y., Hugh Han, J., & Beynon-Davies, P. (2019). Understanding blockchain technology for future supply chains: A systematic literature review and research agenda. *Supply Chain Management: An International Journal, 24*(1), pp. 62-84.

Warburg, B. (Director). (2016). *How blockchain will radically transform the econmy* [Motion Picture]. Retrieved March 17, 2019, from https://www.youtube.com/watch?v=RplnSVTzvnU

Weimert, B., Prinz, W., Urbach, N., & Holly, S. (2018). *Blockchain and Smart Contracts: Technologies, research issues and applications.* Fraunhofer Institute . Berlin: Fraunhofer-Gesellschaft.

Weng, C., & Black, C. (2015). Taiwanese farm workers' pesticides knowledge, attitudes, behaviors and clothing practices. *International Journal of Environmental Health Research, 25*(6), pp. 685-696.

Wieland, A., Handfield, R., & Durach, C. (2016). Mapping the Landscape of Future Research Themes in Supply Chain Management. *Jounal of Business Logistics, 3*, pp. 1-8.

Wognum, P., Bremmers, H., Trienekens, J., Van der Vors, J., & Bloemhof, J. (2011). Systems for sustainability and transparency of food supply chains – Current status and challenges. *Advanced Engineering Informatics, 25*(1), pp. 65-76.

Wortmann, F., & Flüchter, K. (2015). Internet of Things: Technology and Value Added. *Business & Information Systems Engineering, 57*(3), pp. 221-224.

Wüst , K., & Gervais , A. (2017). Do you need a Blockchain? . *Crypto Valley Conference on Blockchain Technology*, (pp. 45-54). Retrieved from https://eprint.iacr.org/2017/375.pdf

Wyman, O. (2018). *Disruption in Fruit and Vegetable Distribution.* Berlin: Fruit Logistica.

Xu, J. (2016). Are blockchains immune to all malicious attacks? *Financial Innovation, 2*(1), pp. 2-25.

Yiannas, F. (2018). A New Era of Food Transparency Powered by Blockchain. *Innovations: Technology, Governance, Globalization, 12*(1-2), pp. 46-56.

Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where Is Current Research on Blockchain Technology?—A Systematic Review. *PLoS One, 11*(10), 1-27.

Zaheer, A., McEvily, B., & Perrone, V. (1998). Does Trust Matter? Exploring the Effects of Interorganizational and Interpersonal Trust on Performance. *Organization Science, 9*(2), pp. 141-159.

Appendix

Appendix 1: Email: Importers & Experts

1) *Swedish Fruit Importers*

Hi xxx,

We are two Master-Students from the Logistics and Transport Management program at Handelshögskolan in Gothenburg and we are currently in the beginning of our Master-Thesis. The thesis revolves around trust issues along the fruit supply chain when importing globally to Sweden, like e.g. trust issues regarding origin, correct storage and handling, temperature, etc. During the second step, we are then looking at whether/ how Blockchain solutions can solve the identified trust issues.

We believe that it's interesting to look at the principal fruit importers, since you are the major Swedish players in, what we understand, is a fragmented and complex supply chain with a multitude of global suppliers.

For our thesis, we are aiming to interview the major Swedish fruit importers about the described trust issues. Therefore, we would be happy if you have time for a 30 - 60-minute interview to support us in our objective.

We are more than happy to talk about further details via phone or e-mail. We look forward to hearing from you soon.

Best regards,

Christian Bremer & Carl-Philip Lindqvist

2) *Blockchain & Supply Chain Experts*

Hi xxx,

We are two Master-Students from the Logistics and Transport Management program at Handelshögskolan in Gothenburg and we are currently in the beginning of our Master-Thesis.

The thesis revolves around trust issues along the fruit supply chain when importing globally to Sweden. In a first step, we are planning to interview Sweden's three major importers of fruit. Our objective is to identify specific areas where trust issues exist along the Swedish fruit supply chains. Areas of interest are for example Product Origin, Product Type, Cold Chain, Lead-Time, Disruptions, Compliance to Legislations and EU-Standards, Hygienic-sanitary Compliance, Human Rights Aspects. In the following section, we are looking at whether/ how Blockchain solutions can solve the identified trust issues.

We understand that your time is valuable, and we therefore greatly appreciate your contribution. We are more than happy to talk about further details via phone or e-mail. We look forward to hearing from you soon.

Best regards,

Christian Bremer & Carl-Philip Lindqvist

Appendix 2: Interview Guidelines

1) *Interview: Swedish Fruit Importer*

<u>Interview Guideline: Swedish Fruit Importer</u>

Topic: Trustworthiness of information along the physical fruit supply chain for Swedish actors importing fresh fruit from outside Europe.

A. ***General Introduction***

- Would you give us a brief overview of your responsibilities at company X?

B. ***Supply Chain***

- Would you tell us about the last time you ordered fruits from outside Europe?
  - Do you consider this to be the normal process?
    - If not, why was it not a normal process?
  - Is the process different for different fruits and countries?
    - If so, why and how does the process differ?

- Where are your main suppliers from outside Europe located?
  - Which products are you mainly sourcing from those suppliers?
  - Which volumes are you importing from those countries?

- Would you describe the structure of the supply chain:
  - How does the structure in the exporting country look like?
    - Many small/ independent growers?
    - Few/ large growers?

- How would you describe product visibility along the supply chain?
  - What kind of traceability system is currently in place?
  - How far back does the system allow you to trace products along the supply chain?

C. **Trust Issues**

- In general, do you experience lack of trust when importing fruits from outside Europe?
  - Is Trust a problem when importing fruits from outside Europe?
    - If so, why is it a problem?
  - Are there any Regions/ Products that are more or less trustworthy?
    - Why are they more or less trustworthy?
- Is trust an important criterion when choosing suppliers?

Issues	Scale	Open Questions
Product Identification	***High, Medium, Low***	
Origin of Products	*How trustworthy is the information about the origin of products?*	• Is the origin of the product important to you as an importer? • Are you confident that the origin of the products is correct? • How do you assure that the products are coming from the assigned origin? • Have you experienced labelling fraud regarding origin? • Which products have shown to be vulnerable to labelling fraud in terms of origin? • What is the consequence of false labelling?
Harvesting Date	*How trustworthy is the information about the harvesting date of the products?*	• Is the Harvesting Date important to you as an importer? • Are you confident that the information about the Harvesting Date is correct? • How do you assure that the stated Harvesting Date is correct? • Have you experienced fraud regarding the Harvesting Date? • Which products have shown to be vulnerable to fraud in terms of origin? • What are the consequences of false Harvesting Date information?
Eco-Labelling	*How trustworthy is the information about the Eco-Labels of organic products?*	• When importing organic fruits; is the correct labelling of organic fruit important to you? • Are you confident that Eco-Labels are valid? • How do you assure that the Eco-Labels are correct? • Have you experienced labelling fraud regarding Eco-Labelling? • Which products have shown to be vulnerable to Eco-Labelling fraud? • What are the consequences of false labelling of organic fruit?

Product Movement		
Cold Chain	*How trustworthy is the information regarding the Cold Chain, including storage, transportation and disruptions?*	• Is it important to you that the Cold Chain is constant? • Which are the most critical stages along the supply chain regarding the Cold Chain? • How confident are you that temperature disruptions are reported accordingly? • How confident are you regarding the correctness of the information with respect to the Cold Chain? • What are the consequences of a broken Cold Chain?
Lead-Time	*How trustworthy is the information about the Lead-Time, including storage, transportation and disruptions?*	• Is the Lead-Time of the products important to you? • Which are the most critical stages along the supply chain regarding lead-time? • How confident are you that lead-time disruptions are reported accordingly? • How confident are you regarding the correctness of the information with respect to the lead-time? • What are the consequences of an extended Lead-Time?
Product Safety		
Compliance to Import Regulations, EU-Standards	*Can product information regarding compliance to import regulations be trusted?*	• Are you confident that the products comply to import regulations? • Are you confident that the use of fertilizers and pesticides is documented correctly? • Are you confident that the products have been handled in a hygienic appropriate environment?
Ethical Information		
Labour Conditions at Production Site	*Can product information regarding the compliance to Labour Conditions at production site be trusted?*	• Do you have requirements regarding labour conditions at production site? • How do you check on those requirements? • Are you confident that the labour conditions at production site are according to company standards? • What are the consequences of a breach of those requirements?

2) *Interview: Blockchain & Supply Chain Experts*

Interview Guideline: Blockchain Experts

Topic: Trustworthiness of information along the physical fruit supply chain for Swedish actors importing fresh fruit from outside Europe.

A) General Information

- Would you give us a brief overview of your responsibilities/ background in terms of the Blockchain technology at company X?

B) Fruit Supply Chain & Blockchain

- What are the benefits and drawbacks of blockchain in general?
- Are you familiar with the concept of supply chain management and the transport and logistics industry? If no, explain key aspects and issues.
- Do you think BC could be useful in the transport and logistics industry? Drawbacks?
- Are you familiar with setting of fruit supply chains from outside Europe?
    - If No:
        - Small independent farmers
        - Deliver to packaging locations of the exporter
        - Brought to the port and shipped to Europe
        - Mainly, port of entry is Netherlands
        - Produce gets loaded onto trucks/ or feeder ships to bring products to Sweden
- Would you describe your perception of how the Blockchain Technology might impact a Fruit Supply Chain?
    - As you see it, what are the main benefits of the Blockchain Technology in a Fruit Supply Chain context?
    - As you see it, what are the potential limitations of the Blockchain technology in a Fruit Supply Chain context?

- Have you come across trust related issues in Fruit Supply Chains?
    - If yes, would you please describe in more detail?

Issues	Scale	Open Questions
Product Identification	***High, Medium, Low***	
Origin of Products	*How suitable is Blockchain technology to provide trustworthy information regarding the Origin of Products?*	• In the course of your work/ research; Have you come across trust issues regarding the information about the Origin of Products? • How can Blockchain technology ensure trustworthy information about the origin of fruit products?

Harvesting Date	*How suitable is Blockchain technology to provide trustworthy information regarding the Harvesting Date?*	• In the course of your work/ research; Have you come across trust issues regarding the information about Harvesting Date of Fruits? • How can Blockchain technology ensure trustworthy information about the harvesting date of fruit products?
Eco-Labelling	*How suitable is Blockchain technology to provide trustworthy information regarding the Eco-Labels?*	• In the course of your work/ research; Have you come across trust issues regarding the correctness of Eco-Labels? • How can Blockchain technology ensure trustworthy information about Eco-Labels of fruit products?
Product Movement		
Cold Chain	*How suitable is Blockchain technology to provide trustworthy information regarding the Cold Chain?*	• In the course of your work/ research; Have you come across trust issues regarding information about the Cold Chain? • How can Blockchain technology ensure trustworthy information about the Cold Chain of fruit products?
Lead-Time	*How suitable is Blockchain technology to provide trustworthy information regarding the Lead-Times?*	• In the course of your work/ research; Have you come across trust issues regarding the Lead-Time? • How can Blockchain technology ensure trustworthy information about the Lead-Time of fruit products?
Product Safety		
Compliance to Import Regulations, EU-Standards	*How suitable is Blockchain technology to provide trustworthy information regarding compliance to Import Regulations?*	• In the course of your work/ research; Have you come across trust issues regarding the information about Compliance to EU Standards and Regulations? • How can Blockchain technology ensure trustworthy information about Compliance to EU Standards and Regulations of fruit products?

Ethical Information		
Labour Conditions at Production Site	*How suitable is Blockchain technology to provide trustworthy information regarding the Labour Conditions at Production Site?*	• In the course of your work/ research; Have you come across trust issues regarding the information about Labour Conditions at Production Site? • How can Blockchain technology ensure trustworthy information regarding labour conditions at Fruit production sites?

- All considered, do you see a potential for the blockchain technology with respect to the trustworthiness of information regarding the physical flow of fruits?