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Traceability in the Food Industry

How can Blockchain Technology benefit food traceability within the supply chain?

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Traceability in the Food Industry: How can Blockchain Technology benefit food traceability within the supply chain?

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ABSTRACT:

Throughout history to this day, the food industry has been facing numerous food contamination incidents. Globalization and an increasing complexity of the food supply chain creates the need for high trust in the information exchanged, therefore there is a lot of focus on food traceability. While there have been improvements to food traceability by the advancements in information systems, transparency and trustworthiness of data still remain key problems. Blockchain technology has been one of the latest technological developments that has the potential to greatly improve trust between the members in a food supply chain. However, blockchain technology is still in an early adoption phase. This thesis aims to evaluate blockchain technology in the context of food traceability. The authors present a framework that compares blockchain technology characteristics against the driving forces of food traceability and evaluates challenges faced in the adoption of blockchain technology. The findings of the study indicate that blockchain is in a good position to positively impact trust in the food industry by increasing transparency and integrity of data. However, blockchain technology may be very difficult to implement in long chains due high need of collaboration between organizations and poor scalability.

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List of Abbreviations

1. Blockchain (BTC)
2. Diffusion of Innovation (DOI)
3. Distributed Ledger Technology (DLT)
4. Electronic Identification (EDI)
5. European Union (EU)
6. Food and Codex Alimentarius Commission (CAC)
7. Food and Drug Administration (FDA)
8. Food Safety Modernization Act (FSMA)
9. Food Traceability System (FTS)
10. General Food Law (GFL)
11. Hazard Analysis and Critical Control Point (HACCP)
12. Information System (IS)
13. Information Technology (IT)
14. International Organization for Standardization (ISO)
15. Pathogen Reduction (PR)
16. Peer-to-Peer (P2P)
17. Radio-Frequency Identification (RFID)
18. Technology, Organization and Environment (TOE)
19. World Health Organization (WHO)

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1 Introduction

This chapter will introduce the underlying issues that lay ground for the study by explaining the background, problem area and the research gap. The theoretical background will be followed by the research question generated from the research gap, the research purpose and the thesis delimitations.

1.1 Background

Food is essential to human beings, but not every geographical location has the same conditions to grow certain types of food or even process it, since it is a very sensitive asset. As the world is going through globalization and is becoming more interconnected, geographical limitations within the food supply chain are shrinking, as food producers can reach consumers on a much broader scale (La Trobe, 2001). Smith et al. (2005) estimate that within the United Kingdom, the distance of food transported via land doubled since 1974. The complexity and broader reach of the food supply chain make tracing contamination increasingly difficult, since every food product goes through several steps inside this chain (Pederson R. & Hernández G., 2014). Over the last few years, public opinion has changed significantly about the importance of food information transparency. Multiple incidents have challenged the credibility of the food industry and food traceability is one of the biggest challenges for the food supply chain (Porter, S. & Reay, D., 2015). Traceability is now considered more of a demand rather than a request among food consumers today. Many consumers now want to know where all products and their ingredients, even the trace ones, come from.

There are reports of food contamination incidents since the ancient times. The Roman elite suffered severe lead poisoning since they had sustained exposure to this chemical element: the lined pots in which acidic food was boiled had lead presence as well as their water pipes, they also used sugar of lead to sweeten their wines at the time (Veronese K., 2012). In the last centuries there are several documented cases of food contamination that generated many victims (Thomson et al., 2012). In 2016 there was a huge international recall of a range of chocolate bars produced by Mars Wrigley Confectionery, after traces of plastic have been found in several products, such as bars of Mars chocolate, Milky Way, Snickers, Celebrations and Mini Mix (Quinn et al., 2016). Mars Wrigley Confectionery, headquartered in Chicago, produces and distributes products for more than 180 countries around the world. This recall affected 55 countries and ended up costing the company tens of millions of dollars (Quinn et al., 2016). In another food-related incident, French meat-processing firm Spanghero is on trial for selling horse meat labeled as pure beef (Jarry E., 2019). The firm allegedly knew it was buying frozen horse meat and switched customs code on the packaging to sell it as beef at premium prices (Jarry E., 2019). One of the most recent incidents happened in Australia related to the contamination of fruits, as there have been numerous reports of sewing needles found in strawberries and other fruits (Luthria K., 2018). This malicious act of one person resulted in shoppers abandoning purchases, growers dumping fruits and government setting aside as much as 1 million AUD to help the farmers to make it through the season (Luthria K., 2018). These

large number of food incidents and scandals make consumers lose confidence in the food industry. To increase quality, integrity safety, and transparency, quality assurance has become a cornerstone of food safety policy in the food industry (Pinto, Castro, & Vicente, 2006). Traceability can be an effective tool to improve safety within food chains and increase consumer confidence in food safety and consumer protection (V. Kher et al., 2010). Furthermore, governments implement stricter policies that heavily rely on tracking foods and ingredients. One such example is EU's General Food Law (GFL), Regulation (EC) N° 178/2002 which makes it a mandatory practice to be able to trace food through all stages of production, processing, and distribution (European, 2002).

The field of information systems, in particular, has shown that technological developments have the potential for radical transformations within an organizational setting (Rogers, 2010). Organizations are using various information systems to enable traceability and increase transparency; for example in the production process, there are production management and enterprise resource planning systems, extension and food health service systems, third-party control database management systems, public inspection database management systems, and several others (Folinas, Manikas, & Manos, 2006). Regattieri, Gamberi, and Manzini (2007) state four pillars that are the basis for an effective traceability system: product identification, data to trace, product routing, and traceability tools. The authors also highlight alphanumeric codes, barcodes and RFID systems, as very promising technical resources to be used in a traceability system. Overall technology development plays a big part in motivating companies to develop full chain traceability systems integrating information at all stages of the supply chain (Bosona & Gebresenbet, 2013). Despite technological solutions available to improve food traceability within the supply chain, the question remains if information between members of the food supply chain can be trusted (Tian, 2017). The trust in food traceability can only be as strong as organizations in a supply chain that own the information. However, as the EU Food Fraud Network Activity Report shows, in 2017 there have been 597 cases regarding non compliance and 178 cases regarding intentional food fraud incidents (AAC, 2017). The real numbers may be higher as reported cases are on voluntary basis and do not include the activities that Member States carry out at national level. In addition, a centralized system has a risk of single point failure and is vulnerable to risks such as hacking and malicious behaviour (McConaghy et al., 2016). Blockchain technology (BCT) has a large potential to address such issues.

Blockchain is one of the latest technological developments that is increasingly becoming more popular in several types of business (Lacity, 2018). Due to its unique transparent nature and high level of trust, many companies are looking into the applications of blockchain technology to increase their supply chain traceability and security (Tapscott, D., & Tapscott, A., 2016). According to Tse, Zhang, Yang, Cheng, and Mu (2017) blockchain has the potential to help manufacturers to record transactions in authenticity. Furthermore, to fight food contamination issues, there are already pilot projects being rolled out which use blockchain technology for food traceability (Kamath, 2018). However, in the academic world blockchain and supply chain traceability are still a rather unexplored topic with only 2990 results returned in Google Scholar when using the keywords "blockchain, supply chain, traceability" compared to the 52.500 results returned if the keyword "blockchain" is omitted. Even fewer results are returned when searching for "blockchain, food traceability" specifically.

1.2 Problem Area

Despite stricter regulations on food supply chain traceability having been created, such as the EU's General Food Law, Regulation (EC) No 178/2002, Folinas et al. (2006) state that they do not put forward a methodology to be followed by all food business operators and argue that companies are free to choose tools that fit their needs and ensure efficient traceability for their products. Furthermore, despite existing government initiatives and available technical resources, human involvement and motivation within companies are one of the most critical factors for creating successful traceability (Anne-Marie Donnelly et al., 2012). As multiple food contamination incidents are due to malicious acts and lack of trustworthiness within the supply chain, the aim should be to limit human factors where possible. Kamath (2018) also outlines the lack of detail regarding internal traceability requirements in the Regulation (EC) No 178/2002 and highlights standardization as one of the barriers in implementing effective food traceability system. Four important challenges identified in the literature include: (i) the lack of a standardized format between various links in the chain when exchanging information (Thakur & Donnelly, 2010; Thakur, Sørensen, Bjørnson, Forås, & Hurburgh, 2011), (ii) differences in the level of accuracy of traceability between links in the chain (V. Kher et al., 2010), (iii) the lack of integration and transparency in retrieving traceability information among the whole supply chain (Salampasis, Tektonidis, & Kalogianni, 2012), (iv) data-related issues such as trust, privacy, security and reliability (Chrysochou, Chrysochoidis, & Kehagia, 2009; Anne-Marie Donnelly, Mari Karlsen, & Dreyer, 2012; Mangina & Vlachos, 2005).

Problematizing these four challenges is not the intention of this thesis, but rather to look into how technological developments such as blockchain technology can be implemented and applied to such problems. Therefore, in this thesis we consider that blockchain technology, despite being still in its infancy, must not be overlooked in the food industry, because it shows that it has great potential to make a positive impact on transforming the food industry for the better. Gartner predicts that blockchain will be used for food safety and traceability by 20% of the top global grocers in the food industry by 2025 (Gartner, 2019a). Reflecting on this relationship between the food industry and blockchain technology, we consider that the food industry at large is yet to be informed of the importance of blockchain technology for improving their traceability, however, those that already apply it struggle to find the best means to leverage its benefits (Gartner, 2019b).

1.3 Research Question

As we see a gap in the potential application of the blockchain technology within food traceability, we analyse theoretical advantages and disadvantages of the blockchain technology within the context of food traceability and build a framework to evaluate blockchain technology as a potential solution to improve food traceability within the supply chain. Therefore, our thesis will focus on answering the following research question:

"How do the blockchain technology benefit food traceability within the food industry's supply chain?"

1.4 Purpose

The purpose of this thesis is to understand how blockchain technology can be beneficial for food traceability by identifying which of its benefits can be applicable within the food industry. Furthermore, this thesis aims to identify challenges and limitations for blockchain technology within the food industry that could impact the adoption of the blockchain technology in this industry.

This thesis may serve as a foundation to help companies within the food industry decide if the blockchain technology is applicable to deal with current issues related to food traceability within the supply chain.

1.5 Delimitation

Despite interesting outcomes from our research results, this thesis is not exempt from delimitations. We focused on evaluating the use of blockchain technology in the context of the food industry with a focus on food traceability. Furthermore our delimitations can be categorized as follows: (a) in this thesis we do not aim to evaluate blockchain technology as such from a technical point of view and its applicability in the food industry, but rather reflect on how blockchain technology can be beneficial for such an industry, by conducting an empirical study; (b) our theoretical framework is limited to choices that organizations tend to make when they want to bring a new technology into their operations, thus we considered that applying Diffusion of Innovation Theory (DOI) from a decision-making perspective enriches that particular point of view that we aim to tackle in this thesis; (c) from a methodological point of view, we are limited to conducting interviews from multiple companies. However, we clearly see a benefit if this thesis would extend to a case-study approach in particular, for richer data.

2 Theoretical Background

This chapter will act as a frame of reference for this thesis which the authors will split into two parts: food traceability in the supply chain and blockchain technology. Due to a limited number of sources available regarding blockchain technology use within food traceability in the supply chain, the theory for these two concepts will be presented separately and combined into a theoretical framework.

2.1 Supply Chain in the Food Industry

Handfield and Bozarth (2012) define the supply chain as a network of manufacturers and service providers that work together to create products or services needed by end users. These entities in a supply chain are linked through physical flows, information flows, and monetary flows. Thakur et al. (2011) describe the food supply chain as an activity of trading goods among several stakeholders such as farmers, producers, processors, distributors, retailers, etc. One stakeholder to another transports raw materials, where they are processed into finished products while going through various transformations such as mixing, cooking, segregating. The processed food products are then transported to distributors and retailers which is the last stage before reaching the consumer (Thakur & Hurburgh, 2009). Tian (2017) uses crop plant production as an example and outlines a typical food supply chain divided into five links: A-Production; B-Processing; C-Warehousing; D-Distribution; E-Retail (Figure 1).

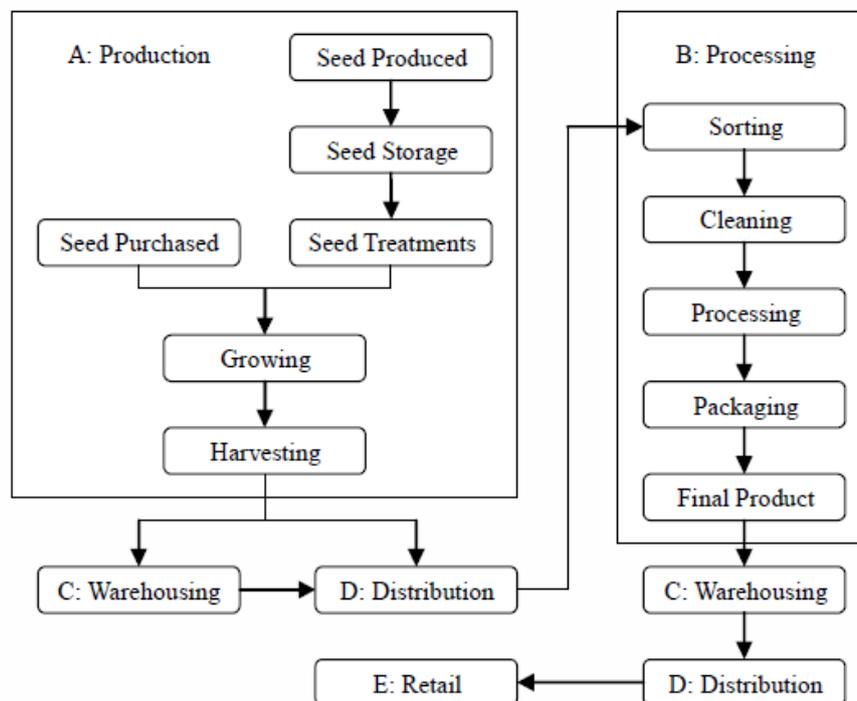


Figure 1. Flow diagram for the food supply chain (Tian, 2017)

Every link in the supply chain has multiple assessments, measurements and monitoring activities done to ensure food safety and quality. For example, at an early production stage,

food processing environment and raw materials should be assessed, measured and monitored. Processing activities should be carried out according to good working practices; the warehousing link should follow best practices to ensure proper storage by recording environment and storage time of products. The distribution link should have properly maintained equipment and retail should follow retail management practices (e.g., using refrigeration; checking freshness lifetime; replacing expired products). At every link, each supply chain needs to develop good working practices and keep records as a routine document (Tian, 2017).

Due to ongoing globalization and increasing complexity of food supply chain networks, there has been an increasing need to have efficient systems for information exchange between food businesses (Thakur & Donnelly, 2010).

2.1.1 Food Traceability Definition

Various definitions and interpretations of traceability can be found within and outside of academia. Olsen and Borit (2013) did a comprehensive literature review, in which they aimed to identify the definition of traceability, particularly within the food traceability context and stated that there is a lot of confusion and inconsistencies towards the definition of traceability, but concluded that record keeping is an essential aspect of traceability. Olsen and Borit (2013) suggest their definition of traceability as the ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications. Another literature review was done by Bosona and Gebresenbet (2013) with a focus on food traceability issues. The review redefined food traceability as an integral part of logistics management that capture, store, and transmit adequate information about a food, feed, food-producing is correct for any substances at all stages in the food supply chain so that the product can be checked for safety and quality control, traced upward and tracked downward at any time required. The European Union (EU) regulation 178/2002 defines traceability as the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing, and distribution (European, 2002).

2.1.2 Drivers for Food Traceability

Golan et al. (2004) present three primary objectives in using traceability systems: (i) improve supply management, (ii) facilitate traceback for food safety and quality, (iii) differentiate and market foods with subtle or undetectable quality attributes. There are multiple benefits that traceability systems can yield to companies. A traceability system with implemented quality control can result in improved quality of raw materials (Galvão, Margeirsson, Garate, Viðarsson, & Oetterer, 2010), improved production efficiency, warehousing and inventory management (Alfaro & Rábade, 2009), achieve lower-cost distribution systems, reduce recall expenses and increase sales of products with attributes that are difficult to discern (Golan et al., 2004). There are several driving forces behind food traceability that can be outlined: regulatory, safety and quality, social, economic and technological (Bosona and Gebresenbet, 2013).

Standards and Regulations

New legislation demands often act as an essential driver for food companies to implement food traceability systems. Many governments put forward food traceability requirements due to political pressure to ensure food safety and avoid food contamination incidents. Many food

companies implement food traceability systems to fulfil regulatory requirements and stay in the market (Bosona & Gebresenbet, 2013). The European Union and the United States are two principal players leading legislative efforts regarding food traceability (Aung & Chang, 2014). Some of the legislation examples of regulatory requirements include the General Food Law (GFL) in the European Union (European, 2002), and the Food Safety Modernization Act (FSMA) in the United States (FDA, 2011). On the other hand, many countries lack specific legislation on food traceability. Charlebois, Sterling, Haratifar, and Naing (2014) reviewed food traceability regulations and requirements of 21 countries and in their report stated that many countries lack specific legislation on food traceability. The authors argue that the global market would benefit if countries moved toward the development of an interoperable and uniform global traceability system. Aung and Chang (2014) also say that to achieve successful traceability it must be built on global standards and highlight the importance of the organizations that develop and publish such standards, such as the International Organization for Standardization (ISO) or the Food and Codex Alimentarius Commission (CAC). To improve recalls through product traceability, authorities like the Food and Drug Administration (FDA) are considering modern technological solutions such as blockchain (FDA, 2019).

Safety and Quality

Food safety and quality are essential aspects within the food industry which are gaining increasing attention due to various food contamination incidents. Food traceability has become important not only due to possible foodborne diseases but also due to food counterfeiting and the issue of sustainable production including labour issues (Bosona & Gebresenbet, 2013). As food safety hazards can occur at any point in a supply chain, food responsibility is shared by producers, processors, distributors, retailers, and consumers (Aung & Chang, 2014). Food safety and quality motivate companies to enhance their traceability capabilities as it is considered an important instrument to reduce the volume of product recalls (V. Kher et al., 2010). The consumers perceive traceability as a guarantee for high-quality and safe products. Thus companies investing in the development of traceability systems may improve quality of their products, have easier access to premium markets and possibly an increase in consumers willing to pay a higher price for traceable products (Germain, 2003). On the other hand, Resende-Filho and Hurley (2012) argue that traceability does not directly impact production systems to improve food safety and is merely a tool to accumulate information about product attributes and processes through the supply chain. While other systems like Pathogen Reduction (PR) and Hazard Analysis and Critical Control Point (HACCP) systems impact food safety more directly, the information generated by traceability systems could facilitate contractual agreements between firms in the supply chain to promote food safety (Resende-Filho & Hurley, 2012). Due to a short life cycle of food products, logistics operations play a critical role in agribusiness. Many food products degrade while on the move, therefore continuous product monitoring and traceability throughout the supply chain are essential to ensure food quality and safety (Mangina & Vlachos, 2005).

Social

The growing confidence of consumers in their food, increasing awareness of society about their health, increasing income and changing lifestyles are some of the social issues that motivate food companies to implement traceability systems (Bosona & Gebresenbet, 2013). While companies are interested in preserving a good image, the leading influencers that move forward food traceability systems are retailers (Heyder, Theuvsen, & Hollmann-Hespos, 2012). However, the authors note that retailers have made high investments into their private labels and therefore need protection against loss of consumer confidence due to food crises. It is worth pointing out that the social aspect may also have an adverse effect on companies' efforts in

differentiating themselves through traceability. Golan et al. (2004) argue that being more easily linked to food product safety problems and potential bad publicity can give enough incentive for a company to remain anonymous even if it has an excellent safety record. Furthermore, the risk of possible deceptions makes consumers doubt the veracity of claims made by producers, which reduces benefit versus cost even further (Golan et al., 2004). Other social implications that motivate the development of food traceability systems are closely related to safety and quality. According to the World Health Organization (WHO), globalization has increased consumer demand for a wider variety of foods, resulting in an increasingly complex and longer global food chain which can make local incidents become international emergencies rather quickly (WHO, 2017). The WHO estimates 600 million – almost 1 in 10 people in the world – fall ill after eating contaminated food and 420 000 die every year (WHO, 2017). The organization states that consumers should know the food they use (this includes reading labels on food packaging, making an informed choice, familiarizing themselves with common food hazards). A heightened public awareness of food safety issues can lead many producers to adopt increasingly precise traceability systems (Golan et al., 2004).

Economic

While a firm's traceability system can help minimize potential damages for the individual company, Golan et al. (2004) argue that the industry as a whole could have much better benefits. An implemented food traceability system can provide a possibility to pinpoint the source of bad product and minimize recall and bad publicity which could hurt sales for many companies in the industry. The food contamination impact to the industry can be illustrated by an earlier stated strawberry contamination incident which resulted in a lot of wasted food and government intervention to support farmers (Luthria K., 2018). Scharff (2015) estimates that the average national cost of foodborne illness was \$55.5 billion per year in the United States alone. Food contamination incidents can cause companies hefty legal fees, lawsuits and result in diminished sales. There have been incidents resulting in a company's bankruptcy (Beach C., 2017) or factory suspensions (FDA, 2017). Some manufacturers have significant financial incentives to adopt a more precise traceability system to be able to reduce the size of the standard recall lot (Golan et al., 2004).

Technological

Technological development is an important factor which pushes a new generation of traceability applications (Salampasis et al., 2012). To implement effective traceability systems requires more sophisticated devices and systems which are prone to high costs and therefore do not attract the attention of food companies (Bosona & Gebresenbet, 2013). However, more effective and cheaper food traceability technologies are emerging, which enable the integration of traceability data within different levels of the supply chain (Bosona & Gebresenbet, 2013). Overall, Information Technology (IT) plays an important role that enhances the effectiveness of record keeping and data access (Chrysochou et al., 2009) which is an essential part of traceability (Olsen and Borit, 2013).

2.1.3 Food Traceability Systems

The food traceability system (FTS) is how business operators ensure to meet food traceability needs. One of the key characteristics of a traceability system is that it is critically reliant on the recording of information, thus robust mechanisms are needed to facilitate the collection and authentication of such information (Food Standards, 2002). While there still may be older paper-based traceability schemes in use, most current traceability systems are IT based

(Salampasis et al., 2012). These IT systems are usually proprietary, developed by businesses as a response to various food traceability demands originating from large retailers or government legislation (Salampasis et al., 2012). Due to a variety of such systems and proprietary nature, it makes integration difficult. Furthermore, due to insufficient representation of legal requirements, such traceability systems are not adequately equipped for tracing products through the chain and are more intended for system certification rather than incident prevention and real food safety improvement (Bechini, Cimino, Lazzerini, Marcelloni, & Tomasi, 2005). Bosona and Gebresenbet (2013) outline many technological innovations applied for product traceability purposes:

- Product identification (e.g. barcodes, RFID tags, electronic identification (EDI) tags)
- Quality and safety measurement (e.g., nanotechnology-based devices, smart packaging devices)
- Genetic analysis (e.g., DNA tests)
- Environmental monitoring (e.g., temperature, freshness, gas indicators)
- Geospatial data capturing (e.g., GPS, Nuclear techniques)
- Data exchange (e.g., EDI, EXL)
- Software (e.g., QualTrace, enterprise quality management (EQM), Food Trak)

While such technological developments have drastically changed and shaped the way we trace information for various domains, the use of product identification has been a major input for tracking food. Therefore, to meet the purpose of this thesis, we highlight RFID technology applications within the food industry in more detail as there is a great potential to use blockchain technologies for intermediary service provisioning in combination with transmission technologies such as RFID (Risius & Spohrer, 2017).

Product Identification - RFID

There are many technological solutions to use for product identification; however radio frequency identification (RFID) is found as one of the most cutting edge technologies for supply chain integrity and traceability (Aung & Chang, 2014). RFID is a significant technological improvement towards traceability with the potential to become one of the most pervasive computing technologies in history, with high potential to be a replacement for bar codes (Roberts, 2006). According to Wang and Li (2006), the reliability and effectiveness of the food traceability system rely on the degree of accuracy and efficiency of the food identification and authentication techniques. The authors state that RFID technology improves the accuracy and reliability of data collection for product identification compared to other existing methods. In a more recent study, Costa et al. (2013) provide an overview of RFID adoption for food supply chain traceability. In one example, the authors outline how RFID enables horticultural producers and marketers to withdraw their traded goods in case of a sanitary crisis efficiently. Furthermore, RFID technology can also be significantly utilized when monitoring processing and storage temperatures. Overall, there is a widening adoption of RFID technology used for traceability of food products, and it is used within different stages of the supply chain - from production, through distribution and retail (Costa et al., 2013). Despite many advantages, there are some social, economic and technical limitations of RFID technology. There are few applications for information tracking systems and few possibilities to utilize cloud computing and upload data into web applications (Costa et al., 2013). Also, there are privacy, ethical and security concerns (Roberts, 2006) (Chrysochou et al., 2009) and RFID is considered to have too high cost to be applicable for low margin products (Chrysochou et al., 2009).

2.2 Blockchain

Now we come to the core technology that this thesis will present and then discuss its enormous potentials for food traceability within supply chains. Blockchain was first mentioned in a paper that introduced the cryptocurrency Bitcoin (Nakamoto, 2008), which is the world's first decentralized digital currency based on cryptography using a peer-to-peer network (Brito & Castillo, 2013). The blockchain technology has the potential to be the next disruptive technology and worldwide computing paradigm (Swan, 2015). According to the World Economic Forum, 10% of the world's GDP (currently about 100 trillion USD) may be on the blockchain by 2025 (Dhaou, S. B., Zalan, T. & Toufaily, E. 2017). However, the terminology of blockchain and bitcoin may be confusing as both words have been used to refer to the blockchain technology in several academic research papers, when instead they should have used the term blockchain to refer to the protocol and client through which transactions are effected and not only the actual cryptocurrency (Swan, 2015). Nevertheless, blockchain technology is applicable to many other uses besides cryptocurrency (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016; Beck et al., 2017; Beck et al., 2018) and an increasing number of enterprises are exploring blockchain technologies to capture significant business value (Lacity, 2018) in several business markets (Tapscott, D., & Tapscott, A., 2016). While blockchain is nowadays mostly seen as the technology enabling cryptocurrencies such as Bitcoin and Ethereum, it will most likely become an even more valuable enabler of social and economic transactions, for instance as a general purpose digital asset ownership record (Lindman, Tuunainen & Rossi, 2017) This is because the distributed data transaction and cryptographic logic that resides at the blockchain's core make it extraordinarily tamper-resistant (Beck, Avital, Rossi, & Thatcher, 2017).

2.2.1 Blockchain Definition

The blockchain technology and its technical specification were first outlined by Nakamoto (2008); however, no established definition is generally accepted (Seebacher & Schüritz, 2017). Based on peer-reviewed literature, Seebacher and Schüritz (2017) propose the following definition for a blockchain:

"A blockchain is a distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding time stamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it can not be altered, turning a blockchain into an immutable record of past activity." (Seebacher & Schüritz, 2017).

Beck et al. (2017) propose a slightly similar definition for a Blockchain:

"The blockchain is a distributed ledger technology in the form of a distributed transactional database, secured by cryptography, and governed by a consensus mechanism. A blockchain is essentially a record of digital events." (Beck, Avital, Rossi, & Thatcher, 2017)

This is complemented by Buterin (2014):

"However, it is not "just a record", since it can also contain so-called smart contracts, which are programs stored on the blockchain that run as implemented without any risk of downtime, censorship, or fraud." (Buterin, 2014)

In this study, all these definitions are considered.

Numerous principles and characteristics can outline the blockchain technology itself. Iansiti and Lakhani (2017) outline five basic principles underlying how the blockchain technology works: (i) distributed database, (ii) peer-to-peer transmission, (iii) transparency with pseudonymity, (iv) irreversibility of records and (v) computational logic. Zheng et al. (2017) outline decentralization, persistency, anonymity, and auditability as key characteristics of the blockchain. Seebacher and Schüritz (2017) summarize multiple characteristics of blockchain technology and outline trust and decentralization as two key characteristics.

This study will use characteristics and their key elements provided by Seebacher and Schüritz (2017), Beck et al. (2017) and Buterin (2015) as a baseline and add information from other sources to complement the theory framework for blockchain.

2.2.2 Blockchain Technical Structure

The blockchain is a distributed ledger, of which all transactions are stored in a chain of blocks. The chain can be described as a chronological chain of blocks (hence the name "block-chain"). Each block refers to a set of transactions that are linked together and added to a chain. Every time a new transaction is confirmed, the chain continuously grows (Xiang et al. 2017).

Navroop et al. (2018) define a distributed ledger as a type of database that is spread across geographical locations or regions. The Distributed Ledger Technology (abbreviated DLT) includes primarily blockchain technology. Although the DLT existed before Bitcoin, the definition of blockchain that originated with Bitcoin stands out for the convergence of a lot of technologies including timing of transactions, peer-to-peer (P2P) networks, encryption and shared computing power together with new consensus algorithms (Navroop et al, 2018). Navroop et al. (2018) believes that distributed ledgers generally consist of three components: (i) a database that archives the current state of a ledger; (ii) a language for transactions in order to change the ledger state and (iii) a protocol used to create consensus among participants over which transactions will be accepted and in what order.

Blockchain technology has a few key differences from common relational databases. For once, blockchain possesses an append-only data structure where new entries are added at the end of the database. In a relational database, data can be easily changed or deleted. The differences between centralized databases and blockchain can be seen in Figure 2.

CENTRALIZED DATABASES VS. BLOCKCHAIN

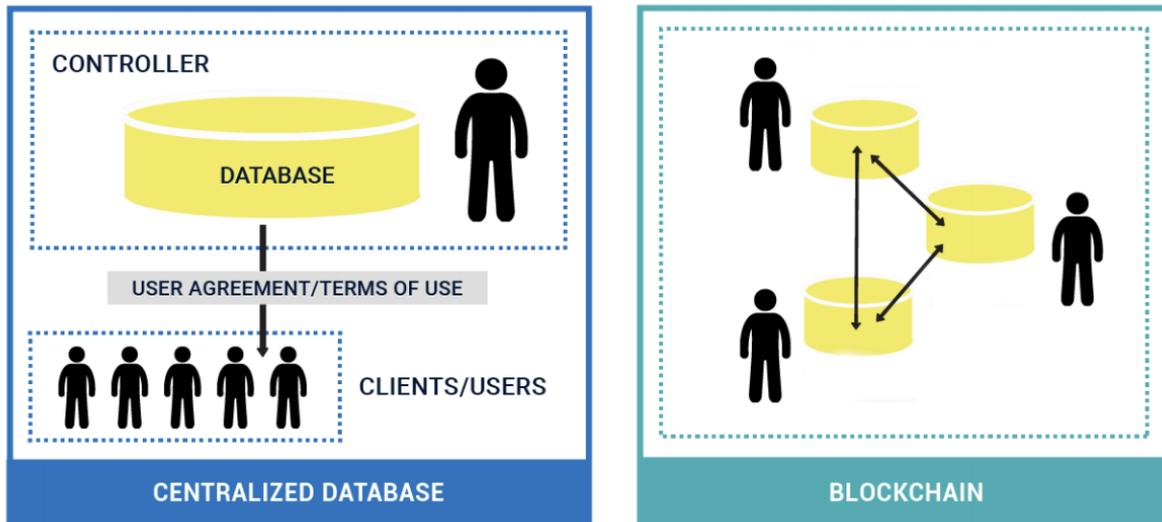


Figure 2. A comparison between the default centralized database architecture and the Blockchain P2P distributed architecture (Navroop et al., 2018)

In addition, usually blockchains are designed for decentralized applications, while relational databases were generally originally designed for centralized applications, of which an individual unit controls all data (Navroop et al. 2018). The difference between distributed, centralized and decentralized systems can be seen in Figure 3.

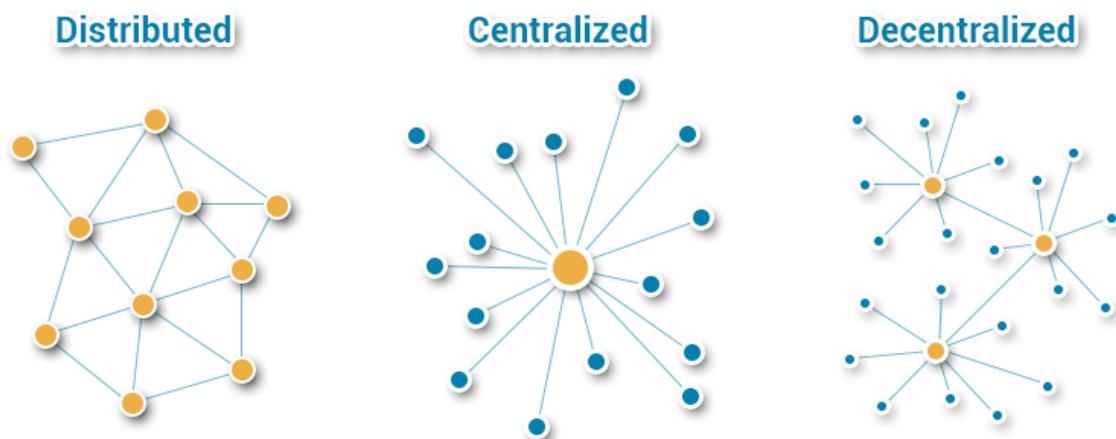


Figure 3. A visual explanation about the differences between distributed, centralized and decentralized systems (482 Solutions., 2018)

2.2.3 Blockchain Types

Blockchain can be generalized into two types: private and public (Sharples & Domingue, 2016). In public blockchains, anyone can access and potentially add to new blocks while private blockchains have restricted access and are usually used within an organization or consortium. Buterin (2015) considers three categories of blockchain systems: (i) public blockchain, (ii) consortium blockchain, and (iii) private blockchain. Zheng, Xie, Dai, Chen, and Wang (2017) present the comparison among the three types of blockchain in Table 1.

Table 1. Comparisons among public blockchain, consortium blockchain and private blockchain (Zheng et al., 2017)

Property	Public blockchain	Consortium blockchain	Private blockchain
Consensus determination	All miners	Selected set of nodes	One organization
Read permission	Public	Could be public or restricted	Could be public or restricted
Immutability	Nearly impossible to tamper	Could be tampered	Could be tampered
Efficiency	Low	High	High
Centralized	No	Partial	Yes
Consensus process	Permissionless	Permissioned	Permissioned

Public Blockchain

As the name suggests, these blockchains are open to the public and anyone can participate as a node in the decision-making process (Bashir, 2017). Users may or may not be rewarded for their participation, and usually these networks offer economic incentives for those who secure them and utilize some type of Proof of Stake or Proof of Work algorithm to validate these participations (Cachin et al., 2017). These ledgers are publicly open for anyone to participate in and are not owned by anyone. All users maintain a copy of the ledger on their local nodes and use a distributed consensus mechanism in order to reach a decision about the acceptance of transactions and the eventual state of the ledger. These blockchains are also known as permission-less ledgers (Bashir, 2017). An explanation chart about a public blockchain can be seen in Figure 4.

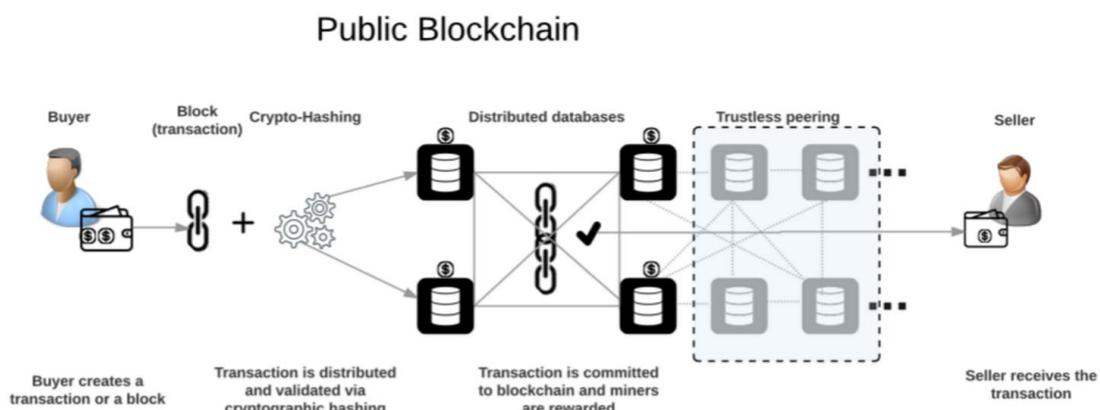


Figure 4. Public blockchain behaviour (482 Solutions., 2018)

Private Blockchain

Private blockchains as the name implies are private and only open to a consortium or group of individuals or organizations that have decided to share the ledger among themselves (Bashir, 2017). A new member cannot join this blockchain unless they are invited by the network administrators. Participant and validator access is restricted. This type of blockchain can be considered a midpoint for companies that are interested in the blockchain technology but are not comfortable with the level of control offered by public blockchains. Typically, they seek to incorporate blockchain into their accounting and record-keeping procedures without sacrificing autonomy and running the risk of exposing sensitive data to the public (Tapscott et al., 2016). An explanation chart about a private blockchain can be seen in Figure 5.

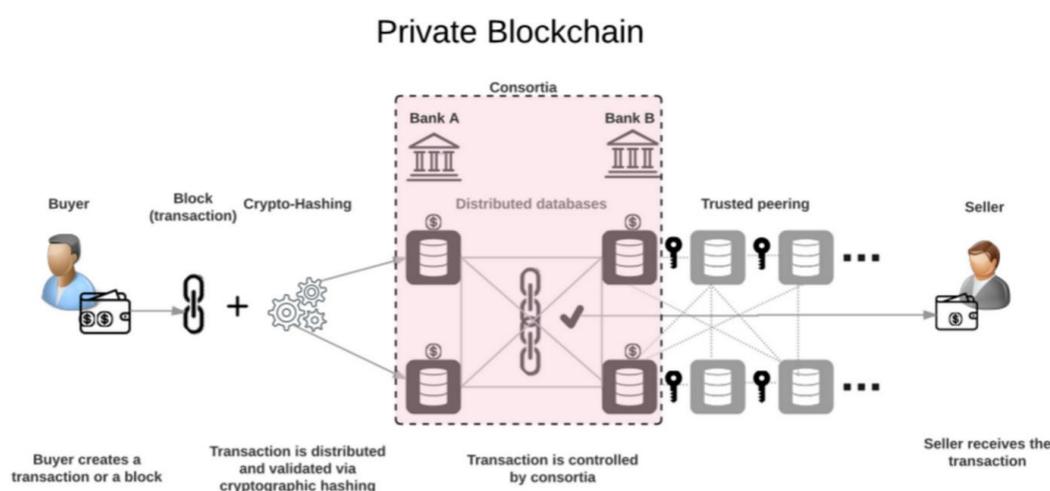


Figure 5. Private blockchain behaviour (482 Solutions., 2018)

Consortium Blockchain

A consortium blockchain is a semi-decentralized blockchain, meaning that it is permissioned but instead of a single organization controlling it, a number of companies might each operate a node on this network. The administrators of a consortium chain restrict the reading rights of users as they see fit and only allow a limited set of trusted nodes to execute a consensus protocol (Bashir, 2017).

Hybrid Blockchain

A hybrid blockchain is a combination of different characteristics that both public and private blockchains have by design. It allows to determine which information stays private and which information is made public. The private part is controlled by a group of individuals whereas the public part is open for participation by anyone (Bashir, 2017). It is possible to achieve decentralization in relation to primarily centralized private blockchains in various ways. Instead of keeping transactions inside their own network of community-run or private nodes, the hash (with or without payload) can be posted on completely decentralized blockchains such as the bitcoin blockchain (Foley, 2018).

There are different needs for every type of blockchain explained. They are highlighted in Figure 6.

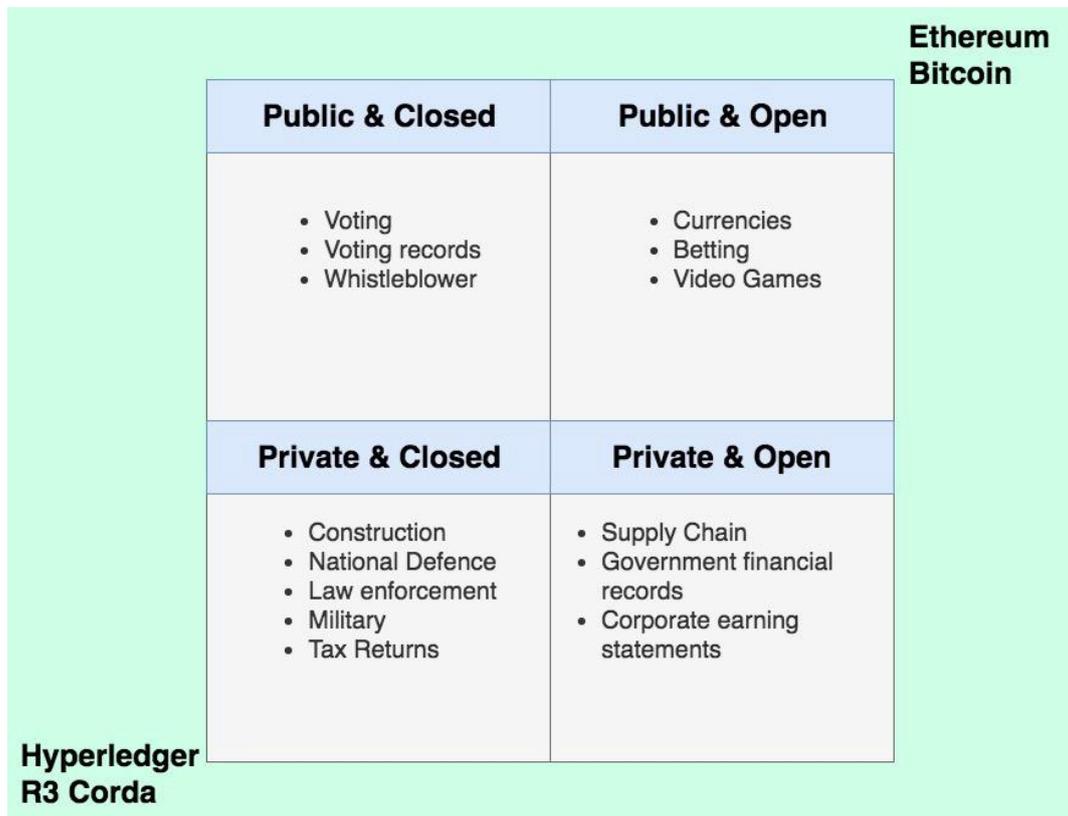


Figure 6. Different Blockchain Uses (Massessi, 2018)

2.2.4 Blockchain Characteristics

Based on a literature review, Seebacher and Schüritz (2017) highlight trust and decentralization as key characteristics that underlie blockchain technology. Transparency, the integrity of data and immutability are key underlying elements for trust, while privacy, reliability, and versatility are key underlying elements for decentralization. (Figure 7).

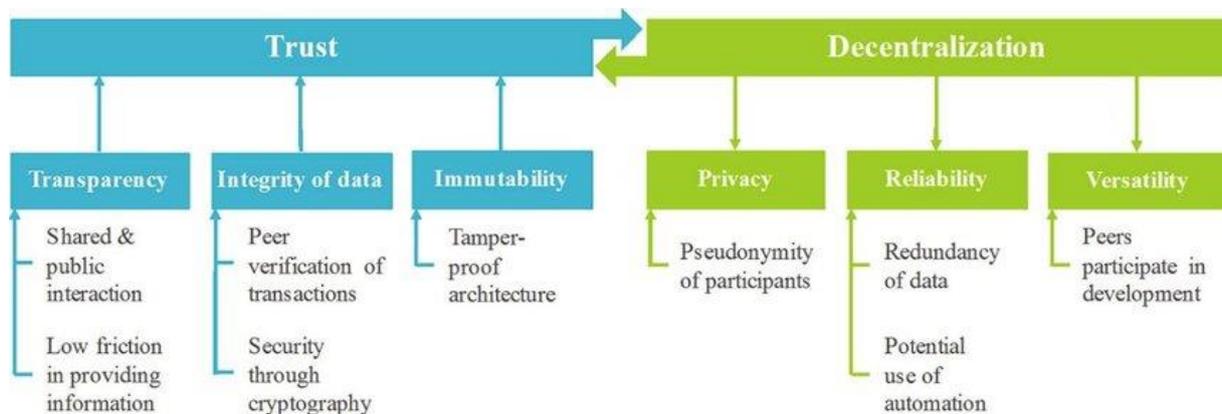


Figure 7. Characteristics of Blockchain Technology (Seebacher & Schüritz, 2017)

Transparency

Blockchain is sometimes referred to as a decentralized, transparent ledger with transaction records, monitored by everyone, and owned and controlled by no one (Swan, 2015). The transparent nature of blockchain comes from the possibility for anyone with access to the system to read every transaction and its associated value (Seebacher & Schüritz, 2017; Iansiti & Lakhani, 2017) and publicly verify the state of the ledger (Wüst & Gervais, 2018).

Integrity of Data

By utilizing blockchain technology, users are able to interact directly with each other as there is no single intermediary who controls the system (Seebacher & Schüritz, 2017) and thus there is little risk of data tampering. The integrity of data is achieved by storing it within the database itself and securing interaction with public-key cryptography (Seebacher & Schüritz, 2017). The ability for every user to verify broadcasted transactions further enhances the integrity of data. If public verifiability is not possible, the integrity of data can only be ensured if the centralized system is not compromised (Wüst & Gervais, 2018). Furthermore, users within public blockchains that use open source protocols can be sure that actions described on the protocol are executed correctly as written in the code without the need for human intervention (Abeyratne & Monfared, 2016).

Immutability

Bashir (2017) states that records once added in a blockchain are immutable. There is the possibility of rolling back the changes but this is considered almost impossible to do as it will require an unaffordable amount of computing resources (Bashir, 2017).

Privacy

There is a possibility of pseudonymity within the blockchain as each node or user on a blockchain has a unique alphanumeric address to mask real identities (Iansiti & Lakhani, 2017; Seebacher & Schüritz, 2017). Users can remain anonymous or choose to identify themselves. However, there is always a trade-off between privacy and transparency. According to Wüst and Gervais (2018), privacy in a public system can be achieved using cryptographic techniques, which may come at the cost of efficiency. There can be potentially harmful consequences if sensitive information is stored online in a decentralized manner and secret key is stolen, intentionally or unintentionally exposed (Swan, 2015; Beck et al., 2018). Beck et al. (2017) argue that blockchain technology may lead to unintended consequences and limit freedom if every event is recorded and cannot be amended or purged.

Reliability

Reliability within the system is established through redundancy of data as information on transactions is shared and stored within the network, and automation which reduces individual mistakes due to little need for manual intervention (Seebacher & Schüritz, 2017). The primary way how blockchain technology ensures data reliability and security is through the use of the system's consensus mechanisms (Swan, 2015), which makes attacks highly unlikely due to the tremendous computational power required (Conoscenti, Vetro, & De Martin, 2016).

Versatility

As blockchain technology moved beyond Bitcoin, it became much more versatile as participants can create and integrate their programs into the blockchain (Seebacher & Schüritz,

2017). Swan (2015) outlines the evolution of blockchain from Blockchain 1.0 which is dedicated to cryptocurrency, Blockchain 2.0 which makes smart contracts possible and Blockchain 3.0 for applications that go beyond currency and market transactions. Smart contracts can enable a new “blockchain economy” where transactions can be autonomously enforced (Beck et al., 2018).

2.2.5 Blockchain Challenges and Limitations

Blockchain technology has its drawbacks. Several challenges and limitations can be barriers to further blockchain technology adoption:

Throughput and Latency

According to Swan (2015), limitation of throughput is often brought up when discussing the Bitcoin network, which is maximized to 7 transactions per second (tps). Low throughput is especially evident when compared to other transaction processing networks such as Visa (2,000 tps) or Twitter (5,000 tps). Bitcoin scalability issues are often cited for showcasing throughput limitations of the blockchain (Conoscenti et al., 2016). However, the Bitcoin network is based on a public permissionless blockchain and is only one of currently many blockchain platforms available. Ethereum, which is one of the most popular public permissionless blockchain platforms and second according to cryptocurrency market size (Coinmarketcap, 2019) has 15 tps and is expected to change to a proof-of-stake model in the future which should greatly improve scalability (Buterin, 2014). Furthermore, permissioned blockchain platforms such as Hyperledger Fabric can have more than 3,500 transactions per second (Androulaki et al., 2018). Swan (2015) highlights Bitcoin’s 10-minute waiting time for transactions to be confirmed which is much longer when compared to just a few seconds in the VISA network. More time has to be spent on a block to achieve sufficient security and avoid double-spending (in which Bitcoins are double-spent in a separate transaction before the merchant can confirm their reception in what appears to be the intended transaction) (Swan, 2015). It is expected for a centralized system to have much better latency and throughput and certain scalability and speed trade-offs arise in decentralization (Wüst & Gervais, 2018).

Awareness and Understanding

One of the key challenges associated with blockchain technology is a lack of awareness of the technology and how it works, especially outside the banking sector (Grewal-Carr & Marshall, 2016). Enterprises face management challenges as blockchain applications must align within complex institutional, regulatory, social, economic and physical systems (Lacity, 2018). A survey performed by Lacity (2018) states that only 10% of respondents deployed at least one blockchain application despite more than half “actively considering” blockchain technologies. Furthermore, blockchain has become a buzzword and anything related to blockchain may result in irrational behaviour. In one example, a company managed to increase its stock price by 500% just by including the word “blockchain” in its name (Megaw N., 2017).

Organization

Only organizations working together to solve shared problems and opportunities can get the most value from the blockchain. However, often the reality is that a lot of organizations are developing their own blockchain solutions and create their own different standards which counteracts the purpose of a distributed ledger and fails to harness network effects (Grewal-Carr & Marshall, 2016). To achieve its full potential, a successful consortium depends on collaboration between different stakeholders that want to adopt the technology. The Corda

blockchain platform is an example of such a collaboration between banks (Warren N. & Leslie M. N., 2018).

Culture

Blockchain technology requires a mind-set shift from the traditional thinking of trusting a central institution to placing trust in a decentralized network (Grewal-Carr & Marshall, 2016). The world is changing where the trust is delegated at the object level and is governed by other objects rather than central authority (Tapscott & Tapscott, 2016). Such a paradigm shift will require businesses to take a more creative approach to identify opportunities (Grewal-Carr & Marshall, 2016). According to Mori (2016), technology is attributed to only 20 percent of barriers to adoption while the other 80 percent is attributed to business processes and business models.

Cost and Efficiency

Public permissionless blockchain implementations such as Bitcoin and Ethereum require high amounts of energy to validate transactions (Risius & Spohrer, 2017). While permissioned blockchain implementations may be more energy efficient it can be difficult to identify the main cost drivers in blockchain implementation and how the cost and processing load will be shared among participating organizations (Grewal-Carr & Marshall, 2016). While initial costs of blockchain adoption may be low, it can quickly run into scalability problems as the number of transactions grows (Bloomberg J., 2018). Even private blockchains such as Hyperledger struggle solving scalability challenges, therefore many enterprise blockchain initiatives do not leave a proof of concept phase (Bloomberg J., 2018).

Regulation and Governance

As Bitcoin cryptocurrency grew and became a multibillion-dollar global market, it attracted the attention of national governments and financial institutions (Crosby, Pattanayak, Verma, & Kalyanaraman, 2016). Government regulation is one of the most influential factors for the development of blockchain technology in the financial industry (Swan, 2015); however, the technology itself is non-controversial and had numerous successful financial and non-financial applications (Crosby et al., 2016). Regulatory structures struggle to keep up with the technological advancements; however, there is significant potential for governments and third-party regulators to adopt blockchain technology and accept information contained within as reliable and authentic (Tian, 2016; Grewal-Carr & Marshall, 2016). Swan (2015) raises questions if smart contracts should incorporate a legal framework as a feature and if a new body of law and regulations are needed to govern technically binding code contracts. While it is uncertain how regulators will respond to blockchain technology, some companies are designing blockchain solutions to comply with existing regulations and some lobby to change regulations (Lacity, 2018).

3 Designing a Theoretical Framework

In this chapter, decision theory and diffusion of innovation theory will be presented. These theories, combined with the technical literature review of blockchain technology and of food traceability within the supply chain, were used as a base model to build an evaluation framework for the adoption of blockchain technology in food traceability.

3.1 Decision Theory

Decision theory is the mathematical study of strategies for optimal decision-making between options involving different risks or expectations of gain or loss depending on the outcome (Hansson, 1994). Decision theory can also go beyond the mathematical definition, being a truly interdisciplinary subject that is typically pursued by researchers who identify themselves as economists, statisticians, psychologists, political and social scientists or philosophers (Hansson, 1994). This study uses decision theory as a basis, since it is aimed to help entities decide if blockchain is the right choice for their requirements related to traceability inside the food industry.

Decision theory is divided into two different theories: *Normative* and *descriptive* decision theory. The distinction between normative and descriptive decision theories is that a normative decision theory is a theory about how decisions should be made, and a descriptive theory is a theory about how decisions are actually made (Hansson, 1994). The distinction between normative and descriptive interpretations of decision theories is often blurred, and it is not uncommon to find examples of disturbing ambiguities and even confusions between normative and descriptive interpretations of one and the same theory in decision-theoretical literature (Hansson, 1994). This study combines both these facets, using how decisions are actually made as an input to create a framework that helps to gather data and analyse how decisions should be made in an uncertain field.

3.2 Diffusion of Innovation Theory

This thesis relies on the diffusion of innovations theory (DOI) to explain at what rate new ideas and technology spread in a social system and at what speed adoption happens (Rogers, 2010). Since blockchain is a relatively new technology, and its adoption in the food industry is still in an early stage, this theory seems extremely relevant for this study.

Rogers (2010) outlines four key elements of the diffusion of innovations: innovation, communication channels, time, and the social system. Key elements impacting diffusion of innovation, the innovation-decision process and attributes of innovations are used for later analysis in this study.

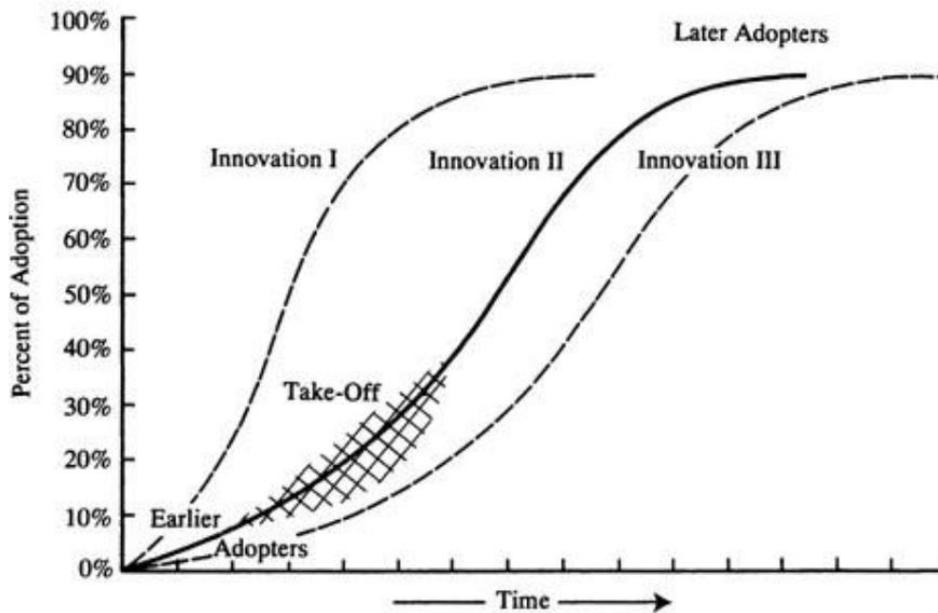


Figure 8. The Diffusion Process (Rogers, 2010)

3.2.1 Key Elements of the Diffusion of Innovations

Innovation

Rogers (2010, p. 12) define innovation as: “an idea, practice, or object that is perceived as new by an individual or other unit of adoption”. It does not matter if an idea is new objectively as it depends how the individual perceives it. If an idea seems new to the individual, it is an innovation. Individuals when facing technological innovation have uncertainty about the potential consequences which are reduced after information-seeking activities. Once potential adopters learn more about the innovation, the uncertainty is reduced and the decision to adopt or reject the innovation can be made.

Communication channels

A communication that has content concerning a new idea can be considered a diffusion process (Rogers, 2010). This communication of information exchange regarding innovation happens through channels between the source and receiver. Mass media and interpersonal communication are the two communication channels. Mass media is aimed towards efficient information spreading while interpersonal communication channels are better in convincing individuals to accept a new idea. Rogers (2010) states that most people evaluate innovation based of subjective feedback from other individuals that have adopted innovation rather than scientific studies.

Time

Time is the third element in the diffusion process (Rogers, 2010). The time dimension is a part of the innovation-decision process, innovativeness and adopter categorization and rate of adoption. The innovation-decision process is the process from when an individual receives knowledge about innovation to acceptance or rejection of the innovation. Rogers (2010) argues that when describing a degree of individual innovativeness, it is more efficient to categorize the adopter. The rate of adoption in the diffusion of innovations describes how quickly innovation

is adopted. It is usually represented as an S-shaped curve (Figure 8) and can be different from innovation to innovation.

Social system

According to Rogers (2010), a social system is defined as “a set of interrelated units that are engaged in joint problem solving to accomplish a common goal”. The members or units of a social system can be individuals, groups or organizations who share a common goal that binds them together. Diffusion of innovation occurs within a social system and is influenced by the system’s structure which can be formal and informal. The nature of a social system has an impact on individual innovativeness.

3.2.2 The Innovation-Decision Process

Rogers (2010) define the innovation-decision process as “an information-seeking and information-processing activity in which an individual is motivated to reduce uncertainty about the advantages and disadvantages of the innovation” (p. 172). During this process an individual or a system makes a series of choices and actions to evaluate new ideas and decide if the innovation should be incorporated into practice. Rogers (2010) present a model of the innovation decision process which consists of five stages:

Knowledge

The first step of the innovation-decision process is the knowledge stage which begins when an individual is exposed to an innovation and gains an understanding of how it works. In this stage an individual seeks information about the innovation and attempts to answer questions about “what the innovation is and how and why it works” (Rogers, 2010). However, active knowledge seeking only occurs if the individual feels the need for the innovation, as exposure and awareness of an innovation alone will have little effect.

Persuasion

The persuasion step occurs once the individual has formed a favourable or unfavourable attitude toward the innovation (Rogers, 2010). During this stage a general perception of an innovation is developed and to make a decision whether to adopt or reject the new idea, an individual may mentally apply it to his present or future situation. During this stage advantage, compatibility and complexity of an innovation are important perceived attributes. Typically, in this stage an individual want to be able to answer the question “What are the innovation’s advantages and disadvantages in my situation?” (Rogers, 2010).

Decision

In the decision stage an individual makes a choice to adopt or reject an innovation (Rogers, 2010). In case of adoption, making use of an innovation is deemed as the best course of action while rejection is the decision not to adopt an innovation. Rogers (2010) argues that most individuals do not fully adopt an innovation without first trying it on a probationary basis which helps to determine applicability of an innovation in their own specific situation. The partial implementation of an innovation on a small scale is an important step before taking a final decision on full adoption. If an innovation cannot be divided for trial it increases the chance of rejection. A rejection after doing a trial run is identified by Rogers (2010) as *active rejection*, while rejection without considering the use of the innovation is referred to as *passive rejection*.

Implementation

The implementation stage happens when an individual puts an innovation to use (Rogers, 2010). At this stage an idea is actually put into practice, but there is still a certain degree of uncertainty about expected consequences. At this stage an active information seeking takes place where the individual tries to answer questions on where to obtain the innovation, how to use it and what potential problems can occur and how to solve them. Problems on an organizational level are more serious compared to the level of an individual adopter as they usually involve more people, and decision makers and implementers are often different people. Depending on the innovation, this stage can last a long time until eventually the new idea becomes a regular part of the adopter's ongoing operations, which can be considered the final step of the innovation-decision process (Rogers, 2010). Rogers (2010) also outline a concept of re-invention which often happens in the implementation stage as users modify or change an innovation in the process of adoption and implementation.

Confirmation

During the confirmation stage the individual seeks reinforcement of the decision made to adopt the innovation (Rogers, 2010). The decision to use the innovation can be reversed if exposed to conflicting messages about the innovation. In this stage the individual seeks to avoid or reduce a state of dissonance. The confirmation stage is resolved either through a later adoption or discontinuance (a rejection of an innovation after adopting it). According to Rogers (2010) there are two types of discontinuance: (i) replacement discontinuance, which can occur if an individual decides to reject an idea in order to adopt a better alternative and (ii) disenchantment discontinuance when a decision to reject an idea is made due to dissatisfaction with its performance.

3.2.3 Five Perceived Attributes of Innovations

Based on past research, Rogers (2010) generalizes five different attributes of innovations that extensively contribute to an innovation's rate of adoption.

Relative advantage

Relative advantage is defined as the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 2010). Relative advantage may be one of the strongest drivers for an innovation's adoption. Sub dimensions of relative advantage include economic profitability, low initial cost, a decrease in discomfort, social prestige, a saving time and effort, and immediacy of reward (Rogers, 2010).

Compatibility

Compatibility is defined as the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters (Rogers, 2010). Three areas of compatibility that can positively or negatively contribute to the adoption of innovation are: (i) sociocultural values and beliefs, (ii) previously introduced ideas, (iii) client needs for the innovation.

Complexity

Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use (Rogers, 2010). Rogers (2010) argues that complexity of an innovation is negatively related to its rate of adoption.

Trialability

Rogers (2010) defines trialability as the degree to which an innovation may be experimented with on a limited basis, which if high can positively contribute to the adoption of the innovation.

Observability

Observability is the degree to which the results of an innovation are visible to others (Rogers, 2010). The visibility of an innovation between members of a social system can positively impact its rate of adoption.

3.2.4 Technology, organization, and environment framework

As blockchain technology can only properly work in a network environment with multiple stakeholders participating, the Technology, Organization and Environment (TOE) framework can be more relevant when explaining intra-firm innovation adoption (Oliveira & Martins, 2011). The TOE framework includes the environmental context in which a company operates and can describe industry, competitors and dealings with the government (Oliveira & Martins, 2011; Tornatzky and Fleischer 1990). TOE was also used as a basis for the creation of our framework.

3.3 Blockchain for Food Traceability - a Theoretical Framework

Decision making theory is essential for an understanding of how decisions are made on what technology comes next to improve a certain industry (Hansson, 1994). In this study we paired decision making theory with the diffusions of innovations theory to guide our understanding of the innovation adoption process and the key factors that influence the adoption of innovation (Rogers, 2010). These theories combined with a literature review influenced our intention to design a theoretical framework to better understand how blockchain technology is viewed from a food industry perspective, in innovating food traceability within their supply chain management. As we have shown earlier, the food industry has yet to see how blockchain technology might influence their supply chain processes, in particular when traceability becomes crucial.

The framework aims to identify the relevancy of blockchain technology characteristics for the food traceability drivers found in the literature review and evaluate the impact of the challenges of adoption of the blockchain technology in a specific context. We suggest that the drivers behind food traceability can be translated as needs and improvement focus areas for organizations. Different aspects of blockchain technology have a potential to impact the needs on a high, medium or low level. This framework will provide an overview of potential advantages and disadvantages of blockchain technology adoption to improve food traceability within the supply chain.

Impact scale		Blockchain Technology Characteristics					
		Transparency	Integrity of Data	Immutability	Reliability	Privacy	Versatility
Drivers for Food Traceability	Standards and Regulations	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High
	Safety and Quality	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High
	Social	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High
	Economic	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High
	Technological	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High

Figure 9. Food Traceability Drivers and Blockchain Technology Characteristics

Impact scale		Blockchain Technology Challenges				
		Throughput and Latency	Awareness and Understanding	Organization	Culture	Cost and Efficiency
Impact	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High	Low Medium High

Figure 10. Blockchain Technology Challenges

3.4 Theoretical Summary of Food Traceability Drivers and Blockchain Challenges

According to our literature review discussed earlier, several studies have been considered to find which drivers are applicable to food traceability, what are blockchain characteristics and challenges. Literature summary is presented in Table 2.

Table 2. Theoretical Framework Literature Summary

Theme	Sub-theme	Supporting Literature
Food Traceability Drivers	Standards and Regulations	Bosona and Gebresenbet (2013), Aung & Chang (2014), Charlebois et al. (2014), European (2002), FDA (2011), FDA (2019).
	Safety and Quality	Aung & Chang (2014), Bosona and Gebresenbet (2013), V. Kher et al. (2010), Germain (2003), Resende-Filho and Hurley (2012), Mangina & Vlachos (2005).
	Social	Heyder et al. (2012), Bosona and Gebresenbet (2013), Golan et al. (2004), WHO (2017).
	Economic	Golan et al. (2004), Luthria K. (2018), Scharff (2015), Beach C. (2017), FDA (2017).
	Technological	Salampasis et al. (2012), Bosona and Gebresenbet (2013), Chrysochou et al. (2009), Olsen and Borit (2013).
Blockchain Characteristics	Transparency	Swan (2015), Seebacher and Schüritz (2017), Iansiti & Lakhani (2017), Wüst & Gervais (2018).
	Integrity of Data	Seebacher and Schüritz (2017), Wüst & Gervais (2018), Abeyratne & Monfared (2016).
	Immutability	Bashir (2017).
	Privacy	Iansiti & Lakhani (2017), Seebacher and Schüritz (2017), Wüst & Gervais (2018), Swan (2015), Beck et al. (2017), Beck et al. (2018).
	Reliability	Seebacher and Schüritz (2017), Swan (2015), Conoscenti et al. (2016).
	Versatility	Seebacher and Schüritz (2017), Swan (2015), Beck et al. (2018).
Blockchain Challenges	Throughput and Latency	Swan (2015), Conoscenti et al. (2016), Coinmarketcap (2019), Buterin (2014), Androulaki et al. (2018), Wüst & Gervais (2018).
	Awareness and Understanding	Grewal-Carr & Marshall (2016), Lacity (2018), Megaw N. (2017).
	Organization	Grewal-Carr & Marshall (2016), Warren N. & Leslie M. N. (2018).
	Culture	Grewal-Carr & Marshall (2016), Tapscott & Tapscott (2016), Mori (2016).
	Cost and Efficiency	Risius & Spohrer (2017), Grewal-Carr & Marshall (2016), Bloomberg J. (2018).
	Regulation and Governance	Crosby et al. (2016), Swan (2015), Tian (2016), Grewal-Carr & Marshall (2016), Lacity (2018).

3.4.1 Summarized Food Traceability Drivers

Standards and Regulations

Regulatory requirements and initiatives driven by governments regarding food traceability. Global standards to facilitate traceability in food supply chains driven by organizations such as ISO.

Safety and Quality

Keep information about product attributes and processes through the supply chain to reduce food contamination incidents, avoid food fraud and non-compliance issues.

Social

Improve confidence of consumers in their food, reduce doubt in claims made by producers and strengthen a brand.

Economic

In case of a food contamination incident, pinpoint the source of bad product and reduce potential volume of recalls, minimize bad publicity, potential damages and diminished sales on an industry level.

Technological

Improve integration of traceability data within different levels of the supply chain, enhance the effectiveness of record keeping and data access.

3.4.2 Summarized Blockchain Characteristics

Transparency

Anyone with access to the system can read every transaction and its associated value.

Integrity of Data

Little risk of data tampering. Ability to verify every transaction and its associated value.

Immutability

Records entered in a blockchain are permanent.

Privacy

A possibility of pseudonymity (hide a real identity). An option to have an increased confidentiality through encryption within private and consortium blockchains.

Reliability

Achieved through redundancy of data and little need for manual intervention.

Versatility

A possibility to create smart contracts and automate transactions for services received. Possible integrations with IoT devices and other technologies such as RFID.

3.4.3 Summarized Blockchain Challenges

Throughput & Latency

The time for a transaction to be placed and validated in a blockchain can be more than expected depending on the amount of nodes and the transaction validation method.

Awareness and Understanding

Lack of awareness of the technology and lack of understanding of how it works.

Organization

The blockchain creates most value for organisations when they work together on areas of shared pain or shared opportunity.

Culture

Moving away from the traditional way of doing things due to the adoption of a new technology that places trust and authority in a decentralised network rather than in a powerful central institution can be challenging.

Cost and Efficiency

Public permissionless blockchain implementations such as Bitcoin and Ethereum require high amounts of energy to validate transactions. Blockchain implementation also requires high amounts of storage, that can increase costs.

Regulation and Governance

Since its a relatively new technology, governments and financial institutions are seeking regulations, specially for cryptocurrencies. In the food industry, the necessity of a global consortium might also be needed to use the full advantages of blockchain.

4 Research Methodology

This chapter explains the methodology for the investigation of the research question and the motivation behind these decisions. It presents the interpretive approach applied using interviews as the qualitative data collection technique. The interview process is divided into pre-study interviews and the main study with interviews extended with a card exercise. The reasons for selecting the interviewees are also presented, followed by the data analysis methods. All this is carried out under set ethical and professional standards that ensure acceptable quality of the instruments used, methods, and results attained.

4.1 Research Strategy

For this thesis, we used a qualitative research approach from an interpretive perspective (Bhattacharjee, 2012). We applied deductive reasoning to identify or apply theoretical concepts to our observed data (Bhattacharjee, 2012; Recker, 2013). This goes well together with the interpretive approach. Most of the research around food supply chain traceability is relatively recent and has become even more important due to the increase of globalization of food markets. Therefore, we aimed at constructing a theoretical framework instead of testing a particular theory as given, because we consider that our theoretical framework can be used in the future for initiating theory building in this area (Bhattacharjee, 2012).

4.1.1 Pre-Study Interviews

First, we wanted to validate our research topic and learn more about the food industry. So we decided to do pre-study interviews, combined with the literature review being done in parallel. Pre-study interviews, also called pilot interviews, offer the advantages of giving advance warning about where the main research project could fail, where research protocols may not be followed, or whether proposed methods or instruments are inappropriate or too complicated (Chenail, 2011).

For that, we did an exploratory interview with Fredrik Ohlsson, Tetra Pak's IT director as part of the study design. We chose Tetra Pak because they are the world's leading food processing company and could provide us valuable information about this field. Furthermore, Tetra Pak has a unique overview of a food industry needs as it serves many different food and beverage producers. Unfortunately, this interview was not recorded, but it led to interesting findings and challenges, and the decision of the broad topic we wanted to conduct this research on. It also leads to the the next pre-study interview that was crucial for discussing the gaps and challenges found in the literature review and the creation of our framework.

Before we completed our theoretical framework, when we had found the food supply chain drivers (described in section 2.1.2) and the blockchain characteristics (described in section 2.2.4), we identified the need to test the framework from an industry perspective. In doing so, we booked an interview with Jonas Bengtsson, Tetra Pak's blockchain specialist to discuss our findings with an open-ended interview. This interview can be found in Appendix 2.

The initial analysis of this open-ended interview showed that the blockchain technology use must be challenged, thus we identified the need to continue with the process of designing the theoretical framework, where we identified the blockchain challenges and limitations (described in section 2.2.5).

4.2 Main Study - Interview Extended with a Card Exercise

In order to answer our research question, our main data collection technique was face-to-face and video conference interviews with interviewees from several backgrounds that are related to food supply chain management and traceability. The interviewees were contacted through direct contact (e-mail or phone) or indirect contact (LinkedIn messages). Half of the interviews were done face-to-face (4 of 8) in Sweden, and the other half was done through video calls (4 of 8) with two respondents from Brazil, one from the Netherlands and one from Singapore.

The conducted interviews have a semi-structured character, despite the structured framework, because they follow a conversational form that allowed follow-up questions and bidirectional discussions about the topic, or other topics and links that emerged during the interview (Recker, 2013). By having the interviews done in this way, we were allowed to have specific themes that we could follow, but we also had the freedom to extend our questions and get more in-depth answers from our respondents (Recker, 2013). Details of the interview questions can be found in Appendix 1, while the transcribed interviews can be found in the Appendixes 2-10. The interview questions were asked together with a card exercise, that will be explained in details in section 4.2.2, to help the respondent visualize their answers, and even change them after answering. The interviews were held in a two-stage interview process: The first stage was about the benefits of blockchain characteristics, described in 2.2.4, according to each food traceability driver that was described in 2.1.2, and the second stage is about the blockchain challenges and limitations, described in 2.2.5. In order to simplify the interview process, avoid ambiguity and improve clarity, the authors summarized the literature review to provide a short description of these food traceability drivers, blockchain technology characteristics and challenges. These descriptions can be found in section 3.4 divided for food traceability drivers (3.4.1), blockchain characteristics (3.4.2) and blockchain challenges (3.4.3).

For the in-person interviews, we wanted to ensure getting the most valid and truthful data as possible, therefore we considered where the interviews would be held beforehand. We tried to conduct the interviews where the respondents felt most comfortable and meet up in places easily reachable for the interviewee (Schultze & Avital, 2011). This was, for example, at their offices or workplaces. For the Skype interviews, they could choose any place and time that was comfortable to them, independent of their time zones.

To get as much information from the interviews as possible, it was also important to recognise the level the respondents were on, and tried to adapt our own level to theirs, in areas such as language, the role of the interviewee and personal experience (Schultze & Avital, 2011). Before each interview, we would ask each of the respondents if we could record the audio of the interview and publish their names (Bhattacharjee, 2012), respecting the decision of the respondent and always protecting the confidentiality of the companies through Non-Disclosure Agreements.

4.2.1 *Selecting Respondents*

The group of participants selected is a crucial point to the success of the research study (Schultze & Avital, 2011). Since the interviews are used as a main source for data collection, the quality of the data collected depends predominantly on the participant's involvement with the research topic (Whiting, 2008). We followed Bhattacharjee's (2012) recommendation to select respondents from different contexts and organizational levels related to food traceability and blockchain technology to obtain different perspectives on our phenomenon of interest. To find the respondents and identify respondents that could contribute to this study, we used convenience sampling, expert sampling and snowball sampling (Bhattacharjee, 2012). The number of selected respondents were aimed to reach a point of saturation in our data sampling, where no more interviews will yield any new insights (Bhattacharjee, 2012).

The process of selecting the right respondents and succeeding to book an interview with them, started at the early stages of this research. This process has been conducted in different directions, as follows: The first stage was to identify and list companies, organizations, associations and communities that are strongly involved in the themes of the research topic. These themes involved two non-related fields: food traceability and blockchain, and therefore it was challenging to find respondents that had experience in both fields. Since we could explain technical details of the technology being proposed (blockchain), we also considered respondents with little or no knowledge in the technology, but with experience with food traceability, food safety and food supply chain in general. The second stage was to actually find the respondents. Since we planned to use a card exercise to help with the interview questions, it was interesting to gather data from respondents in-person. Since Tetra Pak is the world's leading food processing company and their research and development headquarters are located in the city of Lund in Sweden, we decided to contact some key professionals that could contribute to our research topic. Half of our respondents are from Tetra Pak, Sweden. To gather diversity from other countries, markets, contexts and specializations, we contacted several expert professionals through a professional social network called LinkedIn. The other half of our respondents have diverse backgrounds from Brazil (a major food supplier in one of the largest food markets in the country; and a senior food supply manager from one of the biggest food companies in the world, with over 30 brands in its portfolio that exports to 150 countries), Netherlands (an academic researcher in the fields of blockchain technology and food supply chain) and Singapore (a blockchain and food processing specialist from one of the largest blockchain consultancies in the country). Since it is a very sensitive topic, some of our respondents required to remain anonymous.

The following respondents have been interviewed:

Table 3. Summary of Respondent Details

Respondent Code	Organization	Country	Position
Rsp1	Tetra Pak	Sweden	Blockchain Specialist
Rsp2	Tetra Pak	Sweden	IT Director
Rsp3	Tetra Pak	Sweden	Food Safety and Quality Expert
Rsp4	Tetra Pak	Sweden	Food Safety and Quality Expert

Rsp5	Fisheries and Aquaculture Production	Brazil	Food Producer
Rsp6	Ætler Blockchain Consulting	Singapore	Blockchain and Food Specialist
Rsp7	BRF Brazil Foods S.A.	Brazil	Senior Food Supply Manager
Rsp8	HU University of Applied Sciences Utrecht	Netherlands	Lecturer and Blockchain in Food Supply Chain Researcher

Table 4. Summary of Interview Details

Respondent Code	Interview Date	Interview Type	Duration (record)
Rsp1	10th May 2019	In Person	58:04
Rsp2	13th May 2019	In Person	49:56
Rsp3	14th May 2019	In Person	48:49
Rsp4	16th May 2019	In Person	47:47
Rsp5	20th May 2019	Skype Video Call	51:28
Rsp6	22th May 2019	Zoom Video Call	41:28
Rsp7	22th May 2019	Skype Video Call	1:04:48
Rsp8	23th May 2019	Skype Video Call	56:36

4.2.2 Enriching Interviews with Card Exercises

Card Exercises can be an interesting and enriching tool to be combined with interviews (Nurmuliani, Zowghi & Williams, 2004). With a background coming from child psychology techniques, visual tools effectively help to identify the thinking process and remember past actions or answers (Nurmuliani et al., 2004). Visual tools such as card exercises are also largely used in agile methodology techniques for the development of information systems, creating a richer experience and data collection in the process (Morgan & Maurer, 2006). To facilitate and guide our interview, since it was heavily based on concepts from the literature review, we created a card exercise based on the card sorting technique (Spencer, 2004). We guided the interview with the cards that can be found in Appendix 1. The interview was divided into two phases: (i) analysis of the benefits of the blockchain technology applied to food traceability and (ii) analysis of the challenges and limitations of adopting the blockchain technology in that specific context.

First we presented all the blockchain characteristics (the green cards) and then we started presenting the food traceability drivers (the blue cards). Since each food traceability driver is a complex context, we decided to present one at a time, waiting for the respondent to answer about each blockchain characteristic for that driver (with the purple-shaded cards) until we moved to the next one. That was made to focus the attention span of the respondent, since the complex-nature of the questions could lead to confusing the context of the different drivers. The respondent could then answer each different combination of driver versus blockchain characteristic with a card representing the values *high*, *medium* and *low*, to explain the importance of each blockchain characteristic to that specific driver.



Figure 11. Physical version of the card exercise for the first part of the interview

Then we presented the challenges and limitations for adopting blockchain technology (the red cards), also presenting one card at the time to focus the respondent's attention.



Figure 12. Physical version of the card exercise for the second part of the interview

Since half of the interviews were made through video conference tools, a virtual version of the card exercise was also created through the tool Miro, where the interviewers and the respondent could interact with the cards at the same time.

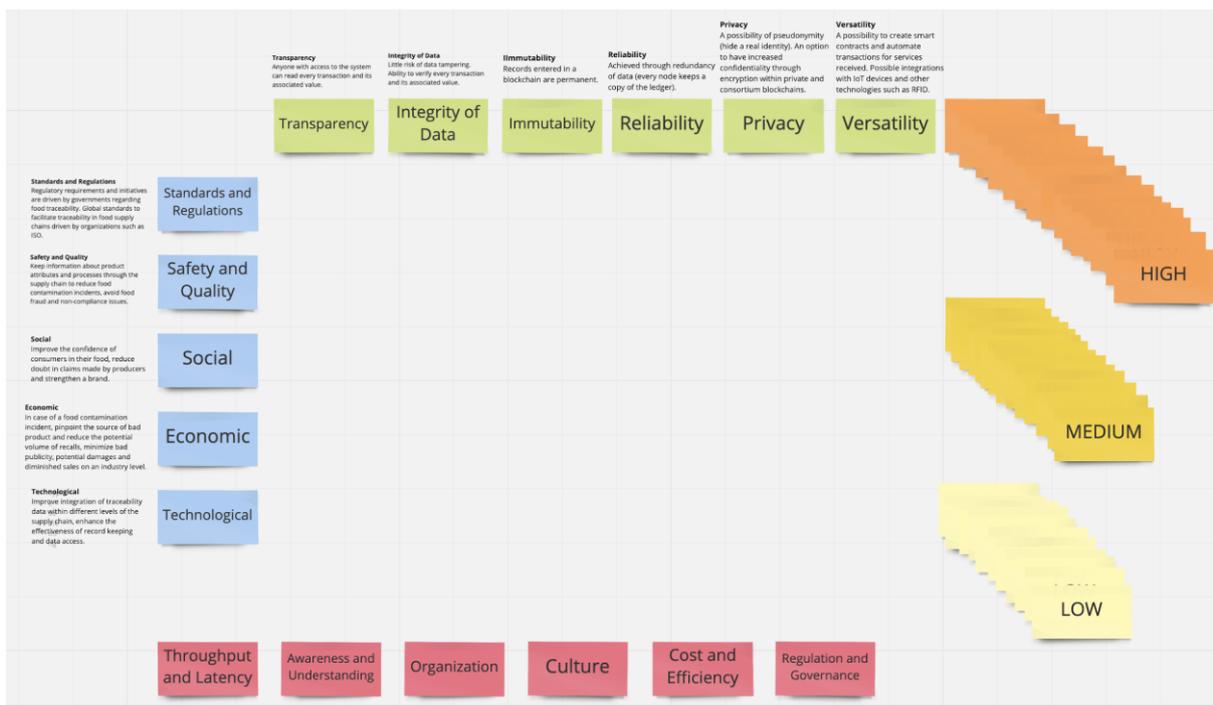


Figure 13. Virtual version of the card exercise

4.3 Data Analysis Methods

After completing each interview, we transcribed the recordings, thus ensuring that quotes are said correctly and that the respondent has not been misinterpreted when conducting the analysis in the later stages of this thesis (Bhattacharjee, 2012). Kvale (1996) defines transcribing as the

transformation or change from one form to another. In this thesis, we transformed oral language into written words representing the oral sentences, which resulted in the transcripts that can be found in Appendixes 2-10. Not all the interviews were conducted in English. The interviews with the Brazilian respondents were conducted in Brazilian Portuguese, having the need of being translated after the transcription and revised by a neutral person (Appendixes 5 and 7).

After each transcribing was done, we analysed the transcription document individually and colour code each answer to discover similar or contradictory responses from the respondents (Bhattacharjee, 2012), following the same color codes from the physical card exercise answers (for the values high, medium and low) as it can be seen in Figures 14 and 15 from the next chapter. This also enabled us to find hidden connections and interpret our findings before sharing our findings with one another (Bhattacharjee, 2012).

4.4 Scientific Quality and Ethics

To ensure that this study maintains good quality throughout as well as follows the ethics within the Information Systems field, this section will touch upon Klein and Myers (1999) seven “principles for interpretative field research” and discuss the ethical principles in scientific research presented in Bhattacharjee (2012).

The first principle, *the fundamental principle of the hermeneutic circle* suggests that we as researchers should strive for a specific understanding.

The second principle, *the principle of contextualisation* states that we, as researchers, need to have an understanding of past events to understand the present state that is being examined.

In the beginning of each interview, we situated ourselves as well as the interviewees. We followed Myers and Newman’s (2007) recommendation and asked them about their background and experience. By doing so, we collected useful information for the writing up, which ensures validity for the readers of our papers.

The third principle, *the principle of interaction between researchers and the subject* refers to a critical reflection of how data is collected, and about the interactions between the researchers and the participants in the study. For our study, we consider the ethics around how the interview is executed and the interactions between us as researchers and the respondents. Therefore, the common view of ethics that is presented by Bhattacharjee (2012) is suitable to consider in our study.

Firstly, voluntary participation and harmlessness were achieved by not forcing any participant to take part in this study. We also need to consider that the respondents are not harmed in any way when publicising this thesis. Secondly, informed consent was obtained by clearly describing that the participant could withdraw at any point of the study if they did not feel comfortable or because of time restrictions. Thirdly, we assured anonymity and confidentiality, by letting the respondent know that they could be anonymous if they wished to do so, or in a milder version ensuring confidentiality where the identity of the respondent could not be identified in the study. Fourthly, disclosure was achieved by informing the respondent of our intentions with this study and what we would use it for, for them to decide whether to participate or not.

The fourth principle, the *principle of abstraction and generalisation* is ensured through looking, analyzing and comparing the data that we have collected through the lens of the theories and literature, that are described in the theoretical background chapter (chapter 2).

The fifth principle, *the principle of dialogical reasoning* helps to find possible contradictions between the theoretical preconception guiding the research and compare it with the actual findings, in combination with cycles of revision of this principle.

The sixth principle, *the principle of multiple interpretations* relates to our understanding and sensitivity towards the participants' interpretations of the questions that were asked, depending on their context, background and values.

The seventh principle, *the principle of suspicion* states that we as researchers need to reflect and be aware of any biases and systematic distortions in the answers of the respondents.

5 Findings

This chapter presents the analysis of findings obtained following the methodology outlined in chapter 4. The results are described according the structure of our research framework. The findings are summarized in figure 14 and 15. Direct quotations from the transcripts are cited in the following manner: Rsp1:15 refers to Respondent 1, section 15.

5.1 High Level Outlook

In this section we present the results obtained and details of the respondents and the interviews. Figures 14 and 15 represents the answers given by our respondents, colored in the same way as the card exercise result that complemented the interview. Green cells represent the blockchain technology characteristics, blue cells represent the drivers for food traceability, red cells represent the blockchain technology challenges and purple-shaded cells represents the values *high*, *medium* and *low*. In the case respondents gave more than one answer, the cell regarding that answer was splitted to accommodate more than one answer. The number of times each driver x characteristic or challenge was rated high is also presented.

Impact scale		Low		Medium		High		Blockchain Technology Characteristics																			
								Total high: 27		Total high: 30		Total high: 20.5		Total high: 14		Total high: 13		Total high: 18.5									
		Transparency		Integrity of Data		Immutability		Reliability		Privacy		Versatility															
Drivers for Food Traceability	Standards and Regulations	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2								
		Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4								
		Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6								
		Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8								
	Safety and Quality	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2								
		Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4								
		Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6								
		Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8								
	Social	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2								
		Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4								
		Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6								
		Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8								
	Economic	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2								
		Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4								
		Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6								
		Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8								
	Technological	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2								
		Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4								
		Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6								
		Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8								

Figure 14. Impact of blockchain technology characteristics on drivers of food traceability

Impact scale	Low											
	Medium											
	High											
Blockchain Technology Challenges												
Total high: 5.5		Total high: 2		Total high: 5.5		Total high: 3.5		Total high: 4		Total high: 1.8		
Throughput and Latency		Awareness and Understanding		Organization		Culture		Cost and Efficiency		Regulation and Governance		
Impact	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2
	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4
	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6
	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8

Figure 15. Impact of challenges on blockchain technology adoption

5.2 Food Traceability Drivers

Respondents talked about the importance of each blockchain characteristic (transparency, integrity of data, immutability, reliability, privacy, versatility) for each food traceability driver (standards and regulations, safety and quality, social, economic, technological).

5.2.1 Standards and Regulations

Transparency is considered a highly important factor for standards and regulations for the majority of the respondents. According to Rsp1 (20) transparency is a must due to the need to be able to prove something and withstand an audit. Furthermore, blockchain technology allows for complete transparency when compared to conventional databases as the auditors will be interested to understand who changed what information, as well as when and how you can delete and change a record (Rsp1:20). In addition, transparency can provide a clearer picture of food safety by helping the final consumer understanding the origins of food (Rsp6:21) and create more trust in these origins (Rsp5:20). The importance of visibility of product information for standards and regulations is further highlighted by Rsp8 (5). Rsp8 (5) states that standards and regulations aim to have full food traceability throughout the supply chain, therefore transparency is a highly important aspect. Rsp3 (21) believes that transparency is important so that all stakeholders and participants of the blockchain could see the changes and updates. Rsp4 (4) considers transparency highly important from a standards point of view, more so than from a regulation point of view. Rsp7 (4) believes transparency is also useful to understand which part of the chain was not in compliance with standards and regulations and act faster if this is the case. The reason for this are standards that are driven by the customers (Rsp4:4). On the other hand, according to Rsp2 (6) it's not important for everyone with access to the system to be able to read every transaction.

Rsp1 (20) believes that integrity of data and immutability is a key aspect of the blockchain and is also extremely important, same as with transparency, as auditors need to be sure the data presented is correct. In contrast, database records can be changed and paper can have dates changed and resigned (Rsp1:20). Rsp2 (8) and Rsp5(22) also consider that integrity of data and immutability go hand in hand and are highly important from a standards and regulations point

of view. Integrity of data is also highly relevant for the auditors to ensure partners in a chain are held accountable (Rsp8:13) and if integrity of data is not preserved, there is a risk for the whole chain (Rsp7:12). Overall the key aspect of blockchain technology is that information can be trusted as it cannot be changed therefore integrity of data and immutability is highly important for standards and regulations (Rsp6:32). Rsp4 (10, 14) agrees with the high importance of integrity of data and immutability and elaborates that the immutability aspect is relevant because it is driven by big customers as a requirement to keep production data for a long time as a way to maintain traceability.

Within standards and regulations, integrity of data seems to be the only blockchain characteristic that is considered of high importance unanimously by all respondents. At the same time, while most respondents also agree on the high importance of immutability, Rsp3 (21) has a different opinion and rates the aspect of immutability as low relevance. The thinking behind this decision is that legislation and standards change frequently and need to be updated. Rsp8 (17) looks at immutability from a trust perspective and states it is more relevant for lengthier supply chains, while shorter supply chains working together may already have developed a high level of trust and therefore the immutability aspect may not be as important (Rsp8:17).

Respondents have mixed opinions on the reliability aspect of blockchain technology within standards and regulations. Rsp2 (8), Rsp4 (16) and Rsp7 (16) consider reliability as of high importance, as there is a demand to ensure redundancy of data. On the other hand, Rsp3 (21), Rsp6 (38) and Rsp5(22) rate reliability as medium and think redundancy of data does not matter much. Rsp5 (22) says that it is nice to have redundancy, but it is not an essential characteristic. Rsp5 (22) states that a centralized system could work in the same way. Rsp1 (22) and Rsp8 (21) rate reliability as low because they consider this characteristic as given and do not think it is important if copies of data are kept within different nodes. Authorities only care that standards and regulations are followed and do not care much about the redundancy of data (Rsp8:21). Rsp1 (22) also states that trust is what really matters.

Respondents have a mixed opinion towards privacy. According to Rsp1 (22, 27) it is important to be compliant with standards and regulations and you should not be able to hide behind anonymity. From a standards and regulations point of view it is important to understand who has created a record (Rsp1:27) However organizations still must be compliant with privacy legislation such as GDPR (Rsp1:22). Rsp3 (21) believes privacy is important so that everybody understands where new standards and legislation come from. According to Rsp4 (18) in a business-to-business environment it is essential that confidential information between two parties is protected. A lot of information is shared only with authorities (Rsp4:18). Rsp5 (25) rates privacy as low because he believes we should not have much privacy regarding food products. Rsp2 (19), Rsp6 (36, 38), Rsp7 (20) and Rsp8 (28) rate privacy as medium. It is not that critical to hide behind the data (Rsp2:19; Rsp8:23) but it is important to rely on your suppliers and service providers to have a trusted product in the market (Rsp7:20).

Rsp1 (29), Rsp2 (19) and Rsp7 (24) rate versatility as of high importance. According to Rsp1 (29) one of the main advantages of the versatility of blockchain technology is to be able to integrate with Internet of Things (IoT) devices to put information on the ledger. To be able to ingest any type of data from anywhere is also considered an important aspect (Rsp2:19). Automation and reduction of manual input is a way forward; however, it is important to build the blockchain around IoT devices to make sure they are sending out the right information (Rsp1:29). According to Rsp4 (20) there is a lot of legal data and certifications linked to a product which must be kept in order to follow good manufacturing practices. However, the

versatility aspect from a standards and regulations point of view is considered of medium relevance by (Rsp4:22) and Rsp6. According to Rsp3 (21) the versatility aspect of automating transactions and smart contracts are not considered all that important from a standards and regulations point of view. The same happens with Rsp5 (27, 29) who believes that versatility can be really interesting, but not in the standards and regulations context. While currently there is little demand for versatility from a standards and regulations point of view, these requirements can change in the future where the authorities may require more information to be available (Rsp8:30).

5.2.2 Safety and Quality

For safety and quality transparency is considered highly important by the majority. According to Rsp3 (23), Rsp5 (37, 39, 41), Rsp6 (21, 46, 49) and Rsp7 (34, 38, 40) transparency combined with integrity of data and immutability are highly important because safety is an essential aspect for standards and regulations. The quality aspect is also relevant for the end consumer (Rsp3:23, Rsp7:34). Rsp4 (26) and Rsp5 (37) states that food safety is at the top of the agenda in the food supply chain and how traceability is high on the agenda to avoid food fraud or any type of food adulteration. This drives the need for transparency and many companies are working on these solutions (Rsp4:26). Rsp8 (34, 35) believes that being transparent and sharing data while securing integrity is what creates value. Furthermore, Rsp4 (28) states that integrity of data plays a big role for a system's trustworthiness and that criminals should not be able to fake the data. Rsp2 (23) does not believe that it is necessary for everyone with access to the system to be able to read every transaction and therefore puts low value on transparency for safety and quality. When it comes to data integrity, Rsp1 (31) assumes it is a given and follows from transparency therefore evaluates it only as medium.

Respondents that rate immutability highly relevant for safety and quality usually consider it to be important for building trust and be closely related to transparency and integrity. Rsp8 (38) considers immutability to be one of the advantages compared to other ERP systems as blockchain cannot be muted, changed and altered. A contrasting opinion on the immutability aspect is provided by Rsp1 (31) who considers it as of low importance. The main reason is that in the context of food immutability can become one of the main pain points because data in the blockchain remains forever and will become irrelevant after a certain time period as food does not have a long lifespan (Rsp1:31). Some food, such as fruits, have a very short shelf life and information on them becomes obsolete and irrelevant quite fast. Potentially after certain time period (around 6 years) a new blockchain could be re-started to avoid cluttering it with irrelevant data (Rsp1:31). Rsp4 (32) evaluates the immutability aspect from a safety and quality perspective only as medium importance and Rsp4 (32) believes it is more relevant for standards and regulations.

Respondents have mixed opinion regarding reliability, and some did not comment much on the reasons behind their ratings. Rsp4 (34) considers reliability in the same category as integrity and trustworthiness of data. Rsp7 (44) believes it is really important to track the correct information about food contamination events and track the origin of it. Rsp8 (41) has the opposite opinion and considers reliability to be of low importance as it is not the main advantage of blockchain.

Privacy from a safety and quality aspect is considered highly important by Rsp2 (23), Rsp3 (33) and Rsp7 (46). According to Rsp3 (33) and Rsp7 (46) privacy is related to confidence while according to Rsp2 (23) it is important to have an option to remain anonymous in case there is a

need to report quality problems. Privacy and transparency are considered opposite characteristics and it is important to be able to choose to either be fully transparent or retain anonymity based on a situation (Rsp2:23; Rsp8:42). Rsp1 (36) rates privacy as medium as you do not need to show a real username and only share a key to decrypted information to certain people.

Versatility is considered highly important within a safety and quality context by six out of eight respondents. Rsp1 (38) sees versatility as being able to trigger events within the blockchain, integration with IoT devices and automating transactions. Versatility can increase confidence in data (Rsp3:33) and is considered more important for companies than for legislators (Rsp4:38). The relevance of versatility for confidence in data is also expressed by Rsp8 (44). If a supply chain is able to integrate blockchain and IoT devices, this could potentially have a very high impact on data quality that could result in fewer certification requirements (Rsp8:44).

5.2.3 *Social*

Transparency is considered highly important by the majority of respondents. Rsp1 (40) considers transparency high in a social context because if an organization is caught cheating it can be the end of it. Rsp5 (47) relates transparency to integrity of data and immutability. Rsp7 (58) says that transparency is also important to show publicly good and bad experiences the final consumer had, in order to create confidence in the brand and continue consuming it.

Transparency is closely followed by the integrity of data as the second most important characteristics. Blockchain can only be successful if it involves multiple stakeholders, since from a security point of view, running a blockchain alone does not utilize the advantages of the technology (Rsp1:44). In the end, consumers expect food to be handled in a good way regardless of whether blockchain is used or not (Rsp1:44). Rsp3 (39), Rsp6 (64), Rsp7 (70, 74, 76) and Rsp8 (51, 52) state that transparency is highly important to gain consumer confidence and integrity of data is highly important to be able to secure information. According to Rsp4 (45) transparency is the name of the game and all stakeholders should be able to find information and trust it due to integrity of data. Rsp1 (44) believes that integrity of data and the risk of tampering is of low importance and the actual focus is on putting the correct information in the first place.

Rsp1 (44) considers immutability highly important, but dependant on the scenario. Rsp7 (82) says it is very important because it involves consumer trust. According to Rsp2 (35) integrity of data, immutability and reliability are closely related and highly relevant in a social context. Rsp4 (47) considers immutability as of medium importance while Rsp3 (39, 42) and Rsp8 (54) do not consider immutability that important for consumers and rate it as low.

Reliability is rated medium by Rsp6 (67) who believes that in a social context, consumers do not care much about technological details. However, from a privacy point of view, there is high concern about information collected about consumers (Rsp6:67; Rsp8:60). Redundancy of data is not important in a social context and data exchange is already secured by other traditional means such as EDI and other web services (Rsp8:59). Rsp3 (42) does not believe the smart contracts aspect is relevant to consumers, but believes that integration of IoT technology could be highly relevant for the social aspect and enable consumers to obtain information through their phones. A similar opinion about the potential integration of information to consumers is held by Rsp4 (51, 57) and Rsp7 (94), however as of now the respondent believes consumers do not have a formed habit of constantly checking product information (Rsp4:53). Rsp5 (47)

believes that it would be nice to have information in real time. Rsp6 (72) does not see creating smart contracts and integration with IoT as very relevant for the consumer, but instead sees it as more relevant for the producers. Rsp8 (61) also views the versatility aspect to be more advantageous for partners in the chain.

5.2.4 *Economic*

In case of crisis, an organization must be cooperative with authorities otherwise a small issue could become a very big problem if there is a lack of transparency involved (Rsp3:46). This opinion of a high importance of transparency is also shared by Rsp4 (59). The ability to recall is a big topic in the food industry and currently government organizations such as the FDA have a mandate to issue a public recall and block a certain product very effectively (Rsp4:59). If supported by tools, the recall can be executed efficiently and blocking can happen, for example, in the supermarket during a purchase event instead of relying on consumers by spreading knowledge through conventional media such as news on TV (Rsp4:61). Rsp6 (77) also thinks the aspect of transparency can improve communication with the customers. If information regarding products is shared and transparent within the chain, it can lead to faster recalls (Rsp8:65).

Rsp1 (52) considers transparency as of medium importance. The transparency in an economic aspect is only relevant if an event happened, otherwise there is little of interest held in the information (Rsp1:52). A similar opinion is shared by Rsp2 (39) who believes it is not that necessary for everybody to be able to read everything. Rsp7 (96, 98) believes transparency should be considered high because food processing companies need to know where a specific product is being distributed, in case of frauds or contamination, to do the recalls as fast as possible.

Integrity of data within the economic context is unanimously rated as highly important. In the opinion of Rsp1 (52), due to high stakes, an ability to ensure integrity of data is highly important regardless of what technology is used. According to Rsp3 (46) and Rsp4 (63) it is important to ensure integrity of data and minimize the risk of tampering, which otherwise could render the data worthless and would result in a loss of trust in the system. While integrity of data can result in high trustworthiness in the system it is unlikely that in consumers eyes it will be viewed any differently than any other IT system (Rsp8:66).

On immutability, Rsp1 (52) and Rsp4 (66) state that the aspect of permanent record storage is not as relevant due to the limited lifespan of food products when compared to other long life products such as cars. Rsp7 (104) states that immutability is high because if some information is erased, is not possible to find the origin of some problem that might happen. Rsp1 (54) and Rsp5 (47) considers reliability as of medium importance and Rsp1 (54) states that creating many copies of the ledger makes it harder to change the data in it. Rsp4 (69) considers reliability highly important as it is closely related to integrity of data and transparency.

On the aspect of privacy, Rsp1 (54) elaborates that it is important to be very careful on how and what kind of data is stored and how it is obtained and outlines the need to comply with directives such as GDPR. Rsp5 (49) says privacy is important to avoid "which hunts". Rsp7(110) says it is medium because of the need to clarify in which step of the chain a problem might have happened. Rsp8 (72) overall considers privacy of low importance, but also highlight that it might be relevant from a GDPR perspective.

Versatility, according to Rsp1 (54) at first might seem of low importance if viewed from inside a single company, however when considering the full complexity of the supply chain, versatility becomes much more relevant. Rsp3 (50), Rsp5 (49) and Rsp7 (112) considers versatility important in order to trace everything and have full confidence in a given recalled batch. Blockchain integration with the IoT network could potentially reduce recall costs (Rsp8:72). Versatility could also play an important role when integrating consumers into a recall (Rsp4:75).

“If there will be an economical backlash on you it would be damn good if you would have IoT devices that is proving either that you're right, or that you're wrong.”

-Rsp1 (54)

5.2.5 Technological

Transparency is almost unanimously rated highly important from a technological point of view. According to Rsp1 (56) transparency becomes a key thing that actually drives a handshake between places and finds status changes. Rsp2 (52, 54) considers all blockchain characteristics to be highly relevant from a technological point of view. Rsp3 (56) outlines the importance of transparency in case of a food contamination event to avoid bad publicity. Rsp4 (80,82, 86) found it difficult to connect technological driver and blockchain characteristics. In addition to the transparency and integrity of data, Rsp3 (56) believes that information should be encrypted and not open for everybody and be available only to selected stakeholders. Otherwise there is a risk of organizations taking information and using it out of context.

Regarding immutability, Rsp1 (56, 58) highlights that it is highly dependant on the lifetime of a product. Due to systems relying on each other, the immutability aspect is important to ensure there are no missing links (Rsp1:58). According to Rsp2 (54) trust is more relying on the technology itself rather than central authorities and blockchain technology has the potential to be trustworthy due to the integrity of data, immutability and reliability.

On the aspect of privacy, Rsp1 (58) highlighted the importance to handle information of the IoT or the real users correctly and once again outlines the GDPR directive. From a technological point of view, it is important to respect privacy but also be able to identify who has actually done what (Rsp1:60). Rsp5 (71, 73) highlighted different contexts where this characteristic could have a high or low importance. As a scenario in which privacy has higher importance Rsp5 (71) believes that the information contained in IoT devices should stay private until they are validated and registered in the blockchain.

The technological driver was skipped in interviews with Rsp7 and Rsp8. Rsp6 (105) was also not able to comment much in this context.

5.3 Blockchain Technology Challenges

5.3.1 Throughput and Latency

Rsp1 (77) states that the technical limitations of throughput are not important anymore as private blockchains are able to offer speed and much faster consensus mechanisms. Rsp8 (76) did not run into cases of throughput and latency issues, but does not rule out cases with a possibility where of throughput creating a bottleneck. The throughput and latency question must be addressed from an architectural point of view, because it may not be necessary to capture every record (Rsp1:77). For example, when IoT records information it could be that a more generic event such as an average during a certain time period should be recorded, or an event triggered and recorded only if the product is below or above a certain temperature at any point in time (Rsp1:77). It would make sense to have a functional model between devices that is listening and recording information, reacts based on a set of rules and posts selected values on the blockchain (Rsp1:77). Rsp3 (67) and Rsp4 (96) are not sure if throughput and latency of blockchains can be a limiting factor. On the other hand, Rsp2 (78, 105) believes that throughput and latency are big limitations of blockchain technology and it does not scale well and does not meet the high throughput requirements of today's IT. Rsp5 (81) and Rsp7(122) believe that this challenge has a high importance because of the amount of information that might have to be processed. Rsp6 (120) also considers throughput and latency to be major problems and provides as an example the transaction speed of the Ethereum blockchain vs the VISA network.

5.3.2 Awareness and Understanding

Rsp1 (78) and Rsp3 (68, 70) consider awareness and understanding to be a barrier of low importance when it comes to the adoption of the blockchain technology. Rsp3 (68) compares blockchain technology to having a phone, which might be a challenge to understand how it works, but can still be used. A similar opinion is held by Rsp2 (79), Rsp4 (114) Rsp7 (126) and Rsp8 (79) who also believe not everybody needs to understand blockchain technology. However, according to Rsp2 (107, 109, 113) even consultancy companies such as IBM and Microsoft struggle finding people with good blockchain understanding. Often in some cases, blockchain technology might be overhyped (Rsp2:109) and used just for the sake of using blockchain when in reality the problem could be solved by more conventional means (Rsp2:79). Furthermore, Rsp3 (70) believes that some concepts of blockchain technology are not new and have been used since the 70s. Rsp1 (78) considers blockchain as a key technology which is part of a solution, but not a solution itself. People usually do not have prejudice against certain technologies and if blockchain technology is sold, it should not be sold as a blockchain technology, but rather as a trusted solution with full immutability (Rsp1:78). The understanding of trustworthiness of information in the blockchain is more important than the know-how (Rsp6:121; Rsp8:79). Rsp4 (112, 114) thinks that as bigger and more technology oriented companies have more resources and competence compared to small and medium businesses, the lack of awareness and understanding will be less of a challenge. Rsp5 (83) believes that the challenge of awareness and understanding is of high importance because you first need to convince people that blockchain technology is important, and then you need to make people understand how it works and how relevant it is, or it is not going to be used.

“So right now we have a few blockchain products because we wanted to do a blockchain product. But when you look at the problem, we want to solve, in all cases, you can actually solve that with a normal type of data storage.”

-Rsp2 (79)

“If you should sell a blockchain solution, you shouldn't sell it as blockchain. You should sell it as a trusted solution with full immutability, and then stop there”

-Rsp1 (78)

5.3.3 Organization

Rsp1 (82) believes that collaboration between stakeholders is a key aspect of blockchain applications and rates this challenge as high. A similar opinion is held by Rsp2 (72), Rsp3 (73) and Rsp5 (85) who also believe that collaboration between organizations can be a challenge and it is necessary for all the stakeholders to add information. Rsp5(85) and Rsp7(128) also reinforce the idea of having a central entity, like governments and large companies to enforce it. Rsp2 (72) outlines a few types of blockchains: a platform like blockchain which connects many different organizations, and a blockchain maintained by a crowd, not dependant on other organizations. The adoption of blockchain technologies could require changes in business strategies and business models which can be especially difficult for traditional organizations that are used to work in silos (Rsp6:121). Rsp8 (81, 83) states that collaboration can become a barrier if the chain is long, but is not likely to be a big obstacle for short chains that already have high collaboration established. Rsp4 (118) on the other hand, does not see much resistance to blockchain technology within the food industry and rates the challenge of collaboration between organizations as a low risk.

5.3.4 Culture

Rsp1 (83) sees culture in the same bracket as awareness and understanding. In the end, it is still an IT solution and the company culture should not care that it is a blockchain technology. Rsp3 (75) has a more conservative outlook on the culture aspect and believes that culture could get in the way of blockchain adoption depending on the actors and how they are using the blockchain. It could be that within different countries blockchain technologies would not work the same way (Rsp3:75). Rsp4 (120, 121) states that there is an increasing interest from authorities like the FDA in the reliance of a decentralized network to enable a quick alert system for recalls. On the other hand, Rsp2 (79), Rsp6 (122) and Rsp8 (87) identifies culture as a big challenge. Blockchain could be compared to the internet itself, with a power to decentralize governance (Rsp2, 79). Rsp8 (87) strongly believes in a self governing supply chain and putting less trust in central authorities. From a business perspective, Rsp6 (122) highlights the lack of top management support for a decentralized way of working and considers this to be one of the key challenges that prevents trying out the technology.

5.3.5 Cost and Efficiency

Rsp1 (83) and Rsp7 (91) consider cost and efficiency to be a big challenge. Blockchain implementations are much more expensive compared to normal databases. Therefore, when designing an IT solution, the most important question that must be answered is what data needs to be stored and captured on blockchain and what should be stored off chain (Rsp1 83). Rsp7(146) and Rsp8 (93) rate the cost issue as of medium importance and state that larger organizations may have more funds available to implement blockchain projects. However, cost

generally is not considered to be a big issue as organizations that pioneer the blockchain technology want to profile themselves around the latest and newest blockchain projects (Rsp8:93). Rsp3 (78) considers the cost issue to be less relevant in countries that have access to cheap energy. Furthermore, according to Rsp3 (78) blockchain technology might not benefit all the actors in the same way and it could result in a situation where cost and rewards are not distributed evenly. The opposite opinion is shared by Rsp2 (83) who is not sure if blockchain is actually a more expensive solution, but thinks it could even be cheaper. Rsp4 (123, 125) is not sure if a blockchain solution would be expensive, but in case the cost is high, there will always be a lot of resistance. Rsp6 (123) also believes that to adopt a new technology it must make sense from a business perspective.

5.3.6 Regulation and Governance

Multiple respondents have a split opinion on the importance of regulation and governance when it comes to blockchain technology. Rsp1 (84) believes that it is highly situational as many countries have their own rules and regulations. The complexity can increase a lot when product travels cross-border (Rsp1, 88). Furthermore, some companies such as IBM and Microsoft are working on a GS1 standard and try to involve regulators, but the reality is that involvement is limited due to the lack of funding (Rsp1:88). Rsp2 (91) is of the opinion that regulations and governance hamper the growth of blockchain in the context of cryptocurrencies, however in the food context, Rsp1 believes that governance is not needed for blockchain and the trust is built within the technology (Rsp1 91, 93). Rsp3 (81) sees regulation and governance as a problem at a medium level as legislation has not fully progressed into the digital world. Rsp4 (127) sees a trend of decreasing resistance towards blockchain from the authorities, due to the high need to deal with issues related to food fraud and recalls. Rsp4 (127) also sees a big potential for consumers to bypass standard producers and instead have a direct link with the legislators and provide feedback. Government resistance will continue to decrease once authorities recognize the blockchain technology as a big opportunity for the consumers to support traceability and recalls (Rsp4 127). Rsp5 (99) and Rsp7 (150) do not have high trust in central authorities and the government, and believe that in the majority of contexts, this challenge can be considered low. Rsp8 (95, 98) is of the opinion that the lack of regulations is actually what makes innovating blockchain projects possible. Rsp6 (124) believes that there should be some regulations and governance in place towards blockchain platforms, mainly to avoid abuse of power by big, powerful corporations.

6 Discussion

This chapter aims to present and discuss empirical findings together with the literature. The discussion follows the structure of the theoretical framework and presents the benefits of blockchain technology for food traceability drivers and outlines the challenges. Decision and diffusion of innovation theories are used to help explain certain aspects of adoption of blockchain technology. Moreover, we also introduce our discussion on the empirical findings divided into two forms of implications. First, implications to research presents our findings that influence how reviewed literature on concepts and theories has driven our theoretical framework design and how we foresee changes and implications related to that. Second, we present an extensive discussion of our implications to practice that follow from section 6.2.

6.1 Implications to Research

Reflecting on our proposed theoretical framework that is influenced by the literature on blockchain technology and food traceability within a supply chain, coupled with theories on decision-making and DOI, we recognize the need to present at least two important empirical findings that influence how our theoretical framework can be further improved and viewed by our theoretical context.

On the first implication, we realize that our theoretical framework showed to be too structured on how the drivers are identified. This led our respondents to tackle drivers more in a fluid form rather than a structured form as the theoretical views influenced us to do (Bosona and Gebresenbet, 2013). While evaluating the blockchain characteristics, the food traceability drivers could also relate to one another, creating possible relations between the drivers.

On the second implication, we found that the technological driver resulted in a lot of confusion amongst the respondents when evaluated against the blockchain characteristics and did not fit the framework narrative. According to Salampasis et al. (2012), the technological development is an important factor which pushes a new generation of traceability applications. It can be argued that the development of the blockchain technology itself is a technological driver which enables improvements of certain aspects of the food traceability within the supply chain. To compare blockchain as a technological driver against blockchain characteristics does not make much sense, therefore moving forward, the authors will use findings related to the technological driver as a supporting material only. The importance of this particular implication is also visibly presented in Figure 16, to illustrate how the technological driver becomes of lesser importance compared to the rest of the drivers.

Impact scale		Blockchain Technology Characteristics																																			
		Total high: 27		Total high: 30		Total high: 20.5		Total high: 14		Total high: 13		Total high: 18.5																									
Low		Medium		High		Transparency		Integrity of Data		Immutability		Reliability		Privacy		Versatility																					
Drivers for Food Traceability	Standards and Regulations	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8										
		Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8																
		Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8						
		Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8						
	Safety and Quality	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8										
		Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8																
		Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8						
		Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8						
	Social	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8										
		Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8																
		Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8						
		Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8						
Economic	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8											
	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8																	
	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8							
	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8							
Technological	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp1	Rsp2	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8											
	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp3	Rsp4	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8																	
	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp5	Rsp6	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8							
	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8	Rsp7	Rsp8							

Figure 16. The overview of the blockchain technology characteristics

6.2 Implications to Practice

6.2.1 Food Traceability Drivers and Blockchain Technology Characteristics

The findings show that when the food traceability drivers are evaluated separately against blockchain technology characteristics, most respondents do not show a clear distinction between the drivers. If one blockchain characteristic, for example transparency, is considered to be highly relevant for standards and regulations, it most likely will be highly relevant for the remaining drivers: safety and quality, social and economic. Furthermore, it is difficult to clearly draw a separation line between all the food traceability drivers as they are interconnected to some extent. From a standards and regulations point of view, due to the political pressure, governments drive companies to improve food traceability by introducing different legislative efforts (Bosona & Gebresenbet, 2013), (Aung & Chang, 2014). This is in line with the comments made by Rsp3 (23) and Rsp6 (21) that the aspect of safety is important due to standards and regulations, while the quality aspect is relevant for the end consumer Rsp3 (23). This points to a social driver which states that increased public awareness about food safety can motivate companies to improve food traceability (Golan et al., 2004). In the economic aspect companies are incentivized to invest into food traceability systems to reduce recall size and avoid bad publicity among others (Golan et al., 2004). The connection between economic and standards and regulations drivers can be drawn as government organizations now have the mandate to issue public recalls and block certain products (Rsp4:59).

While the blockchain technology in this paper is represented by the six outlined characteristics, or key elements as outlined by Seebacher & Schüritz (2017), it is important to understand that while some characteristics may be more relevant than others in a food traceability context, they cannot be separated as they are all part of the blockchain solution, and therefore, all characteristics must be considered in the design of blockchain solution. Furthermore, some of the respondents view certain characteristics to be in a similar bracket in terms of functionality and their level of importance. Figure 16 shows that transparency and integrity of data are the most important blockchain technology traits when it comes to food traceability while reliability and privacy are the least relevant. If we generalize the blockchain technology into the two main aspects of trust (transparency, integrity of data, immutability) and decentralization (privacy, reliability, versatility) as suggested by Seebacher & Schüritz (2017), we can argue that, based on the feedback from the respondents, trust takes priority over decentralization in a food traceability context.

Of course, trust and decentralization are not mutually exclusive, however, if a centralized solution is able to provide similar confidence and trust in the data, the decentralized aspect may not be relevant anymore (Rsp5:22). Sometimes a blockchain solution is forced unnecessarily to solve a problem, that could be solved by simpler means (Rsp2:79). On a similar note, some companies reportedly were able to exploit investors by adding “blockchain” or “crypto” to their name while having nothing to do with the technology itself (Megaw N., 2017). Such blind trust in blockchain technology can be related to the “relative advantage” DOI attribute. It seems that the relative advantage of blockchain technology can be perceived as superior to traditional alternatives and thus it can become the strongest driver for the adoption of blockchain technology (Rogers, 2010). Going further, we will discuss how different blockchain characteristics are perceived within a food traceability context and how different challenges and limitations can influence the adoption of the blockchain technology.

6.2.2 Transparency, Integrity of Data and Immutability

Transparency, integrity of data and immutability are rated as the most important blockchain characteristics for food traceability (Figure 16). With these three qualities, blockchain technology is in a unique position to provide a high level of trust in information stored on the ledger, which is one of the key challenges defined in the problem area section. Such level of trust is relevant when engaging with authorities. Auditors are especially interested in full traceability and want to understand who put what information, how information can be verified, as well as who can change and delete records (Rsp1:20; Rsp4:4), Rsp8 (5). Unlike a centralized system, blockchain does not have a single intermediary and in theory is much harder to be compromised (Seebacher & Schüritz, 2017; Bashir, 2017). When it comes to integrity of data and immutability, blockchain has an advantage when compared to traditional ERP systems, as data on stored on the blockchain cannot be muted or altered in any way (Rsp8:38). Furthermore, food equipment manufacturers have an increasing pressure of securing information which is not only driven by authorities, but also is an important requirement coming from the food manufacturers (Rsp4:10, 14). Such shared focus on food traceability throughout the supply chain is aligned with the literature, which states that retailers invest in white labels and push food manufacturers to invest in food traceability systems (Heyder et al., 2012; Aung & Chang, 2014). In a pre-study interview, the respondent also emphasizes that the retailers have been the driving force behind technology development for food traceability. This can be related to compatibility - a second attribute of innovation in the DOI theory which states that client needs for the innovation can positively contribute to the adoption of innovation (Rogers, 2010). In addition, the respondent also mentions that to be ready for customer demands, some companies

create proof of concept of blockchain applications to test the technology and realize that blockchain is not necessary. This is in line with the DOI theory trialability attribute, which states that if innovation can be applied in a limited scope it can positively influence its adoption and is an important factor when deciding to adopt or reject an innovation (Rogers, 2010). In blockchain case, it seems that many organizations choose not to pursue further adoption of the technology (Gartner, 2019b).

Food safety and traceability within the food supply chain is at the top of the agenda and a lot of effort is spent to fight food fraud or any type of food adulteration (Rsp4:26, Rsp7:44). This drives the need for transparency and trustworthiness in the system. The focus on food safety and quality and avoiding food fraud is in line with the literature presented earlier by Bosona & Gebresenbet (2013). Different stakeholders are interested in different aspects. Transparency, integrity of data and immutability are considered highly relevant to ensure food safety requirements are met which is important for authorities (Rsp3:23; Rsp6:21, 46, 49). Meanwhile quality is mostly relevant for the consumers (Rsp3:23) as the consumer expects food to be handled in a correct way regardless of whether blockchain is used or not (Rsp1, 44). In general, the consumer is not interested in how the technology works (Rsp8:53, 66). Interestingly, while the majority of respondents considers the aspect of transparency to be highly important, some respondents (Rsp2:23, Rsp4:18) do not believe it is necessary for everyone to be able to read every transaction. It largely depends on what information is hosted on the ledger, who are the stakeholders and what is the purpose of the blockchain application. There is a lot of confidential information in a business-to-business environment and selective transparency is a must. While blockchain technology offers a possibility to secure information by means of restricting access and encryption, potential harm can come if secret keys protecting information get stolen or exposed (Swan, 2015).

Transparency and integrity of data in the food industry would still be a great beneficial factor. All the stakeholders should be able to find information and trust it (Rsp4:45) and it could actually play a role in increasing consumer confidence (Rsp3:39; Rsp6:64; Rsp8:51, 52). Heightened public awareness of food safety issues can push the development of food traceability systems (Golan et al., 2004). However, if product information is hosted on the blockchain and shared with the consumers, transparency and integrity of data may not have a big impact in improving consumer confidence. Rsp4 (53) believe consumers do not have the habits formed to constantly check product information. On the other hand, consumer confidence can be influenced indirectly. If integrity of data related to a product is secured and the risk of tampering is eliminated, this could greatly reduce the risk of non-compliance and food fraud incidents (Rsp3:46; Rsp4:63), which could potentially result in customers perceiving such products safer and higher quality (Germain, 2003).

The immutability aspect of blockchain technologies is considered by some respondents as an integral part of the blockchain technology and a highly relevant characteristic, usually considered in the same category as integrity of data (Rsp1:20, 44; Rsp2:8, 35; Rsp6:21, 46, 49; Rsp8:38). On the other hand, to keep permanent records on the ledger is not a necessary requirement for food products due to their short lifespan. The requirement to keep records for certain period of time comes mostly from food manufacturers (Rsp4:10, 14) and legislators (Rsp3:21). After 6 years, potentially a new blockchain could be re-started to avoid cluttering it with irrelevant data (Rsp1:31).

6.2.3 *Reliability, Privacy and Versatility*

The reliability aspect of the blockchain is a little hard to pin down as different interpretations exist in the literature and in our findings. In our thesis we highlighted the reliability as the redundancy of data created by multiple copies of the ledger within different nodes. Findings show mixed opinions where reliability is considered highly important due to legal requirements and ensuring integrity of data (Rsp2:8, 35; Rsp4:16, 69) or considered not as relevant as the redundancy aspect is taken for granted (Rsp1:22; Rsp3:21; Rsp6:38; Rsp8:21, 41).

As mentioned earlier, some respondents believe that information within the blockchain should be handled with care. It is essential that in a business-to-business environment confidential information is protected. Due to the nature of sensitive information, it is unlikely that public blockchain can be considered in a business-to-business environment, however private, consortium and hybrid blockchains should be able to deal with the requirements to protect sensitive information ((Tapscott et al., 2016; Bashir, 2017). The trade-off is, however, that other than public blockchains, they have a higher risk of data tampering as outlined by Zheng et al. (2017). Some respondents consider privacy to conflict with transparency. There are opinions it is not critical to hide behind the data and in some cases, regulators should be able to identify the entity behind it (Rsp2:19; Rsp1:22, 27; Rsp8:23). Nevertheless, caution is expressed regarding how data should be handled, mostly due to GDPR requirements and the confidential nature of information (Rsp4:18; Rsp1:54; Rsp8:72). The potential harmful consequences of recording every event in a blockchain are also outlined by Swan (2015), Beck et al. (2017) and Beck et al., (2018). While the blockchain technology provides a possibility to be anonymous and reveal identity when needed (Iansiti & Lakhani, 2017; Seebacher & Schüritz, 2017) it is advised to carefully consider what information should be recorded.

Versatility can also be a valuable blockchain characteristic in certain cases. With current digitalization trends and the fourth industrial revolution (industry 4.0) happening, there is a big potential of integrating IoT devices with blockchain technology (Rsp1:29, 38; Rsp3:42; Rsp8:30). Blockchain applications beyond cryptocurrency application are also discussed by Swan (2015) and Beck et al. (2018). The versatility aspect of the blockchain can improve confidence in track and trace processes as IoT devices could potentially automate and replace manual data entry. Furthermore, IoT devices combined with logs in the blockchain could act as a backup evidence in case of food contamination incidents (Rsp1:54) and even result in fewer legal requirements needed regarding certifications (Rsp8:44).

6.2.4 *Blockchain Challenges and Limitations*

Throughput and Latency

The throughput and latency drawbacks within blockchains are often cited and cryptocurrencies such as Bitcoin and Ethereum are given as an example to showcase this limitation (Swan, 2015; Conoscenti et al., 2016; Wüst & Gervais, 2018). We decided to keep this limitation in our framework due to different possible requirements for data throughput within different parts of the food supply chain. While there are some diverging opinions on this particular topic, the general consensus amongst our interviewees is that throughput and latency limitations can be highly relevant when trying to adopt blockchain technology. However, the reflections were mostly based on general feeling and perception (Rsp2:97; Rsp8:76) and sometimes cryptocurrency transactions were brought up as an example for a high risk regarding throughput and latency (Rsp6:120). In some cases, respondents were not entirely sure if this is a limiting

factor at all (Rsp3:67; Rsp4:96). The lack of precise arguments regarding this technical challenge shows the complexity of the problem. It can negatively influence the blockchain technology adoption as according Rogers (2010), the higher perceived complexity of innovation, the slower the adoption of an innovation. On the other hand, Rsp1 (77) does not consider throughput and latency to be a big challenge anymore and believes that it is an architectural problem that must be addressed when designing the system. It is not necessary to capture every record. This argument in favour of the available efficiency of private blockchains is also in accordance with arguments brought forward in the literature (Androulaki et al., 2018).

Awareness and Understanding

While the blockchain is sometimes used as a buzzword and there might be a general lack of understanding of the technology itself, the majority of respondents believe deep knowledge is not required to identify its benefits. Blockchain technology should be treated as any other IT solution and the know-how does not need to rest within the decision makers, but rather within the experts responsible for implementation. However, Rsp2 (107, 109, 113) highlighted that there is a gap of knowledge even within the blockchain consultants. In addition, the hype regarding blockchain and the fear of missing out can be very strong. According to Rogers (2010) when evaluating innovation, most people rely on subjective opinion of other individuals who adopted the technology rather than relying on a scientific approach. This can result in a potential risk of using blockchain for the wrong purpose or in a wrong environment (Rsp2:79), therefore blockchain technology should be considered just as another IT solution with the focus on transparency, integrity of data and immutability (Rsp1:78). The understanding of trustworthiness of information is more important than the know-how (Rsp6:121; Rsp8:79).

Organization

The collaboration between organizations can be one of the most important challenges that can get in the way of successful blockchain adoption. Organizations tend to prioritize their own internal traceability systems (Rsp3:96) and one of the key challenges for an effective food traceability is the lack of standardization of information between various links in the chain (Thakur & Donnelly, 2010; Thakur et al., 2011). In a blockchain environment collaboration can be difficult as different stakeholders may have different input values. Furthermore, organizations sitting on the most critical information may benefit the least from a blockchain solution (Rsp1:82) which could result in reduced willingness to collaborate and update with the necessary information (Rsp3:73). The collaboration aspect can be especially difficult for traditional organizations that are used to work in silos (Rsp6:121), even more so if the chain is long (Rsp8:81, 83). On the other hand, the food industry is developing a positive attitude and openness towards modern technologies such as blockchain (FDA, 2019), which could lower the resistance to adopt blockchain technology (Rsp4:118, 120). According to DOI, a social system could greatly influence the adoption process (Rogers, 2010), therefore if stakeholders in a chain are interested in solving a common problem and see a blockchain technology as a potential solution, the adoption is much more likely to succeed.

Culture

A paradigm shift is happening in the world where trust is delegated at the object level which is governed by other objects rather than a central authority (Tapscott & Tapscott, 2016). A strong notion towards decentralization and self governance of the supply chain is shared by Rsp8 (87). The decentralized nature of the blockchain may require big adjustments in a corporate culture, which relies on central authorities and a traditional way of doing things (Grewal-Carr & Marshall, 2016). Such mind-set can hinder blockchain adoption (Rsp2:79; Rsp6:122),

especially when not the technology itself, but business processes and business models are considered to be the main barriers of technology adoption (Mori, 2016). The challenge of changing business models and business processes is also highlighted by Rsp6 (121, 122). Some respondents believe blockchain should not be treated differently than any other IT solution and generally that resistance is related to awareness and understanding of the technology (Rsp1:83, Rsp4:120). According to DOI theory, as time passes and general awareness towards blockchain increases, the adoption rate will increase (Rogers, 2010). While culture maturity towards decentralization is growing, adoption may depend on the area of implementation (Rsp:123) and geographical location (Rsp3:75).

Cost and Efficiency

One of the bottlenecks of blockchain technology lies within scalability. Blockchain does not scale well and as the volume of transactions increases, energy costs rise tremendously (Bloomberg J., 2018). Due to high costs compared to traditional databases, before deciding to implement a blockchain solution it is important to identify essential information that should be hosted on the blockchain while the rest should be stored outside the blockchain (Rsp1:83). Overall, there is a general uncertainty amongst the respondents regarding costs related to blockchain applications (Rsp2:83, Rsp3:78, Rsp4:123), therefore we can argue that blockchain is not yet widely perceived as a very expensive solution. It is possible that the cost issue will be less relevant in countries with access to cheaper energy sources (Rsp3:78). However, it can still be difficult for organizations to divide the costs due to varying levels of benefits of blockchain implementation between different stakeholders (Rsp3:78). While the cost can hinder blockchain adoption if a business cannot justify the returns (Rsp6:123), early adopters are prepared to commit more resources in order to profile themselves around the blockchain technology (Rsp8:93).

Regulation and Governance

Overall the lack of regulations aimed at blockchain technologies outside the financial industry (Swan, 2015) is considered a positive thing by the majority of the respondents. Regulations and governance are not perceived as a necessity as the trust is built by the blockchain technology itself (Rsp1:91, 93) and without governance interference, it is easier to innovate (Rsp8:95). Due to globalization, the supply chain in the food industry can involve multiple countries which can make matters very complicated as each country has its own rules and regulations (Rsp1:84). According to the DOI theory complexity is one of the attributes that negatively affects the adoption of innovation (Rogers, 2010). However, government institutions looking into blockchain technology could also have a positive impact on the adoption by promoting modern technologies to secure food traceability (FDA, 2019). This is in line with comments made by Rsp4 (127) who believes the government resistance will further decrease as they recognize the benefits of blockchain technologies for improving food traceability and efficiency of recalls. The non-controversial reputation of the blockchain technology is further supported by the literature (Crosby et al., 2016). On the other hand, some regulations might be necessary for the development of the blockchain platforms to avoid abuse of power by corporations that have a lot of influence and resources.

7 Conclusion

This chapter summarizes this research study by highlighting the most important findings. In the first section we describe how the study has answered the research question and fulfilled the purpose stated in chapter one. The following sections presents the key findings regarding the blockchain technology characteristics and challenges, and some suggestions of future research to be done in this area.

7.1 Research Question

The ambition of this thesis was to explore the benefits and challenges of blockchain technology and how it can be leveraged to improve food traceability in the supply chain within the food industry. We therefore proposed the following research question:

"How do the blockchain technology benefit food traceability within the food industry's supply chain?"

To answer this question, we have developed a theoretical framework consisting of food traceability drivers and blockchain technology characteristics and challenges. We have used this framework to evaluate the use of blockchain technology within the context of food traceability by conducting a qualitative study where we interviewed eight experts with different backgrounds related to the food industry. These experts were asked to evaluate the importance of each of the blockchain technological characteristics against each food traceability driver on a scale of *low*, *medium* or *high* where high represents the highest importance, explaining why they chose that answer. The experts were then asked to evaluate the relevance of challenges faced by blockchain technology as barriers towards the adoption of the blockchain technology on a scale of *low*, *medium* or *high* where high represents a highly relevant challenge. Again, these experts were asked to give an explanation and context for their answers.

7.2 Key Findings

In this section, we present key findings emerging from this study about characteristics of blockchain technology, as well as challenges faced by blockchain technology applied to the context of food traceability.

7.2.1 Blockchain Technology Characteristics

In our empirical findings it became evident that most respondents did not differentiate much between the drivers behind food traceability when evaluating blockchain technology. From the blockchain perspective it makes little difference if the need to improve food traceability comes from new standards and regulations requirements, or safety and quality aspects or due to social and economic concerns.

Our respondents almost unanimously consider the transparency and integrity of data as the most relevant blockchain characteristics for food traceability. The aspect of immutability is also

considered highly important and is often labelled in close relation to the integrity of data as it makes information immutable and almost impossible to change. These three characteristics are what defines blockchain technology and can potentially solve the key challenges for an effective food traceability system related to transparency, trust and other data-related issues as outlined earlier in the problem area. However, according to our study, the immutability aspect of keeping food related records permanently in the blockchain is not considered important. Due to the limited shelf life of food, the information may become irrelevant after a few years and end up wasting resources as time goes on.

We have shown that the transparency and data integrity enabled by the blockchain can especially be useful for building trust with authorities and provide an advantage when performing audits. This is one of the key aspects tackled in research. Food safety is one of the top focus areas in the food industry and a lot of effort is spent on the prevention of food fraud and food contamination. As the supply chain usually involves multiple stakeholders, there is a need to have a trustworthy and transparent system. This is where blockchain technology can excel when compared to traditional ERP systems as there is no central authority responsible for the data. However, blockchain is only as good as the data it contains. A lot of attention should be given to ensure the data entered in the blockchain is correct as it is impossible to apply any changes to it. Blockchain can also provide an opportunity to improve collaboration between the stakeholders within a supply chain as the blockchain potential can only be realized when stakeholders work together.

According to our empirical findings, reliability and privacy are the least relevant blockchain characteristics for food traceability. At this age, when cloud solutions are dominant, the redundancy of data by keeping multiple copies of the ledger is taken for granted and should not be a selling point of the blockchain. Privacy is often conflicting with transparency and when it comes to food traceability, the more transparency, the better. While it is possible to safeguard sensitive information to some extent through encryption and restricted access, blockchain is not a suitable solution if confidentiality is of utmost importance.

Interestingly, empirical findings show that the aspect of versatility of blockchain technology illustrates well different priorities of different drivers behind food traceability. The integration of blockchain technology with IoT devices can greatly improve the confidence in track and trace processes by automating data entry and potentially recording more information. According to the literature, further opportunities of automating transactions via smart contracts exist, however most respondents focused on IoT integration exclusively.

7.2.2 Blockchain Technology Challenges

There are multiple drawbacks that can limit the adoption of the blockchain. Our empirical findings show that throughput and latency is still perceived as a highly limiting factor, however no hard arguments are provided on why it would be a big challenge for food traceability specifically. Throughput and latency should not be a big challenge if this limitation is considered when designing the blockchain platform. However, scalability can still be an issue as many blockchain initiatives remains in a small scale and never leave proof of concept phase. The higher energy requirements when scaling up translates to high costs which can be difficult for businesses to justify.

According to respondents, collaboration between organizations can be a very challenging aspect when implementing a blockchain solution. The blockchain will not replace internal traceability systems which are often a primary focus for many organizations. To succeed, every stakeholder in the chain must recognize the added value. The unwillingness of one chain participant to share information could fail the whole initiative. Smaller chains that already have a good cooperation are more likely to overcome the collaboration challenge. However, if participants in smaller chains already have a trustworthy relationship and efficient food traceability systems, it is unlikely that a blockchain will be able to provide much additional value.

Based on our empirical findings, it is not important to understand in detail how the technology functions to identify the benefits. The blockchain technology should be treated as any other IT system and only be used for the right purpose, such as if there is a need for high transparency and high trustworthiness of data within a chain. However, to successfully adopt blockchain it might require some business flexibility and the change of mind-set to place trust in a decentralized network.

7.3 Future Research

The food industry can be really complex and represent several different contexts based on the part of the food supply chain they represent, the size of the companies, the type of food products being dealt with and the countries being involved, with various governments regulations. In our empirical study we were not able to represent all parts of the food supply chain as illustrated by Tian (2017). Furthermore, to provide some generalizability we took a very high level approach when discussing possible benefits of blockchain technology for food traceability. Future studies could narrow down the scope and focus on different parts of the food supply chain that have already implemented a blockchain solution. Alternatively, future studies could focus on a blockchain implementation within a small food supply chain. In all these contexts, the blockchain challenges for its adoption in the food industry could have a greater emphasis, since there are almost no papers regarding this subject.

Appendices

Appendix 1 - Interviews Preparation

Contacting Respondents

Message sent to invite respondents:

Title:

Academic Interview about the use of Blockchain for Food Traceability

Message:

Hi X,

How are you?

I am a master's student at Lund University in Sweden and I am doing my master thesis on the use of blockchain for food traceability together with another student named Gediminas Rapalis.

Would it be possible to conduct an interview with you for our thesis? We will present you some characteristics and challenges of Blockchain technology and ask how relevant you think they are for the main food industry supply chain drivers. I believe there is a lot that you can add to our research. The idea is to have a physical or Skype interview from 60 min to 90 min, according to your availability. This interview will be recorded and transcribed in the thesis if you authorize. There is also the possibility of anonymizing your identity if you prefer.

In case you are not available, there is someone else that you can recommend me regarding this subject?

Thank you very much!

Warm regards,
Soraya Sybele Hossain

Interview Guide

These questions were asked with the support of a card exercise, as a visual tool for the interview, to make it more interactive and focused:

Questions - Part 1 - Food Supply Chain Drivers versus Blockchain Characteristics:

Related to the Standards and Regulations Driver:

1. How useful Transparency is for Standards and Regulations? Why?
2. How useful Integrity of Data is for Standards and Regulations? Why?
3. How useful Immutability is for Standards and Regulations? Why?
4. How useful Privacy is for Standards and Regulations? Why?
5. How useful Reliability is for Standards and Regulations? Why?
6. How useful Versatility is for Standards and Regulations? Why?

Related to the Safety and Quality Driver:

7. How useful Transparency is for Safety and Quality? Why?
8. How useful Integrity of Data is for Safety and Quality? Why?
9. How useful Immutability is for Safety and Quality? Why?
10. How useful Privacy is for Safety and Quality? Why?
11. How useful Reliability is for Safety and Quality? Why?
12. How useful Versatility is for Safety and Quality? Why?

Related to the Social Driver:

13. How useful Transparency is for the Social Driver? Why?
14. How useful Integrity of Data is for the Social Driver? Why?
15. How useful Immutability is for the Social Driver? Why?
16. How useful Privacy is for the Social Driver? Why?
17. How useful Reliability is for the Social Driver? Why?
18. How useful Versatility is for the Social Driver? Why?

Related to the Economical Driver:

19. How useful Transparency is for the Economical Driver? Why?
20. How useful Integrity of Data is for the Economical Driver? Why?
21. How useful Immutability is for the Economical Driver? Why?
22. How useful Privacy is for the Economical Driver? Why?
23. How useful Reliability is for the Economical Driver? Why?
24. How useful Versatility is for the Economical Driver? Why?

Related to the Technological Driver:

25. How useful Transparency is for the Technological Driver? Why?
26. How useful Integrity of Data is for the Technological Driver? Why?
27. How useful Immutability is for the Technological Driver? Why?
28. How useful Privacy is for the Technological Driver? Why?
29. How useful Reliability is for the Technological Drivers? Why?
30. How useful Versatility is for the Technological Drivers? Why?

Wrap up question for the first part of the interview:

31. There is any food supply chain driver or blockchain characteristic that you would like to add to our list? Why?



Figure 17. An example of the physical version of the card exercise for the first part of the framework

Questions - Part 2 - Blockchain Adoption Challenges:

32. How Transparency can influence the adoption of blockchain technology?
 33. How Integrity of Data can influence the adoption of blockchain technology?
 34. How Immutability can influence the adoption of blockchain technology?
 35. How Reliability can influence the adoption of blockchain technology?
 36. How Privacy can influence the adoption of blockchain technology?
 37. How Versatility can influence the adoption of blockchain technology?

Wrap up question for the second part of the interview:

38. There is any challenge or limitation that you think we should consider? Why?
 39. How was your experience with this card exercise? Are there any suggestions for improvements?
 40. Is there any addition consideration that you would like to make or present an interesting case for us?



Figure 18. An example of the physical version of the card exercise for the second part of the framework

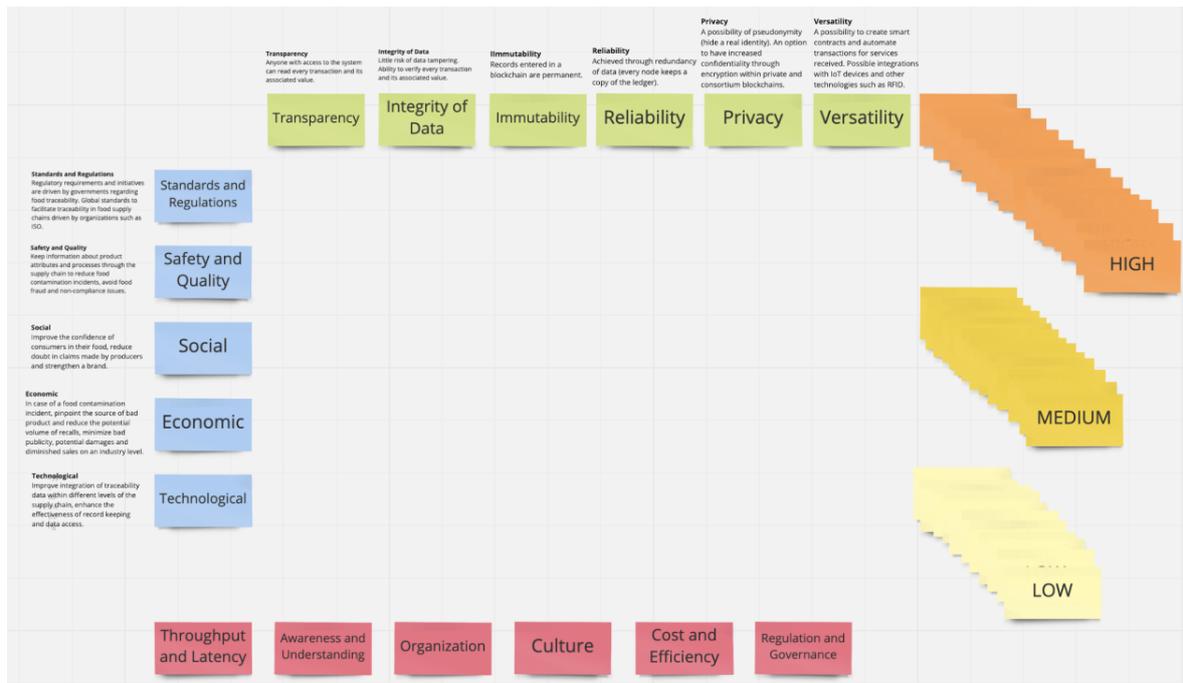


Figure 19. An example of the virtual version of the card exercise

Card Exercise

Blockchain Characteristics

Transparency

Anyone with access to the system can read every transaction and its associated value.

Blockchain Characteristics

Integrity of Data

Little risk of data tampering. Ability to verify every transaction and its associated value.

Blockchain Characteristics

Immutability

Records entered in a blockchain are permanent.

Blockchain Characteristics

Reliability

Achieved through redundancy of data (every node keeps a copy of the ledger).

Blockchain Characteristics

Privacy

A possibility of pseudonymity (hide a real identity). An option to have increased confidentiality through encryption within private and consortium blockchains.

Blockchain Characteristics

Versatility

A possibility to create smart contracts and automate transactions for services received. Possible integrations with IoT devices and other technologies such as RFID.

Food Supply Chain Drivers

Standards and Regulations

Regulatory requirements and initiatives are driven by governments regarding food traceability. Global standards to facilitate traceability in food supply chains driven by organizations such as ISO.

Food Supply Chain Drivers

Safety and Quality

Keep information about product attributes and processes through the supply chain to reduce food contamination incidents, avoid food fraud and non-compliance issues.

Food Supply Chain Drivers

Social

Improve the confidence of consumers in their food, reduce doubt in claims made by producers and strengthen a brand.

Food Supply Chain Drivers

Economic

In case of a food contamination incident, pinpoint the source of bad product and reduce the potential volume of recalls, minimize bad publicity, potential damages and diminished sales on an industry level.

Food Supply Chain Drivers

Technological

Improve integration of traceability data within different levels of the supply chain, enhance the effectiveness of record keeping and data access.

Blockchain Challenges

Throughput and Latency

The time for a transaction to be placed and validated in a blockchain can be different depending on blockchain type, the number of nodes and the transaction validation method (around 15 transactions/second for public blockchains and 3500 transactions/second for private ones).

Blockchain Challenges

Awareness and Understanding

Lack of awareness of the technology and lack of understanding of how it works.

Blockchain Challenges

Organization

The blockchain creates the most value for organizations when they work together on common interests and common problems.

Blockchain Challenges

Culture

Moving away from the traditional way of doing things due to the adoption of a new technology that places trust and authority in a decentralized network rather than in a powerful central institution can be challenging.

Blockchain Challenges

Cost and Efficiency

Blockchain implementation requires high amounts of energy and storage, that can increase costs. It is difficult to decide how the cost and processing load will be shared among participating organizations.

Blockchain Challenges

Regulation and Governance

Since its, a relatively new technology, governments, and financial institutions are seeking for regulation, especially for cryptocurrencies. Outside financial industries there has not been much focus on regulation.

LOW

MEDIUM

HIGH

Appendix 2 - Pre-Study Interview

Respondent: Jonas Bengtsson - Solution Architect and Blockchain Specialist at Tetra Pak

Date: 25th April 2019

Interview Type: In Person

Duration: 1:18:21

Interview Language: English

Line	
1	To answer your questions or to kind of draw some kind of big picture on this. I want to know, kind of, how much you know or what do you think that blockchain as such.
2	Because for me, blockchain is a technique that you could enable for a good purpose, where the solution is requiring.
3	If you don't need it, don't use it. If it adds value, use it. And bring it in carefully. I mean, everyone says that so... That can be.
4	So, so my question to you is, how do you elaborate on that. What are your thoughts on this?
5	Interviewer
6	Well, what we see is that, let's say blockchain have some very good quality characteristics.
7	If you say, when it comes to this relevant for food traceability such as immutability, transparency and integrity of data.
8	But as you say, then you have a different blockchains right? Public and private ones.
9	And some of those qualities largely depend on, you know, what kind of blockchain for example you're using what kind of consensus mechanisms are there.
10	So for us...
11	Interviewer
12	... And now its kind of a trending topic to see use of blockchain for everything.
13	And we, we want to know if it's really necessary if it's really useful, and what exactly can contribute for this area, so that's why we wanted some opinions as well.

14	Because we saw some successful cases we didn't get a lot of information or unsuccessful cases, that's what we wanted and that could be interesting for us.
15	Mainly, understanding if it fits, or not inside a company, or if you think it fits or not.
16	Jonas
17	Yeah, let's start this... I don't know where to start this, really.
18	If you think of it from an internal company point of view, what would be your thought on where it should be suitable to use blockchain?
19	Interviewer
20	Traceability... mainly
21	Jonas
22	Would you not be able to do that without blockchain?
23	Interviewer
24	It depends on the properties and characteristics that you need...
25	Jonas
26	Within your own company? If you don't trust your own employees who would you trust?
27	Interviewer
28	Yeah... but if you have different suppliers that, mainly...
29	Jonas
30	Now we're inside the company.
31	Interviewer
32	Yeah, okay. Yeah...
33	Jonas
34	Only inside a company where would you fit blockchains into that?
35	Interviewer
36	You kind of want to have to avoid, let's say, possibility of some error, right?
37	Because blockchain can hold information and you want to ensure that this information is correct.

38	So if we're talking about, or if I think about TetraPak point of view is what I, in my head, I imagine so you have a bunch of sensors that can record some sort of information and you put this information into the ledger that is blockchain.
39	And you want to make sure that is okay, can't be tampered, it can't be changed by anyone, and that the tool always was what you put it there, you cannot, you know, rollback and do any changes to it so that it can be very... in a confident way presented that is okay as an archive, sort of, you know, that is untampered and that is correct.
40	Interviewer
41	It comes from the trust issues that you mentioned, there was some causes of fraud inside companies that some employees put some dangerous substances in some food, production or parts and they cause some problems in the end line, and that was really hard to detect.
42	Interviewer
43	I think you know about the beef case, the French manufacturer where they changed the custom labels and sold it as a beef when you bought the horse meat.
44	Jonas
45	But then then ask one question: is it possible to fake the data in a blockchain?
46	Interviewer
47	Well yeah, it depends if what you enter right? So if you enter fake data it's going to be fake data from that point of view.
48	Interviewer
49	Yes the blockchain is just a ledger that gets information inside so it depends on the way that you acquire that data. It can be fake or it can be trusted depends on the way that you get it.
50	Jonas
51	The biggest difference there is that if you set up a blockchain the smart way you would know who lied when they lied. And you can't really change that. But inside your own company...
52	I mean, if you look at it, look at it from a SAP point of view, you have a change log on, who has done that we have the name just all over the place.
53	So we have the name. We have the dates. And we have a complete changelog.
54	So from their point of view I don't see a reason for having a blockchain.

55	Because there's nothing to share with anyone.
56	Blockchain in my mind is something that you share with someone else.
57	There's a reason for sharing it. Or there's a reason for trust.
58	And as soon as you go outside your company, then is the question of who will you have this blockchain together with.
59	Because blockchain is part of a solution that is run as a team sport.
60	Which means that the three of us have something to share. But we don't necessarily trust each other.
61	So if I promise to pay you something based on that you have made some service of something.
62	As soon as I have done that and can prove that or you have done that and can prove that was happened.
63	Then I committed myself to pay. That's the contract, that's the smart contract or that's a paper copy.
64	The thing with a paper copy is that you and me will have one each.
65	And he doesn't sees it. If it's interesting for him to take over what you have produced and sent to me, and know that I am a user or owner that, that could be information that could be shared.
66	And that should be trusted information, for instance.
67	But as long as you're within your own corners, I have problems seeing the value of blockchain.
68	Because the blockchain, don't even, it's not even possible from an IT point of view, to set up a blockchain with one node. Because that's a database.
69	And you have all the keys to change everything. And you have the consensus mechanism, which you can choose as you wish...
70	Interviewer
71	... and you lose all the good properties ...
72	Jonas
73	... so you can go all the way down to the genesis block and build it up again, and you can change as much as you want to. And you don't have, you haven't add any trust at all.

74	Interviewer
75	What about the data, okay, within the company.
76	I see your point, but then usually this data that you can be used through the supply chain so if I, if I'm a consumer, and I scan my product.
77	I want to get information through all the chain, and this information, I want to know that it's gonna be trustworthy.
78	And then, as if you look at it from one company's point of view, it makes no sense.
79	But then, this data, that you have in your node, you share with the supplier node, that share with the logistics company another node, maybe with the retailer's has another node...
80	And for what I've seen so far, retailers have the driving force to apply this technology within the supply chain.
81	But, which is been driven by the consumers.
82	Jonas
83	Why do you think that?
84	Interviewer
85	Why? It's because there's a bunch of events that happened with the food contamination.
86	And it's kind of a demand is coming from the consumer pathway, from what I see at least so far, that the consumers want to know.
87	Because, if you buy...
88	Also the retailers they have their own brands as well.
89	So if something happens... It's the, you know, the retail brand that will suffer not the, maybe, manufacturers somewhere in early stage.
90	Jonas
91	They want to push down the lane trick, train, a bit. And who doesn't want to have the blockchain? who doesn't want to have it thought?
92	Interviewer
93	Well, probably the manufacturers. They are not so, interested that least according the research.
94	Let's say that...

95	What is your incentive to be super transparent were the only thing that can happen to use, can bite you back. If something happens.
96	Jonas
97	What do you think is the biggest hurdle to get the blockchain working?
98	Interviewer
99	Well, my guess maybe would be have multiple stakeholders agree on that maybe?
100	Jonas
101	The whole setup of a blockchain rules.
102	What should go on to the blockchain, what should not go into the blockchain, who is contributing, who is reading, what is the agreement, and who's paying for the whole thing.
103	That's over 90% of the blockchain work.
104	10% is the technique and gettin that, that's a no brainer.
105	Actually, it's extremely quick. It's simple to get into play, but agreeing within companies...
106	Because you need to think about it like this stuff.
107	You have competition and your customers are playing out competition between suppliers.
108	So when we are a supplier to our customer, we also have our competitors that are suppliers to the same customer.
109	How much of our information do we want to share with them that they can use in a bad way, against us, or vice versa.
110	There is a reason why companies is not sharing information today. One is that they're afraid of losing business.
111	Another thing is stupidity.
112	Because if you think about sharing information for the good of yourself, or for others, is pretty harmless.
113	But you need to agree upon the rules, and you need to get more back than you pay for it.
114	So, if you think of it from a logistics, because I think you have been looking at this logistics shame, a number of times.

115	I guess if you'd have been recently reading about the avocado from Kenya, 30 different...
116	Different people, stakeholders, or organizations that is touching, somehow, the avocado from where it's harvested until it's in the shop.
117	And that means that you have the people in the field.
118	You have them harvesting it, them to the boxes, the boxes go to the truck, the truck is loading it over to containers, the container is loaded in ships, it's on the boats, you have all the clearances from customs from health security from whatever agriculture staff that you can think of...
119	And then the boat is arriving somewhere, it's reloaded, it's going away on the boat again.
120	Then it arrives in some port somewhere where its custom played.
121	And then it continues its journey, quiet, with so many people, touching the whole thing.
122	And the good thing with blockchain is that you don't really know who will touch it.
123	You know what should happen, because it will go through customs and they will need to approve it, that you know.
124	And everyone else that is handling it could, potentially report, that they have been doing something with. They can approve it, they can say that they have loaded, unloaded it, because they get paid from a transport point of view, so, I have loaded his container to my truck and now I have a confirmation from somewhere else that I have unloaded it.
125	Please pay me for the work that I've done because my proof that I actually worked is now on blockchain. You have agreed to a smart contract that you will pay me for picking up and delivering.
126	So, each of these small steps in the supply chain you can think of it like a receipt of an action that is actually happening.
127	You see status. You see progress. And you can actually put a smart contract for payment on it. And that's a cool thing.
128	So how secure will this blockchain be? From data and status point of view.
129	Interviewer
130	Secure...?
131	Jonas

132	How do you know that the status is accurate?
133	How do you know that the status actually happened?
134	Interviewer
135	Well, it all depends. The means, how is it recorded right?
136	Is it one scanner? So, you...
137	From what I understand...
138	You have to have some sort of redundancies, because again, if you decide on one transmitter, or one sensor or one scanner, and they find a way to somehow...
139	or they are malfunctioning...
140	Jonas
141	This is very much like manually going into website on your phone.
142	It seems to be a thing that exists everywhere.
143	Interviewer
144	So there has to be some sort of way to double check kind of...
145	Jonas
146	The thing is that you approve or you confirm that I have come, and unloaded truck, because your input that I have unloaded the truck is validating that you are not responsible for it anymore. I become responsible for it, and that you receive it.
147	At my end is kind of might prove that I'm not responsible for it anymore. And you take ownership of it. And it's also proved that I have done to work.
148	Interviewer
149	Yeah this kind of invalidates as well...
150	Jonas
151	Yes, but thing is that if you don't put something into the blockchain.
152	Or someone else say, "no, I don't care about this"
153	Interviewer
154	Will collapse or something.
155	Interviewer

156	Yes, agreed.
157	Jonas
158	Then then the entire thing collapses, and you have a 30 chain process that is broken somewhere.
159	And what has happened with it from a traceability point of view. At that point in time?
160	But yes, you can add sensors IoT devices. And inside a container which will give you an average temperature the highest peak the lowest peak, GPS coordinates...
161	You can see if you have dropped the container because there's a shake sensor in it.
162	You can see if someone has opened it and when they have opened it, because it could record that light that has going to it, or the air pressure that has changed.
163	All of that is possible, add values and awareness.
164	Interviewer
165	If I just come to the argument where they do not want to, let's say, some someone in the supplier chain say "I don't have resources, don't have time, whatever..."
166	If you want to get payment you do this, you don't do this step, well...
167	Someone who didn't do the step does not get paid, or has a penalty for it. I mean...
168	Jonas
169	I totally agree.
170	Interviewer
171	... kind of one way to ...
172	Jonas
173	Fantastic. But what you're talking about now is that the agreement between you and me, is has nothing to do with the blockchain. Because the rules for that are set by a consortium for the public.
174	So who is writing rules? It's kind of like, yes we want to write it, who is writing it?
175	Well, no one really knows and who owns it...
176	Well from a public point of view, no one owns it and that's the fantastic thing...
177	Interviewer

178	In the smart contracts, you can make a rule that you have to register the data for it to trigger, somehow, like when you finish up and you're not into one, as you say, register anything, then the smart contract wouldn't trigger.
179	Jonas
180	Sure... and that's absolutely correct.
181	And then you have the competitor in this environment, which is saying: "Blockchain? No, not really" We are much better, we have a simple solution.
182	So from a tracking point of view. You come to us.
183	We have all events that happens to any truck, forklifts, anything that goes on the road, train or boat or flight, we have it all.
184	So just register to us, and if you register all the events to us, we take care of the payments as well.
185	So, if I would say that you are forced to go into my blockchain and do this and say: "Well, I already have an agreement with that guy who is sorting this out anyway, so yes, you can talk to him and see if he can have that information because I don't want to do it in two places".
186	So while I'm lowering your into here is kind of like one of these discussions that we have had along the road here of use cases, and where you kind of come into arguments and stuff that some is very pro and some are definitely not.
187	And then it all boils down to. What's the added value for anyone.
188	Because if there is no added value it's extra work that no one wants to pay for.
189	And the cost for blockchain is more expensive than any other IT solution.
190	And IT solution as such is not invented. So, according to Gartner 90% of all blockchain projects, could just as well be done in a normal database.
191	There is no real use case for that. So many of them have tried the proof of concept to run this as a blockchain to realize that, well, blockchain is not needed, but we have tested to talk to each other, to have an understanding of what we can share, what we can communicate, and they have continued with that, because it's a new way of thinking.
192	Interviewer
193	I'm just thinking, when you say the added value, let's say, probably you will never have as efficient system as centrally manage as you say one maybe a service provider that does the role of the blockchain, but takes responsibility of security and everything.

194	And imagine if one of the suppliers, were involved in some scandal, then the trust could collapse.
195	That's one of the risks maybe it's a small risk which I'm probably sure that has been discussed.
196	But then, all the investments, all the way of working, could be maybe not worth much, especially if you deal with the supplier...
197	If someone paid off the supplier, you know, I know, the owner of this service provider and I'm a big food producer...
198	You can manage locks inside, you know, you have the keys to the database, you know, you can do something probably...
199	Jonas
200	Now you came into certain places in certain countries where blockchain is not that popular. They don't want to have it.
201	Interviewer
202	Yeah, but but isn't that blockchain primarily, like China is especially looking at that, because in China is a cheap culture, kind of, you know, shortcuts and you know cutting the corners. And as a consumer like with this baby powder, for example, issued that has been the poisoning.
203	Jonas
204	Yeah...
205	Interviewer
206	Maybe added value in Sweden of truthfulness is not as much as this in other countries where the risk factor is much higher.
207	Jonas
208	I mean, you come from a country where... sorry to say that...
209	Interviewer
210	... no problem, you can say it ...
211	Jonas
212	... kind of, my wife's cousin is married to a lady from Argentina, and we were kind of discussing this...
213	And well if you're not caught, but that's fine.

214	If you're caught, well that's blame and then you go to church and say sorry, and then you continue as before.
215	Interviewer
216	Yeah, that's the culture...
217	Jonas
218	Do you have kind of like, all that from super honest to cheating as long as you come along with it.
219	But the problem for the companies, is that it will never be stronger than the weakest link, and if that goes down to individuals in the company we have a problem.
220	If it goes up to management, then the whole company's having a huge problem.
221	And... I'm looking for something here...
222	Interviewer
223	You know, from the cost point of view, hasn't been done some benchmarks to say, okay, the blockchain solution and alternative let's say the standardized the database solution by some supplier... Is it like... How many times is blockchain more expensive, if there's such a thing... If this has been set...
224	Jonas
225	Let me say like that...
226	I don't think that blockchain...
227	Let me say that like this...
228	What do you know about the way that Amazon, Microsoft and IBM, why or how they monetize on blockchain specific in this case, or any kind of cloud service?
229	Interviewer
230	How they monetize.
231	Jonas
232	How do they charge for their service? What seems to them...
233	Interviewer
234	Computing power right?
235	Interviewer

236	They provide all the technical infrastructure for it.
237	Jonas
238	And they sell you a service based on usage.
239	So, if you think of it like, I'm IBM, and I sell primarily a database storage, security, uptime.
240	And you have a small database with your stuff. And you have a small database with your stuff. I have a small database on my stuff. And then we'll do a blockchain of that together.
241	That means that your stuff, your stuff, and my stuff is in the same database. And then we replicate that by three times one per each node.
242	Then you can calculate why they are interested in using blockchain.
243	The more nodes that you add in, is a replica of the same database.
244	And since there's only an append part of this, you can't remove it, you cannot... there is not like a normal database where it can have a retention period saying, remove everything that is three years old, you store everything from the genesis ledger and onwards.
245	That comes into the next point of course saying: Store as little as possible on blockchain.
246	You should only save and share what is actually adding value for anyone.
247	But the guys who are providing you with a service.
248	They are selling storage, and availability.
249	On top of that, to analyze a blockchain database.
250	You don't go into the blockchain database.
251	You create a database on the side, which is structured like normal SQL database, which is fast and easy to read, and rights are mainly to read from which you've been combined with stuff that's off chain to have always an architecture of on chain data, off chain data and mix of the two for the user.
252	When you have that, you can imagine that the database that you had before, you still have it. And database you had, you still have it. But you have added a bit of his and mine, and that's your added value.
253	From payment point of view, we have first a consolidated database of all our information. And then I'll decide you have what you have today.

254	And then you have a third party, but that is the application layer on this.
255	So from monetizing point of view, from usage of service, now it's only micro cents for each kilobytes that you add on.
256	But it's quite a lot of them.
257	And that's where these companies, see a huge profit of this.
258	Experience is, for me, has been, for the my learning personal view on this is that Microsoft, IBM, Amazon, provide a service part.
259	They also provide typically a way to do the consensus part about the ordering service.
260	So you make sure that if you get multiple requests to put something on the blockchain, that is sorted out, and also goes out for validation, so get the consensus mechanism, working before you put it on the chain.
261	So they are handling that service and that's a tip, it's called ordering service when you go hyperledger.
262	And that's normally what is limiting the speed, the more complex consensus mechanism you have, the more power usage you will have for everyone else because that's also costs.
263	And then you come into to the game of just storing the information, which is what they want.
264	Interviewer
265	To sell solution, let's say, when you say, because the blockchain includes all information starting with the genesis block to recreate, let's say, new genesis block every certain amount of years to counter...
266	Jonas
267	The problem is that everything is built on the previous record...
268	Interviewer
269	But it's kind of like doing like a kind of a fork, if you will...
270	Jonas
271	Yes...
272	Interviewer

273	... you know, and you're starting something different than the, you know, again, and then you forget about the old one
274	Jonas
275	The example that is fantastic is Bitcoin.
276	There are a few of the initial Bitcoins.
277	That never been traded with.
278	So if you remove the genesis block they're gone.
279	There's no... Since everything is anonymized in that no one knows and owns it.
280	And if that person doesn't even know it. It will be there forever and you can't remove anything in the database.
281	That's a cool thing.
282	So it will just expand, and it grows, and you have a public consensus mechanism on it, and the nodes are replicated all over the place.
283	So from that point of view is not fun.
284	Interviewer
285	I'm really curious to know that, after all these studies, if you find some really... an usage for blockchain inside TetraPak that added some value because it's really quite hard to find.
286	Jonas
287	Sure
288	I think that, as you say, we come to a point where others thinks that we should join a blockchain for certain resource for a reason, it could be some auditing point of view, where you have external auditing, it could be because we are part of something bigger.
289	But the thing is that and that's my personal view, to understand blockchain you can't be alone.
290	You can't say: "Oh, it's so hyped blockchain, so I will create one by myself."
291	And you definitely haven't understood the whole picture or the concept.
292	Because if you build it yourself, you will have two problems:
293	First of all, there is no one to trust. If you're alone.

294	So your second version of that would be, well, I do it first and build it, and then everyone will join.
295	What's the added value for them? Join me, mine?
296	What's the investment cost on my side? Will anyone want to ship in from paying afterwards.
297	Interviewer
298	Probably not.
299	Jonas
300	So, I think, first thing is that, either someone like it consults you has something that runs and wants to involve us.
301	That could be a very good possible use case.
302	But currently, the central players, the one studies kind of like taking ownership of that as a central piece.
303	They are the ones that we're working with today.
304	Since data. We don't care if they use blockchain or not.
305	Because how they store the data that was kind of like, not of our concern.
306	Because we don't have a node on that, because you can't be part of the blockchain without having a node.
307	And you can be very active in the party of the consortium, build... to do this...
308	You can also do it like, starting a private blockchain, you can expand that to consortium, and you can make it public.
309	The problem that you will have, the more ownership that you take yourself.
310	The bill will be higher, and the risk is that competitors are doing the same thing, or that they don't agree to, what you have built into.
311	So, to get a really good case for blockchain, to bring in the people that you normally don't talk to and build something smart around that.
312	And then the question is: what is smart? And what is not smart.
313	Some people say it's about money some says trust.
314	There is fantastic part in Holland.
315	Holland is pretty good on blockchain, on governmental point of view.

316	So, I don't know, have you heard anything about there?
317	Interviewer
318	I heard about Estonia...
319	Jonas
320	They are also good, they're basing that very much on trust.
321	Holland, has... And think of it...
322	Think of the example that you have lampposts out in the city, lots of them, there is a shitload of lamppost.
323	They break. When you should fix them?
324	The community sends out somewhere to someone to repair it.
325	So first of all you need to issue a problem report, then you need to issue a work order, from that must be sent to a company, they go out, they repair lampposts, then they send the invoice to the community, someone is receiving that validating that it has been done, and paying it.
326	That's eight steps, total value, I don't know, let's say hundred euro.
327	Total administration cost for everyone, probably four times as much.
328	So they are trying to using blockchain.
329	Not only for me the purpose of trust, mainly for the purpose of event driven activities and reducing administration because administration doesn't add value.
330	So, setting an IoT device on the lamppost to tell if it's working or not. If it's not working. There is an event going into blockchain saying: this specific lamppost is broken.
331	That creates another event saying: here is a job opportunity for anyone that wants to have it.
332	To fix it.
333	They have a selection of of suppliers that are allowed to repair.
334	So anyone of this can take a posting on the blockchain saying: I'm taking ownership of this correction.
335	No one has touched anything from community point of view.
336	So that go out and fix it. In the smart contract. There is an agreement already saying that repairing this lamppost will bring a few... or money of... I don't know, 20 euros.

337	So they go out, they fixed lamppost, the lamppost IoT device say no I'm working again, on the blockchain. And the smart contract says: "Okay, now you get your 20 euros"
338	In the backend there's an automatic postings in their accounting systems.
339	But you have reduced all administration work.
340	You have actually made a commitment to a supplier that you didn't know who to send to because they picked it up.
341	So instead of sending it to the entire world, they have picked one. Because you have negotiate, you have said this is the price, this is what we will pay for this.
342	Is kind of like a freight auction, vice versa that you've seen in US maybe...
343	That they just say: I have something here that should be moved from here to here it's this size
344	And then they have an auction, and everyone is kind of like setting in high price and then they go lower, then lower, until the one with the lowest price takes it and moves it.
345	Interviewer
346	Are they using the public blockchain for this?
347	Jonas
348	They are using a consortium blockchain on this.
349	Interviewer
350	Okay. Who consists the consortium.
351	Jonas
352	There are few nodes, owned by the government, because this is not the trust issue part really...
353	Trying to show you a picture on something here... is...
354	This is something that I published on our internets
355	Interviewer
356	Is quite recent...
357	Jonas

358	Yeah it's fairly recent, you can maybe read it later, but it's kind of like, this is the example of Netherlands.
359	So from their point of view, they don't care too much about public or consortium to more even of blockchain. They want to reduce administration everyone is happy with that.
360	So, this is what I want to talk about.
361	So you can actually have this, so they will be more considered to be private.
362	So, you have there unknown parties.
363	And this is kind of what I can see that we will use in TetraPak.
364	Maybe if we will do something more internal.
365	It could be for a reason that we haven't really thought of yet, but there could be a reason for doing this on a blockchain from interacting with others whom we don't know...
366	We know that is someone of... a list of things that we don't really know who, but there are trusted partners all of them.
367	So by having a database that is recording something that has happened, we can make an event that is trying to do something else.
368	Interviewer
369	So the focus is more than... not to eliminate trust issues but, reduce the admin work.
370	Jonas
371	So, the normal thing is to say that IoT device we use for expensive stuff...
372	Because it's a high value thing and it costs quite a lot to have an IoT device.
373	The Dutch guys have so well.
374	It's too expensive from administration point of view to deal with all these loads of transaction of small value things. So we automate them because they happen frequently.
375	So that's a total different bunch of and that's why I like to have this as an example.
376	Because when you have public permissions.
377	And that's where you have your consortium.
378	You know who you're dealing with. You could have a number of nodes, and you should have I think, otherwise it isn't really fine.

379	But you have agreed on certain terms.
380	And here is somewhere in between... You also have another Dutch example.
381	And that's related to welfare.
382	You have a family low income.
383	And they are allowed, because they have kids to go to the swimming pool at once a month.
384	So they go to this social secretary, fill in a form, they look at it, approve it, stamp it, and they will get a voucher, they go to the swimming pool, they give them the voucher, the swimming pool lets the people in, take the voucher, sign it that it has been done with a receipt sending that to the community, community will pay the swimming pool.
385	Time for that quite long, administration work quite huge.
386	So, what they're doing instead, is they apply on the web. On a blockchain.
387	That is validating through smart contract of when they were last there, how many they are in the family, and give them a QR code.
388	That QR code is the ID stuff to say that all this is fine. This is approved. If blockchain is not approving it, then it goes to a person for manual approval.
389	They can approve it or decline it.
390	You get a QR code on your phone.
391	You go to the swimming pool and show the QR code, they're scanning up to the blockchain, and the blockchain is done recording that, this family has been here, has a receipt, we have been here, done that, system is setting: "Okay, fine government, pay the money", because they have been here. Done.
392	Interviewer
393	But the oldest, so could be achieved with the... say some company that makes a system...
394	Interviewer
395	Some sort of automation...
396	Interviewer
397	So is it cheaper to write through...
398	Jonas

399	So, what you're saying here...
400	Your question is the question that I got from Daniel saying: "that's as a rookie here, why can't we do this with normal database integration back in"...
401	Interviewer
402	Okay, I didn't see the question before...
403	Jonas
404	I know, and I'll put the answer here.
405	The thing here with all the steps is actually saying: "Yes, but it will bring in manual admin"
406	The termination of who gets what job, more documents is needed to send back and forth, you can do it all.
407	But it will involve manual work that is not really what you want to achieve.
408	And from a blockchain point of view, the family can argue that they haven't been to the swimming pool, but as they have been there, and they have shown their key record which is personal to them, it's kind of hard to say that they haven't been there.
409	From a swimming pool point of view, they can't argue or send in fake bills that someone has been here, or hasn't been here.
410	From a community point of view, if you're entitled to be a swimming pool once a month, that's also a pretty clear.
411	So, all in all, you get low value things through a blockchain in a fairly smart way.
412	Interviewer
413	So okay, interesting...
414	So, actually, blockchain can be good solution to automate the administration than rather just securing the logs, tampering...
415	Jonas
416	Lots of people have been thought of that and that's kind of like, one of the things that we have been discussing quite a while.
417	That is not the blockchain is or isn't the solution.
418	The question is, what is the question that is trying to solve.
419	Because we are trying to solve what we all really can do today with blockchain.

420	And their blockchain doesn't have any value.
421	So, when they use public anonymous, that's where you don't have a central entity, and you transact among all anonymous parties.
422	From transaction point of view, from value or cost point of view, the further to the left to go to, more cost.
423	The more you go to the left, the faster you go, the cheaper it is. <points to a screen>
424	So, if we look at Bitcoin, you have in hundreds per second transaction possible, because everyone should check it.
425	And in this side here, I think I don't know what we're up to today but a couple of hundred thousand per second is not perfect...
426	Interviewer
427	But from the other side, public kind of nobody owns the cost. I mean, you have the... let's say is not, you know, like private...
428	Interviewer
429	Is distributed...
430	Interviewer
431	... yeah is distributed, private is kind of someone has to bear, bear this cost, in public is a market regulates kind of, if you think about Bitcoin, you know, should I mine? If I get cheaper...
432	Jonas
433	Yeah, but if you don't get money from mining you will not gonna mining.
434	So you're taking money from the hype that someone will get money from Bitcoin, or it has a value.
435	Interviewer
436	But, but it's only possible because like a theorem, for examples, with the smart contracts.
437	So there is an incentive for people to mine because it can also be used as a currency in a way.
438	But what about the private...
439	Jonas
440	Where are the money coming from?

441	The cost is there, that's for sure.
442	Interviewer
443	Yeah, the cost is there for sure.
444	Jonas
445	And who is paying this?
446	Because if you should pay Bitcoin, for a Bitcoin transaction what it actually costs.
447	It's, I don't know, I've read some numbers about \$70 USD per transaction
448	Interviewer
449	It depends on the amount of miners that are willing to mine.
450	Jonas
451	So, and that was then calculating electricity supply and computer hardware and everything.
452	But of course this is a big for a transaction of moving information between two totally anonymous people.
453	And the added value is what? trust.
454	But the cost of trust is real money on real computers on our electrical network.
455	And I don't know where the money comes from.
456	Do you? Who's paying for it?
457	There is something saying that Bitcoin is today that worth, X number of dollars.
458	What I mean, if you say gold is worth something, and you have gold that is worth something and you can compare that you have, this is kind of like...
459	There is no security behind from a value point of view, is just speculation.
460	I don't honestly know what to speculate on, even.
461	But when we think about the Dutch cases here, they put in their own cryptocurrency, and put in the money for the pool usage for the lamppost things, that's real money that they put in as coins, to the repair person that gets paid in cryptocurrency, which they can exchange to money.
462	Interviewer
463	This exchange through I guess the government?

464	Jonas
465	Yeah...
466	Interviewer
467	So it's one to one basically...
468	Jonas
469	Yeah.
470	So, since they only have a few, or one or two nodes for security themselves, is not the problem.
471	So what they're gaining trust here is that if you as a repair company has said that you have repaired something and IoT device is kind of showing that it works.
472	But you only had a torch there to kind of... Now it works, kind of, and then you remove it again.
473	You can't really say that I fixed it yesterday, and now it doesn't work anymore, kind of, you have some kind of warranty on that as well.
474	So, there are cool things on this.
475	Now we've been talking about everything outside of TetraPak, yeah, but you can also understand why I'm doing this.
476	Because our examples have been on... very much focused on customers, wanting to track their food stuff, manufacturing...
477	And we can do that, we have no problem of doing that.
478	We can do it as edge computing, we can do it from main system. We can do a number of measuring points.
479	But what do you want to put on to a blockchain and why? TetraPak as a company has no interest in this, and it's really even dangerous for us to do that.
480	For the simple reason that we are... how can we be trusted?
481	If we are supplying our customer with a trust tool.
482	So if you as a consumer should trust, Nestle, for instance, who's kind of interested in this?
483	And we would supply them with a tool... you can use this, so you will be trusted.
484	As a consumer I wouldn't trust that, because as a supplier to Nestle, there is an incentive for me to provide you with a tool that is suitable for me.

485	Do I want to do that and give it away to my competitors...
486	Well, that could be argued.
487	So, what I think, we can do what, I know that we can do...
488	We can provide tools to make sure that our customer can interact with a blockchain solution.
489	Whether we will drive this or not, that's a different story.
490	Because it's not, it's a team sport.
491	But if you should have a blockchain and really works in food manufacturing.
492	You have... First of all, all the ingredients and their backtracking traceability.
493	You have all the equipment that is touching the food stuff, including the people.
494	For sure we can do that with our stuff.
495	Can't do that with our competitors stuff, and in factories full of a mix of everything.
496	So it's kind of in the interest of our customers to engage themselves into a blockchain for food safety.
497	If you think about the blockchain case.
498	That's fine.
499	And we can include, or provide the information of bringing stuff out of our systems to provide them with information, but I don't see that we are driving this as such because we are..
500	And we are all independent or we are kind of like.
501	We are an active part in the whole thing.
502	But we are not the one that is treating, handling the food stuff.
503	So it becomes a bit bigger than that.
504	What could be interesting though is of course to say that...
505	Have you made sure that the machinery that you're working with...
506	let's take some heat treatment, kind of thing...
507	Have it been over a certain temperature certain time? Yes we can say that...
508	But, who has certified that the sensor is showing the right value?

509	Who is taking care of that part?
510	That stuff is a bit more interesting...
511	If you look at from a main system point of view when you're measuring stuff. You're getting one record proximate the person so every 10 seconds.
512	Can't put that into the blockchain... kind like you will blow the entire thing of..
513	But what things should be captured in that case on a blockchain?
514	Interviewer
515	So kinda, can only capture like the end product, sort of, it's not economically to capture the whole process in the blockchain.
516	Jonas
517	Yeah, you could, you could build something on top of this, that is capturing average values during a certain time period.
518	It could on event. Pick out peaks, saying, this is a peak value, higher alone.
519	At a certain point in time at a certain thing, and creates, and based on a smart contract, understanding that this should go in a blockchain, this should not..
520	Interviewer
521	Isn't more feasible because you have your own standard database system adapted for this high data, big data, and then, at some point, you consolidate this data and that okay this is a product that all data was correct confirmed by internal our system and then we put this product on the blockchain and then traceability kind of starts, from there on, kind of...
522	Jonas
523	And that's why, what was just kind of saying is that, that's why it's possible for Walmart to say, we can do this on avocados, we can do that on mangoes, we can do that on beef.
524	We can't do that on fish. Why is that?
525	Interviewer
526	Is it... I mean the... The concept is the same, I mean they're just different product or...
527	Jonas
528	The same product from when you harvest it.

529	So, it's not mixtured. It's not combined with something else, it doesn't go in a process equipment more than...
530	On the highest, could be some temperature checks or it could be a cool chain is normally what you measure from a fish point of view.
531	So measuring that the fish through a sensor indicator is telling that it never been below a certain or above a certain degree.
532	And that you can actually do in a package, you don't even need to do that on the blockchain.
533	As soon as you're gone above a certain temperature, the consumer will know that.
534	But of course you can change that, IoT device somewhere in the chain, so from a blockchain point of view, you would like to capture as soon as he has been going below, or below or above. You have this on the medical side, as example that you have a cool chain on on certain medicals to make sure that you don't give medicine that has been over a certain temperature and certain time, because then it's useless.
535	And that's also to track during the supply chain, who has made the fault.
536	Who have handled this in a irresponsible way outside the limits of your agreement.
537	And that's a use case of blockchain that is very, very interesting.
538	It's not where we are because we don't have that kind of requirements on us.
539	And if it becomes, yes of course we're interested.
540	But what we have prepared yourself on, is to say: yes we can join blockchain.
541	What can we expect careful of joining a blockchain, which everyone should be very careful of is that you shouldn't commit to adding things on a blockchain, if you don't have a clean house.
542	So you don't commit to have cleaning every Monday and proving that on a blockchain, and then not do it.
543	Because the only reputation that you will destroy them is wrong.
544	Because shiny on blockchain means shiny in reality, because otherwise the trust is out the window, and you have this recorded.
545	And that's why certain countries and certain organizations don't want blockchain.
546	And it's also, I wouldn't say hurdle, but, in food industry globally, there are weak points, and there are strong points, the ones with strong points and strong commitment and quality all over the place, they really want to go into blockchain.

547	Because they can prove that they're right.
548	The ones that have that commitment to customers, but don't really deliver on them... They have a challenge.
549	And I think that's the beauty of blockchain, because it could force suppliers to take the responsibility that we think that they already have.
550	The problem is, of course, that there is a cost to this, that no one wants to pay for, currently.
551	Interviewer
552	So TetraPak is not actively now, doing any blockchain, because I think...
553	Jonas
554	We have made a POC.
555	We have a proof of concept. We have it live on a Microsoft Azure Ethereum setup.
556	The concrete conclusion is that blockchain part is working fine. Okay, we have no problem with that.
557	Interviewer
558	So you do exactly what?
559	Jonas
560	To record information that will be shared with government.
561	So, you have quality or certificates, organizations around that want to do certain validations.
562	And they only accept them in fiscal writing papers.
563	Because you can't cheat with a paper, because that have the signature, and someone has written a date and there is a stamp on it so you can fit into that.
564	I'm joking... That's kind of a mindset that you have. Yeah. And they can come in and make an audit and want to have all the papers and go through all that.
565	But they don't trust IT, because IT can change.
566	And I say, depending on how you build your database.
567	Yes, you can change that you can also show that you have changed, and track every change that you do.

568	And if blockchain is more trusted in something else that's put in blockchain because we know that we have a clean house at home.
569	So from that point of view we can share this information, and that's fine.
570	So from a proof of concept point of view, we have made a scenario where this is perfectly working, and the concept of blockchain as part of the solution is working fine.
571	The problem. I wouldn't say the problem that. Yeah, I can say the problem is the application side, not because of blockchain.
572	But building the application to be a full scale nice looking thing...
573	That cost money, lots of money. And if you should deploy, lots of money application you want to know that you will gain some money on that, because otherwise it's just wasted in something, and blockchain is not the solution, blockchain enables that capability to the solution that is needed for trust point of view, which is fine.
574	But the technique of blockchain is what we have been missing to be able to do this before, but blockchain is not the solution is just one technical aspect to the entire thing, because you can combine this with IoT information, with AI information, with the BI information, with personal reading or automatic data capturing.
575	Blockchain is still just something that capture information, data in a trusted way an immutable way from change point of view.
576	As long as you don't have anyone to play with, as long as you don't have any more nodes than your own, where is the added value?
577	Because I can still change everything in the blockchain.
578	But we are proving to ourselves that yes, this works perfectly fine, technical side no issue
579	Interviewer
580	But the governments are leaning towards accepting blockchain as an alternative to paper?
581	I mean there was a reason for doing it...
582	Jonas
583	They are... let me say that, they will never approve anything because they don't commit to anything at all.
584	But if we can say to them, we do it like this, and we validated like this, and this is how we can prove that this is correct.

585	They will not say no.
586	But they never approved something.
587	They say: Yes, fine.
588	And that discussion we have with them to say: okay with this work in your way...
589	I mean, have you any major concerns of this... no.
590	Interviewer
591	The audit is done by the government, or you have to hire a consultant company
592	Jonas
593	We have... that could be whatever...
594	And I think this is the same for everything that goes for a trust, that some companies are doing this as a business.
595	They want to have blockchain driven on theirs ir others solution, because then they will have the governance validity check as part of their service to this.
596	So everything comes to end game saying: Who will pay for the different services. Who wants to have blockchain working.
597	According to a Gartner call I have, there has a three to five years from now, is kind of where you will see major differences, where blockchain really will be bit more some cases you will find early adopters.
598	But you need to first of all, there's one key question that's your ID.
599	Think about a world where all of you, everyone on the planet would have a digital ID.
600	So you will leave a trace on any blockchain. Because you want to do that, then you can say goodbye to passports.
601	You can just apply for a visa saying, I want to get into this country, I get the yes or no answer.
602	The best example I, one of the best examples I love about this is you go to a bar.
603	You want to order a drink.
604	What's their question to you?
605	Interviewer
606	What drink you want right?

607	Jonas
608	Yeah, that's the first one. But if you go to Sweden, the first thing they will ask you is...
609	Interviewer
610	ID...
611	Interviewer
612	Age...
613	Jonas
614	Right, good. You asked the right questions both of you, because you did it in two different way.
615	You said, "show me your ID" and you said, "how old are you".
616	The thing is that they don't care about that, what they want to say is that by law, I'm forced to know that I'm allowed to serve you a drink.
617	And to make that happen. You need to be over 21.
618	So the question should be are you over 21.
619	And you should answer yes or no. And that question should be correct.
620	So if you can just prove that you are you and they are just saying, can I serve you a drink, and he will get a response back. Yes.
621	He doesn't care if you're 21, 23 or 25.
622	Currently, you show your ID in US, it's written address, including everything else on your social security number and all that you can think about the fraud possibility that you are sending out by handing over your ID to someone, and everyone else that is leaning over the bar.
623	That's when things becomes fairly interesting and that's what they call the, the zero...
624	Something about the serial answer a question, kind of thing. You asked for something, today.
625	Your total economical status to provide you with a loan.
626	The question should actually be: am I safe loaning you money?
627	They shouldn't know anything about your income, how many kids you have or anything...

628	Can you pay it back? That's the only thing that I want to know.
629	And you can store that behind that, in the blockchain without any problem. If you're clever enough to create smart contracts.
630	That's when the world will change so dramatically on blockchain.
631	But currently there are two really interesting people in blockchain.
632	One is consultants, selling the service of providing your solution.
633	And the second one is, of course, the ones, providing crypto currencies.
634	Because they need money.
635	Because you feeding loads of money first of all and then suddenly they have the value.
636	And then you start distributing that people, something that doesn't really have a value.
637	Somewhere from a speculative point of view it has.
638	Interviewer
639	But if we focus on private...
640	Yeah, I think we're running out time... Maybe we should have another meeting...
641	But when we were. Yes, a lot of applications that we didn't think because we kind of decided to go with the food traceability but from what I see so far...
642	Nothing new you can achieve with blockchain that can be achieved at the moment or at least there's no much more value added compared to the cost of the implementation.
643	Jonas
644	I think from food traceability point of view, TetraPak as a company will provide our customer with tools to join a blockchain
645	We can also apply full traceability on every package that we crate.
646	And we do that currently without blockchain.
647	So, first question is, how much trust, or how much is the value of the trust of us making sure that we do the package in a certain way that we have specified.
648	Well, if the kind of comes up to a point where it becomes really interesting.
649	We have no problem of showing up.

650	I can't see that will be our problem.
651	I can see that the added cost for doing that will be paid.
652	Because every company works the same way.
653	For every cost that you have is accumulated up somehow to the consumer end.
654	And it's not about profit or not profit that any cost that you gain will be on the price tag on the consumer.
655	And as long as the consumer is not willing to or interesting or paying for this, they don't have the requirements.
656	TetraPak is very very interesting blockchain very willing to start up, working with this, and we have something in our, in the back of our heads that will start...
657	But we haven't validated the use cases, yet, because the first thing that you need to do is evaluating the use case.
658	Can we do it without blockchain?
659	Why is blockchain qualifying to be part of the solution.
660	And then, who are we playing with?
661	If you're not playing with anyone, what is the purpose and goal with this?
662	Interviewer
663	And what kind of use cases you want to validate this?
664	Jonas
665	Or, it's, it's kind of an internal legal validation on audits that we're looking at.
666	And more than that I'm not really interesting of sharing right now.
667	Interviewer
668	Okay.
669	Jonas
670	Let's see first words, it is an end so I will go in and try to help them out a bit on understanding the use case...
671	We had, I know that you had, maybe you said from the beginning that you have an use case in Brazil...
672	Interviewer

673	For implemented or for validation...
674	Jonas
675	That we kind... of didn't proceed further... That the information you had in the mail that you talked to understood about...
676	Interviewer
677	... which I have now trying to recall...
678	Jonas
679	There was a use case in Brazil, we talked to our customers, we had a use case discussion with it, it's spot on use case for blockchain.
680	But their internal process of what they wanted to add on blockchain had so many process holes that they need to fix first.
681	They need to clean up their house, not because they don't know what they're doing.
682	But they are doing it in a way that could be alternatively thought of... and then at the end of the day you don't have any trust because when you look at it, there are a number of steps that is missing.
683	Once they have fixed those, I see no problem of creating a blockchain use case for that, it will be spot on.
684	Then if they build it themselves.
685	Or if they join a consortium that is already there, for instance, the IBM hyperledger, fine.
686	Nobody... It's not that they do anything wrong.
687	But putting it on blockchain, if anyone would audit it, what they put in blockchain, they would say: but you can just as well do it faking it.
688	Because there is room for faking all over the place.
689	And that is a bit weird, when you're doing it right. Yeah.
690	But putting the unsecured information on blockchain doesn't add trust.
691	But once they have the entire process secured all the way through, it will be rock solid.
692	So, clean house first, otherwise...
693	Interviewer

694	It's needed, is totally needed
695	Jonas
696	Yes...
697	Interviewer
698	I mean that was really really informative session
699	Interviewer
700	Yeah, that was really nice, thanks for all the information that we've got a lot of insights
701	Jonas
702	I'm kind of happy to share this because I'm one of the few that is working with us in any kind of sense here.
703	Interviewer
704	It is really interesting, when I asked, you just, no... like a group or a team or something... No, just one person in 25.000 people company...
705	Jonas
706	There are people bumping up at a number of times saying: we want to do blockchain and why you use blockchain and...
707	And once you have been talking to them a bit.. yeah... hum... okay.
708	Interviewer
709	You are tired of explaining it already...
710	Jonas
711	No, not at all, not at all, it's kind of like, you should talk about blockchain for the ones that don't think is anything.
712	And maybe you should try to make a bit more mature and sober discussion on the ones that are just running and think this is the best thing since sliced bread, because it's not.
713	And it's not the solution, it's part of a technical solution in a bigger picture...
714	But it can do so much more things...
715	So once have done the ID of each person, and we have globalized that.

716	Interviewer
717	If I ask one quick question...
718	Do you see any potential as a from our side if we will do some research and let's see maybe help you validate some specific case, you see a new remote potential in something I mean don't have that for now but you can think about it.
719	But I'm just trying to see because since I work here, and I really want thesis to have some sort of maybe practical implication.
720	And if I can contribute to the company and the combined with my studies, would be perfect.
721	Because you said you do some case validation, maybe some less sensitive case that we would look at and maybe work on some research and create some framework or something and then try and test that or something like that.
722	Jonas
723	Right now there is nothing in the pipeline.
724	Interviewer
725	Okay.
726	Jonas
727	There is one obscure initiative that I don't even know where it will land
728	So it's too immature to than have that kind of discussion.
729	Interviewer
730	Okay.
731	Jonas
732	If there is a use case in that that pops up of interesting of interest. Sure.
733	If there's anything that you hear in any corridor.
734	Or if you find a smart way of that you think that this is a use case, that actually could work and then I'm more than happy to talk to you again and see if we can get anything.
735	Smart going on that.
736	Interviewer
737	Okay.

738	Interviewer
739	Perfect.
740	Interviewer
741	Thank you so much.
742	I hope it's okay for you have some additional questions I can write through an email...
743	Jonas
744	Absolutely! Listen, and sometimes I post something on jammer, mainly because there are people that drop in comments that is kind of like ocean.
745	You are kind of like naming on the wrong side here so we need to kind of stabilize that a bit. I post something else.
746	Because, going into confrontation when it comes to public things it doesn't really work so.
747	Interviewer
748	All right, thank you again. Have a good day.
749	Jonas
750	You too.

Appendix 3 - Interview 1 [Rsp1]

Respondent: Jonas Bengtsson - Solution Architect and Blockchain Specialist at Tetra Pak

Date: 10th May 2019

Country: Sweden

Interview Type: In Person

Duration: 58:04

Interview Language: English

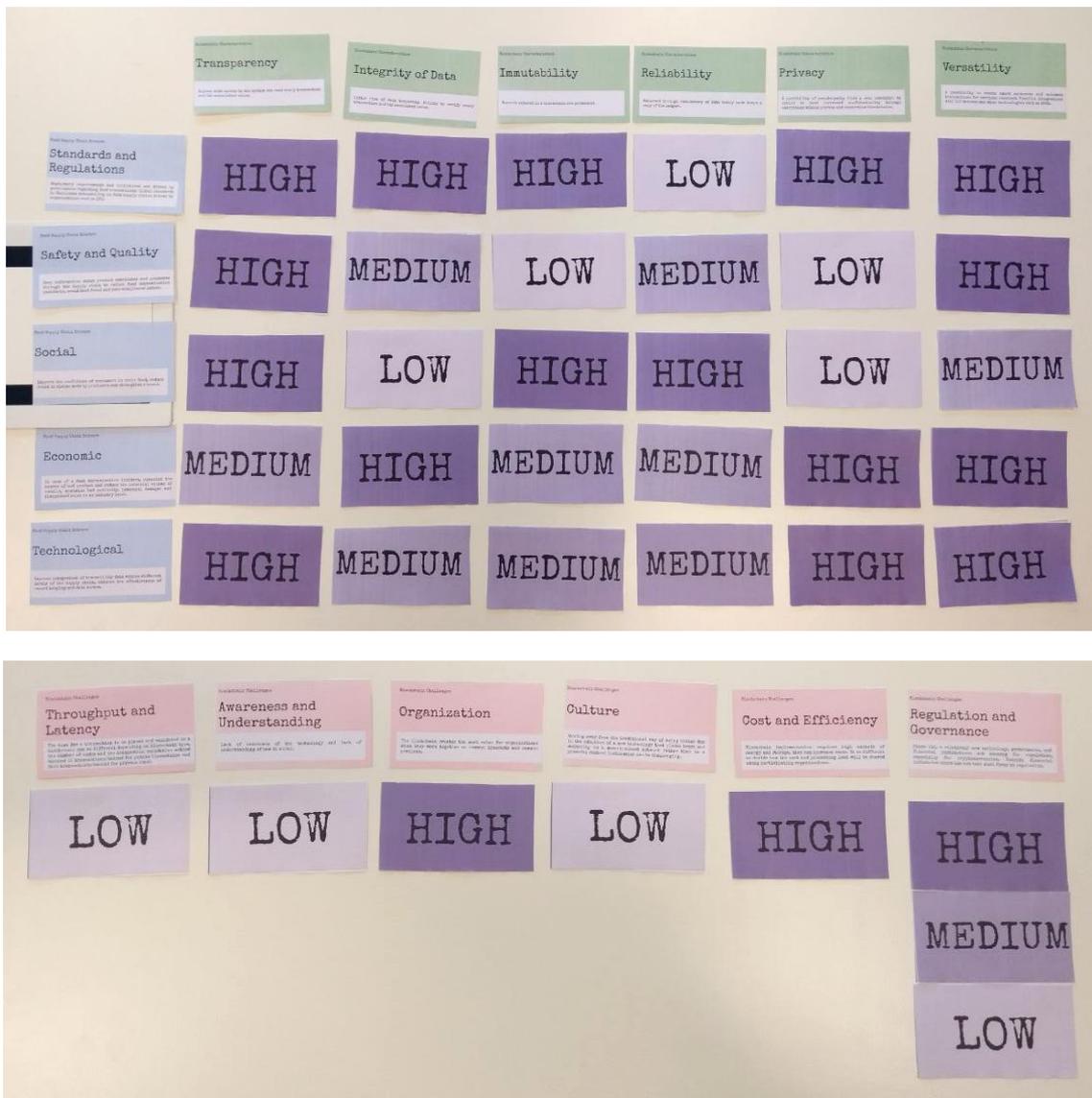


Figure 20. Card exercise completed by Jonas

Transcription Interview 1 - Jonas Bengtsson - May 10th 2018 [Rsp1]

Line	
1	Interviewer: So just to explain this framework first we got the characteristics of blockchain. This is based on literature. And we..if you want to go through them. And then we have some drivers for food supply chain. We're going to present you each one of these drivers and ask how it fits in this characteristics of blockchain using this scale, if you think it's low or medium or high, what's the relevance of it.
2	Jonas: for this
3	Interviewer: for this for this regarding each one of these drivers.
4	Interviewer: so we will go one driver, at the time. We will start with standards and regulations. So if we put that one here.. So, what we asked you to maybe take your time and just think about it. And then basically you can say okay we go through each characteristic and just map it: okay do you think, transparency, the characteristic of the blockchain is the really relevant for regulations and standards.
5	Interviewer: We just put some definitions here in each card in in each characteristic, and for the driver of the supply chain, just to keep it in a specific context, it can go away from this one, but we were just wanted to keep a specific box to not really go away but if you have any, any suggests or anything that you want to add this to this. It's totally free.
6	Jonas: It's fine. Then, then I have a comment on when I read this very very quickly on versatility is technologies like RFID. That's my personal thing because I work with labels and warehouse and RFID. As we look at it now RFID stores, lots of information about something that it came in a time where, the cloud wasn't invented, where bandwidth was something that didn't exist, and where mobility wasn't that reliable at all. I'm not saying that RFID is not good. I'm saying that RFID in terms of blockchain. I wouldn't take that as an example. The IoT part - perfect. IoT - perfect. RFID is not an technology but, it's kind of, you can load data into it, you can read data out of it. But currently we have realized that if you have a QR code. And then you have the ID connected to the cloud. You have today the bandwidth from an application to, as long as the QR code or barcode and your application associates with a place in a cloud, you can have that information and much more information available there. And that is how we have done Tetra Pak the uni-pack set up, so you can scan a package. The code is just the code. It's is the key to a lot and where you have the information, where the RF side of things is a store that contains the information so it's very use is, it's what we needed before we have the cloud. So from a blockchain point of view, it isn't doesn't really fit in there.
7	Interviewer: That's a good comment .

8	Interviewer: Yeah, but this is just to guide so you can forget RFID and let's say from your point of view thing about IoT.
9	Jonas: because I think it's good it's perfect.
10	Interviewer: And if you want us to talk about each one of the definitions it's fine as our if you want us to read them...
11	Jonas: That's fine. So we start here is a standard standard in regulations.
12	Interviewer: so we can put here for example if you're familiar. So if we just put. It's like a matrix.
13	Interviewer: Why do you think like how transparency fits in standards and regulations how, how important is this characteristic for this driver, and then go through each one.
14	Jonas: Okay, that's good, you have a good point here, anyone with access. Yeah, that's, that's absolutely key then.
15	Interviewer: and descriptions are exactly the same.
16	Jonas: Yeah, but I prefer to read like that.
17	Interviewer: If you can explain, also why you put this answer.
18	Jonas: from a standard regulation point of view.
19	Interviewer: Yes.
20	Jonas: That means that we need to prove something, which means that we need to be transparent and could actually withstand an audit. Because if we are transparent, then we can prove that we have done right. And that's the whole thing with setting up the blockchain because currently, if you only have a database, they will, from an audit point of view, want to know who has changed what and when can you delete a record, can you change your record and that's exactly what why they have asked instead of having... instead they asking for paper copies with signatures on... because you can't replace them right? No, just kidding, you can. paper you can take away Take a copy of, resign with a different date, and no one has a clue, but that would actually be one of the key drivers of that. And of course from tempering point of view that's the whole purpose with it. So from that point of view I would also say it's high because that's the rationale for that and mutability. Yeah, I mean, this is the key thing. So I write that on highest reliability.
21	Interviewer: If you need some clarification...
22	Jonas: I understand...that everyone keeps, I mean, if you think of it from... if I should follow improve my quality data for FDA for instance. Then, every now, I don't care

	<p>really if every node keeps a copy of the ledger or not, I just need to be trusted. So if you, this is where we discussed last time whether we have a public or private or somewhere in between what is kind of like a suitable....sign up... I will put that as low. Because I, I assume that reliability on that will exist anyway otherwise we don't have anything so it's kind of a given to me. From privacy point of view. That's a good and bad thing. Because, in order to follow regulations. You have to be a re...a unnamed user from a privacy point of view. You cannot be anonymous, and that's kind of like the whole thing with that. But it's damn important that you follow... they also are compliant. Even though this is standard regulations you still need to be compliant with the privacy state, like GDPR. So it's important he's hasn't high. Are we talking to high importance or high..</p>
23	Interviewer: Yeah, it's a high relevance
24	Interviewer: it's high relevance for for this specific driver.
25	Jonas: because from a privacy point of view, this is high all the time.
26	Interviewer: But there's nothing wrong with that.
27	<p>Jonas: Yeah, so so so from privacy.... The solution is not necessarily providing it with a high rating. But to be compliant, so you can you use the tool within Europe and European citizens. You have to be respecting the rules of that. But from a standard regulations point of view, you have to show who has done the record. Yeah. It's kind of like what you need to match you need to make sure that anonymity meet the from an outside people looking in still can decrypt that to understand who has actually done it. So, so that's kind of a trick point here.And, and yes...</p>
28	Interviewer: so why do you think versatility is important for standards and regulations?
29	<p>Jonas: its it's important for, it's important for standards and regulations for the, for the reason that an IoT device, versus... The more that you can automate the cheaper it will be to do, but also the more trusted you can be, as long as you have made a blockchain around the IoT devices to make sure that they are sending out the right information. So it comes into double turns it becomes a double circle around that because to allow an IoT device. If an IoT device is actually a user with a username and credentials and have to be validated that actually brings in the right values. So from that point of view, it becomes high. And we want to have the accurate data we don't want the person to fiddle with it. If I get your username I can fiddle with...go in there and report on that an IoT device can't. But on the other hand if you don't have security old IoT devices so it's locked down. Anyone that can tamper with an IoT device can actually ask the IoT device to put things on, on the blockchain that is incorrect. So it kind of comes in in double circles on that but it will be one of the key drivers for actually doing this. Manually typing in things is not where I can see where go forward.</p>

30	<p>Interviewer: Okay, just so then, just so you know, you can always come back and change it. At some point maybe some drivers... I see already you're..like it's all connected and then you see maybe some, some drivers - ah, this is what actually I was talking about. So feel free to revisit and change as we go. So, safety and quality, basically to keep information about all the attributes and the processes, through the supply chain of the product. To avoid the contamination incidents. Avoid food for the non compliance basically. So these drivers towards safety and quality, and it's more than that.</p>
31	<p>Jonas: Yeah, I'm from transparency point of view that's the point with me. I mean, you assume that integrity of data is, is is followed, but I can put medium on that without any, any major problems. I would say, actually from immutability point of view I will say low. And that's because I'm talking about food stuff. Yeah, because food stuff, don't have a life time or lifespan and is that long. Since you can't remove anything from a blockchain you can't really remove it, so it's one of the pain points I think, I think we might come into a point where we, we have a blockchain that ends after a certain time period and starts all over the new one, because there is no use of saving to all data. I mean after, I mean Milk. Milk is valid for a week, two weeks, so key storing information that is three years old, maybe don't have that huge impact. If you have products that is lasting for three years, then maybe 6 years would be good retention period, but from a immutability point of view it's kind of low from, from that point of view it's totally related to how long it should be.</p>
32	<p>Interviewer: It's really great feedback, because we actually focus on food and not on other equipment. So that's very good points.</p>
33	<p>Interviewer: just I'm just curious, for the auditing process. Do you think is still low, even if the lifespan of food is short?</p>
34	<p>Jonas: but you don't do that on safety and quality, because safety and quality from food point of view is that from safety point of view, you should regard, if it has been off a call Shane or on a call Shane, all the time. And, from a storage point of view, I mean, even if you have a best before date that is three years ahead. After three years after six years, what's the purpose of the information ship. And that's one of the key challenges with blockchain as such, why store so much data. So if you're talking about food stuff here, I can order it in the sense that it will talk avocados, or mangoes. I mean, Walmart, really, after two years, who is interested in that batch, that has already been off the shelf and eaten, if not destroyed. It's not of interest anymore.</p>
35	<p>Interviewer: very good point</p>
36	<p>Jonas: that every node keeps a copy of the legendary I think that's. Everyone that should be must have. I put that off medium it's kind of like fair enough. And from a privacy point of view...it kind of comes with in two places. You can actually have it.</p>

	<p>Put privacies medium for the purpose that you need to store the information, but you don't necessarily need to show the real username, on, on the blockchain you can have a link that is decrypted for certain people to have access to it, and decrypted to that person. Because from a safety and quality point of view, you're talking about information about reduce food contamination incidents so this is the first part of track and trace then we're talking about. And from a privacy point of view, or privacy point of view on the blockchain, I don't even even change it too low. I don't really want the names to be there. So from, from a GDPR point of view... Since it's public information I don't want to have my name on that. It could be an XY set, kind of thing that someone would access can decrypt to find my name. If that is needed, But it was not needed. It's kind of like record...video recording of people in town you. There is no reason for sharing all the information, but if something has happened then it's really crucial to find the information. I think from versatility point of view I can see it, and I can see my both phones and apps.</p>
37	<p>Interviewer: And let's say, smart contracts for example, this captures everything...</p>
38	<p>Jonas: I would say event driven things in the blockchain. That is triggering...either triggering a smart contract or responding to smart contracts, and it could be through an app, like I talked about the lamp post last time. It's not that far away because when you're in the shop, you will interact with this in some way. If you're the truck driver. It will interact. If you are the IoT sensor inside the truck to make sure that you have a certain temperature, it will interact. So from that point of view, I would say that you would to capture automatic transactions. Absolutely. And I think that's, that's actually pretty high.</p>
39	<p>Interviewer: We're halfway, we only have five drivers, as we know the third one.</p>
40	<p>Jonas: social. So improved confidence of consumers in their food, reduce that...but claims made by producer and strengthen brand. And then, transparency part is kind of like the whole idea of this. I actually don't think that little risk of tampering data availability to verify every transaction. Is that important, because you will get...if you're transparent - you are home free. If you cheat - you're dead forever. That's kind of like the two things that you have.</p>
41	<p>Interviewer: But don't you think so that the let's see as a consumer, if I... if I let's say we let's put the maybe China case when there was the food poisoning with the food baby</p>
42	<p>Jonas: yeah the milk thing yeah</p>
43	<p>Interviewer: so if you're... okay, the company got caught cheated and then maybe it will be dead, but, you know, it was getting away with it for some point, for some time. But let's say if you have a blockchain technology and you know that the data is immutable that wherever the data is in the blockchain and the you are able to trace it back to the origins as a consumer. You are very confident in that product.</p>

44	<p>Jonas: Yeah, but the question is if I as a user. I mean from a setup point of view is of course a high. From a consumer point of view I do as I do today. Even though there is not blockchain. I expect them to hand out food in a good way. So it's kind of what you jeopardize it's actually your name. And then the question is, what do you do if you fail. Blockchain comes with a with a whole thing that is kind of very hard to, to change and that's the whole idea. If you only have one node well, then you don't have a blockchain if you have to still can tamper with it. Well, if it comes that comes to life that you have fake information on the blockchain is worth nothing. If you have huge controls of what you have in blockchain and still fake the data, you have the same problem. So expanding the risk of tampering is still not the key thing. The key thing is actually making sure that you capture adequate information, because you can always cheat in blockchain, but it will remain and you can't really get out of that. So, the risk of tampering I see more as a risk for the ones with the blockchain if someone else goes in and tamper..that that kind of...but what is interesting, then, is from an immutability point of view, that the records are stored permanent, because that one is pointing to the integrity of data. If you can't change it, and it always exists. So, I agree with you, I can reason and swap this and I can put both too high, there is no, really good...it totally depends on the scenario and how you want to have it.</p>
45	<p>Interviewer: We don't have any preference, we're just sometimes trying to...</p>
46	<p>Jonas: that's..that's fair enough. And I think from a reliability point of view I would put this at high. Because if something is....If you want to be reliable on your data on the social point of view. If you're not reliable....from a privacy point of view I still regard this as pretty low. There is. Versatility, creating smart contracts. I think, at least medium where we have to.... It certainly depends on the use case I was thinking, just, just by looking at that and social I was thinking about everything that was on the blockchain food, food trust today, which is kind of like the entire thing from start to end. And yes, from a medium point of view, there will be lots of hand holding to be done if you look at avocados from Kenya, it's kind of like 30 to 40 different people that is handling it. And yes, they can all be equipped with it devices, but it's slightly no not really sure. I don't think so. But if you think of it from what happens within a process from raw material entries entries, until we have packed the guts. There will be lots. Because, but that goes more into the standard regulation. Because if we go into the social part is that how we is every ingredients echo or not. Answer is yes, that's a summary of all the other stuff that we have captured in other places. Or not. From a social point of view and never go into the details of the information, but you should be able to have it. And that doesn't get him to safety.</p>
47	<p>Interviewer: Economic. I mean we wrote, at least according literature, it's all the drivers kind of connected, it's very hard to draw the hard line. But that was focused let's say more about the case of the food contamination so that you can pinpoint the bad product, because usually,as some cases showed, it took a long time for companies to really identify the root cause of the food contamination which you</p>

	<p>know is the time is very expensive. And if you're not able to pinpoint very fast like with, let's say, strawberry needle case that happened in Australia. All strawberry market perished, because of one farmer employee basically putting needles, but then people will not buy any strawberries anywhere in the country.</p>
48	<p>Jonas: So from an economics point of view, you're kind of talking about track and trace and that's probably what you should have instead, because that's one of the key, key drivers for this. And it has an economic upside on this because it's a matter of recalling as small portion, as possible, quickly address and find the problem and isolate that into a small thing from an economical and practical point of view.</p>
49	<p>Interviewer: but let's not focus and not limit ourselves....I mean we can..economic...we can maybe think about the other advantages, let's say potential to save costs as well. potential to save money. If you want...this is just a... just as an example to give potential savings from, you know, avoiding the bigger loss, but also could be a potential improvements as well, that lets you make a supply chain traceability more efficient in some way.</p>
50	<p>Jonas: But the example you have here, which is kind of in this case now, pointing out track and trace, there is a huge value in this. Do we need to have blockchain for that?</p>
51	<p>Interviewer: But all these drivers, they are not really related to blockchain. So these are specifically, what can drive for company to do some improvements in the food traceability track and trace.</p>
52	<p>Jonas: Oh yes, I mean, this is, this is. I think from transparency point of view - medium. Because it's kind of like starting off, events, which is very isolated and the entire world is not interested, until something happened, or you can be proactive and then pinpoint some specific route. I would put high on integrity of data. Because no matter if it's blockchain or not blockchain, the importance of accurate data here, and tampering here is, with economic benefits. So, it must be high, from a high low point of view, because there is huge stakes and the clearer that you can temper something that ...you can cheat. And as I went before I will put kind of medium on immutability on record store in the blockchain permanently. And that's mainly because the lifespan of the product is kind of key. If it would be car it would be high. If it would be, I don't know what, something that is even shorter than than the food supply. I mean food supply, even if you have a can of beans. 10 years. If you have fresh milk - 2 days.</p>
53	<p>Interviewer: So, in your opinion, immutability correlates to the lifespan of the product.</p>
54	<p>Jonas: I would say so that's what you put in the center of you, you should become product centric in in the view in the mindset of the entire. Reliability. I put this as medium. I think it's, it's a way to make sure that you have more than one truth to really stress the integrity. Part of this. So, by making sure that you have multiple</p>

	<p>nodes, where the data is stored in a distributed ledger No matter if it's blockchain or not. It's harder to to change it. Because you can't change one without changing the others. And since you can't change a blockchain. That's kind of what the upside of that. From privacy...I put that as high here from privacy point of view, because again, comes into the economical parts of, if you can temper it is kind of important to know who has done it. And then from a GDPR point of view. You also need to be very very careful of how you store data, what you're storing that data and how to get it, it's only important in a very, very few cases. But when it's important, then you have to do. So maybe I'm, I'm rationalized, or having some kind of reasoning with myself that is totally inconsistent but you can take that on the recording. And for the versatility point of view, and economics point of view. First I was thinking low because I was, I was inside my own company, thinking from a track and trace point of view It doesn't really matter what kind of technique I'm using. Then I swapped focus two totally different scenario, where you have a supply chain with multiple stakeholders. And from an economical point of view. And it doesn't need to only be totally related to food stuff, it could be the carrier, it could be to whoever. that if there will be an economical backlash on you It would be damn good. If you would have IoT devices that is proving either that you're right, or that you're wrong. So when you say that everything has been delivered in a safe and ecological point of view. You also have a backup off of the IoT device related to your truck to say that this is an eco driving thing, industry, social community where this becomes extremely interesting in the future where you have systems of systems and blockchains of blockchains, because then you're talking about an off of an entire ecosystem where the food truck as such, has the emission load to it. And you combine that with how big load it has compared to what it could be so you're not kinda saying you know it's a fantastic eco driven car with only one pallet driving around. It's a full tractor and liberal with the best suitable ecological driver, and the Eco car and everything is like all that. And then, so it's when they interact in the future that this will be extremely interesting and it will grow it will grow, and the data volume will be so high. Currently I don't really see how we can master it.</p>
55	<p>Interviewer: And I think, literally, we'll see when we go through the challenges some of the points you mentioned can be seen, but it's very good point, I think so. So we go to the last driver.</p>
56	<p>Jonas: technological - improve integration traceability of data, within different levels of supply chain. From transparency point of view, it becomes high again, because that that's kind of the key. And the key thing that it actually drives us to have a handshake, if you will, from place to place and find status changes. I put next one to medium, I could put it too high because it comes kind of without saying, but you need to be able to verify the transaction. That's kind of like the key thing. If you then put that as high you could....Yeah...Somewhere there. Immutability records, blockchain's permanent... It depends on the lifetime of the asset that you put in the center, it always is.</p>

57	<p>Interviewer: I was thinking that when we talk about the food would be that let's say for the canned food, let's see that has a very high shelf life, so it's possible. I think it's good that this may be not lower medium so it could be like very short shelf life, milk, for example, and then there can be canned food that can be long term. So, that can be, you know, quite a few years. So it could be relevant depending on the product.</p>
58	<p>Jonas: Yeah. And the problem with this is kind of like, you cannot currently, remove anything from the blockchain. It's kind of there from the Genesis block and then continue onwards. So, when they find a possible trick on that it will be good from data storage point of view. The scary part of that will become when you look at the ecosystem. As I said before, when you have systems on systems depending on each other. Because if you remove one. If you remove a block that is referring to another blockchain. Then suddenly you have missing links. And I don't think the blockchain will really massive enough so something that is not called blockchain when it comes after that will be really addressing that. And, I will put the reliability on medium from a technology point of view, because the statement is saying that every node keeps a copy of the ledger, which is true. But it doesn't need to be that everyone in the blockchain is having a node. So from a technology point of view, I see that we have certain actors with big impact on the data quality and records, but has no value, more than adding a status, adding action. So from that point of view, medium is fine because it's also totally depending on the use case. Possibility to...for real identity. I put it as high again because you need to handle it from a GDPR point of view, but also because the importance from a technology point of view of how to handle users. No matter if it's IoT users or real users. That's the biggest challenge for blockchain. And every country is trying now. Canada was last week, publishing something that's made so the bank association has gone through to say that they have a personal ID. That is based on blockchain so there is, There are steps on in way.</p>
59	<p>Interviewer: The Privacy is not only just about people it's also organizations.</p>
60	<p>Jonas: yes, it's...or anyone in the blockchain that is interacting, but from a technology point of view it's damn important that you both respect the privacy, but also that you capture who has actually done that because otherwise you will from a technology point of view lose to the integrity of the data and immutability because you don't know who has added what.</p>
61	<p>Interviewer: so it's gonna be useless records if you can pinpoint...</p>
62	<p>Jonas:yes if you don't have the privacies part of, then the technology part will be a nightmare. And that's my take on that. And the more that you can pick up automatically, the better. This is industry 4.0 in a nutshell, I mean the whole technical part here and picking up, and also with that the privacy that part of IoT is just as important as it is for you or me as a person.</p>
63	<p>Interviewer: Really interesting feedback and we're done with the drivers.</p>

64	Interviewer: We just finished this part. I will ask you if you want to add or remove any of these drivers that you think it might be, there's something that you either think it's more important in an industry or something that we forgot to put or something that you think is not that important. And about the characteristics of blockchain as well, since you're a blockchain expert maybe you want to add something or remove something as well.
65	Jonas: what I read into the green part here. Characteristics part, the governance is kind of included in this. So, that's up to you. But what they call the governance, data Governance or, or governance reasons is kind of found in a combination of this as well. So it's kind of up to you. You have divided in slightly different wordings. Track and trace would be the obvious part that you put into the economic if you want to add that, or if you want to have another economical top on that definition it's up to you. But maybe you should have track and trace and the economical aspects of that. That would give you kind of more the... But on the other hand, if you're looking for new stuff, then keep it like that. If you look at the traditional thing that is already available.
66	Interviewer: Okay, let's go through the challenges and we will be done. I think on time, hopefully
67	Interviewer: here, we have some challenges for the blockchain technology.
68	Interviewer: On the other page you can see the challenges.
69	Interviewer: Six challenges. Same thing.
70	Interviewer: so just we need to add one of the labels.
71	Jonas: one of each for each one?
72	Interviewer: Yeah, regarding the food industry.
73	Jonas: Today I think throughput and latency is a low thing. And it becomes slower every day.
74	Interviewer: so the the limitations let's say...
75	Jonas: the technical limitations for throughput is not important anymore. There's still a price to it but the more that you go to private or proof of a... Ethereum goes now into proof of stake instead of proof of work. And everyone in blockchain anonymous thinks that that's kind of like, really bad. But they don't trust anyone and that's the purpose with it so. So, but, but I think from from these kind of things we're looking forward to Consortium. And, and private blockchains, and then you will get the speed, because you have a faster consensus mechanism, even though it's not that safe, it's safe enough.

76	<p>Interviewer: Didn't you mentioned last time just to elaborate a bit if we... depending where we are recording at which stage. Let's see if you would like to record, different information at the when the food is processed. They say from the Tetra Pak equipment, then then you end up in a very huge amount of information.</p>
77	<p>Jonas: Yeah, and that needs to be architectural addressed, because you don't want to take every record. You want to have a functionality within the record, taking parts from IoT, and ask yourself, what should I create an event on. I could of course, always have an average. And that's easy enough it's a program that is is taking all the records that it gets and say well average is this during a certain time span. But most probably from a food processing point of view you talk about peaks. Or you below a certain temperature at any point in time, or above. And from quality point of view, you will find those things, and they are bad things, because they are out of specification. And that's why there's a call to have on blockchain. Because the event that should be triggered from that is for someone to take an action to rectify the problem. It could be that you rerun it again through the same process. It could be that you need to trash that thing. Or it could be that you take an additional test afterwards. So, you will not put this throughput and latency or records on the blockchain directly to the feeder of information. You will have a functional model in between. That is listening to what you get from the devices and reacts based on programs that are saying, Take this kinds of values and post a blockchain with this transaction type, at a certain... with certain conditions. So we have a smart contract, before the blockchain to put the event on the blockchain. To start the smart contract in the blockchain, to create an event that is handing someone to do something that's that's how it could work.</p>
78	<p>An awareness and understanding. I actually discussed this with another university guy in related to blockchain last week. And he wanted to have my, my, statement, which I couldn't find but I can provide you with it because I thought about it. And I would say that blockchain is a key technology that is part of the solution. But blockchain is not the solution. So, from a technology point of view, it's a critical piece of the puzzle, the blockchain as such will never be the solution for the overall thing, it's just a technical component. And if you think about that. You don't go around saying that well, due to awareness and misunderstanding. I will not use an SQL database.</p>
79	<p>You simply don't care. And in the future where blockchain fits blockchain will be used. And one will understand that I think that's the current, and I'll put that in my post on Yammer I think, it's not kind of...if you should sell a blockchain solution, you shouldn't sell it as blockchain. You should sell it as a trusted solution with full immutability, and then stop there.</p>
80	<p>Interviewer: So sell it as these characteristics</p>

81	Jonas: Exactly. That's what you should sell. And then if you in any one of these say see that blockchain is needed, and then you add that in as a component for the small data set that you want to have. And you can expand that with a smart contract. But starting from the point that we are looking for the solution where the blockchain is the answer.
82	Organization, the blockchain creates most value for organization. Yeah, that's, that's the highest one, because if you go cross organization and the input values are different for different stakeholders and for those where no value is found they might be sitting on the most critical things. So how you distribute the value is key.
83	And about the culture thing, and adopting new technology, I think. I think it goes with the awareness and understanding. The lower it becomes the slower it goes. But even if the culture will be high, it will not change. So from blockchain point of view, adding that in from a culture point of view is still an IT solution. And they shouldn't care. From cost efficiency point of view, this is where we have the high, because compared to a normal database blockchain becomes much much more expensive. So, if you are having an IT solution. And you think that you should have blockchain in that the first question you should ask, what do I really need to store on the blockchain and capture on blockchain. What should I have off chain. And then how you combine that innovation visual feed for an application or for a person that's a different story. So the architectural part here is making sure that you get the right things on blockchain, and the right thing, outside blockchain. To gain cost and efficiency.
84	Regulation and governance. Yeah, I would say.. I would rate this as high, medium and low. Because from a governance point of view I think the blockchain is great and it's immutable, and it has all those things of it for certain questions. So from that point of view it's a no brainer. When you come into governance, or organization part, were they don't want to utilize transparency due to their own incompetence or their own corruption they will not be really fond of this anyway. But it will probably be somewhere in between from stopping point of view. But there is a high on on this. When it comes to, to the governance or regular regulation part, and that's because we are living from a food point of view. In an international global market where everything is exported everywhere. And every country have its own governance and its own rules, and on regulations.
85	Interviewer: So in the literature, I mean, they say, at least from the government's point of view, its biggest focus, of course, is crypto or financial industries, but not really that much if we take the some third party auditors to check the requirements how you treat the food. And if you come with a blockchain solution. There is no let's say official...official usually accepted the version is paper in a lot of places.
86	Jonas: Yeah

87	Interviewer: So if you come with the blockchain there is no se legal framework that, okay, validates the blockchain as the hundred percent good solution as the same as paper.
88	Jonas: They're working on this on the GS1 standard Microsoft and, and, and, IBM has gone in there and try to involve more of this regulations and governance. But they don't want, they don't have any money to fund it or pay for it, and they don't have any interest of doing that in certain areas when it comes to food trust. But as...I mean, as long as it's transaction between the two of you or it's in our neighborhood, like we're talking about the lamppost again, it's kind of like, as long as you're within one town, it's fine. As soon as you broaden that to a country, it becomes scalability issues. But if you go cross border and you need to be VAT compliant. And you have various different regulations that you should follow that is different. The solution might be as complex as you have problem to getting governance to approve it at the same time, because it's not on their top priority list. So that's.... this could be kind of whatever the other ones...[inaudible 54.48]
89	Interviewer: And that's that from our side. We are finished just on time. Do you have any final comments, what's the general feeling of this way of exercise? Do you have some suggestions to improve some things or do something differently?
90	Jonas: No, I think it's, it's fine.
91	Interviewer: Does it make sense?
92	Jonas: If, if the end result makes sense if you have..when you combine the study from a number of different people I have no clue, but it will be interesting to see because it's also kind of like.. you put all of these things in context and what I've learned....in general, working with this is kind of like...you put a question on the table. And you have ten people who may put their own scenario, and build a story in their brain. That kind of..., they use as a backup or background for their answer. And that's why you get this kind of three different alternatives in the same.... and that's kind of a high low medium....totally depends on the context that you're putting it in. And that's always the problem but we're being kind of generic, because then you get detailed answer on one scenario.
93	But I think that's... I think this is good good way of getting extremely focused. So from that point of view, I'm, I think this is pretty it's a cool way of doing.
94	Interviewer: Okay, Well thank you very much. Thanks a lot for your time.

Appendix 4 - Interview 2 [Rsp2]

Respondent: Fredrik Ohlsson - Director of IT Systems Architecture at Tetra Pak

Date: 13th May 2019

Country: Sweden

Interview Type: In Person

Duration: 49:56

Interview Language: English



Figure 21. Card exercise completed by Fredrik

Transcription Interview 2 – Fredrik Ohlsson - May 13th 2018 [Rsp2]

Line	
1	Interviewer: so first, is this driver about standards and regulations. It's about the the requirements for governments to approve some some food entering their country to get the standards being complied and following the ISO parameters. And for this driver, how do you think transparency is useful or is relevant for food traceability?
2	Fredrik: No, I think it's, I think it's high. Standard regulations need to be very transparent. Yeah. I think it's high. Shall i put it like that?
3	Interviewer: Yeah, it's just like that.
4	Fredrik: Integrity of the data? But then there are shades of everything right? I think your privacy, I think it's high on all of them. Standards and regulations. Relations require the and the government regarding food traceability... (reading the label).
5	Interviewer: If you can explain a bit why put this card and why you think it's high, in your perspective.
6	Fredrik: Anyone with access to the system can read every transaction...(reading the label)? Well, okay, good. So I remove that one. Transparency is actually, you know, anyone with access to the system can read every transaction and...(reading the label) a low. You don't need to have that granularity. But when it comes to integrity of data, little risk of data tampering, right? That's high.
7	Interviewer: Why you think it's high?
8	Fredrik: Regularly to require that an initiated driver to cover the record for traceability, global standard of supply chain...(reading the label). integrity of the data, of course, the quality of the data that nobody has tampered with it, you know, if somebody can tamper with the data, then of course, you know, then they won't be understand it.. [inaudible 02.36] . And I think it's high also that integrity of the data and immutability is also important because you shouldn't be able to.... I think they go hand in hand. Reliability, of course, high as well, it has to be very reliable. Achieved through the redundancy of data every node keeps a copy of the ledger (reading the label). Privacy...
9	Interviewer: These are for the same reasons?
10	Fredrik: Yes, absolutely. Because a standards and regulations....it's regarding the traceability of data. And to be able to trace data it has to be of course reliable. And the integrity of that data has to be extremely high. A possibility of hide real identity an option to have increasing it... (reading the label).
11	Interviewer: Feel free to ask if you have any questions

12	Fredrik: I think privacy is important as well. The ability...
13	Interviewer: So you can hide the real identity of the person or entity.
14	Fredrik: Possibility to to create smart contracts.... It's medium right?
15	Interviewer: It's to interact with different systems or different tools like IoT devices.
16	Fredrik: Exactly, so when it comes to the traceability...
17	<meeting interruption>
18	Fredrik: When it comes to regulators, which is tied to the food traceability, of course, you need to have very high tech integrity of data, you need to be able to trust the data, which means that you shouldn't be able to change it. And that go for the three here (Transparency, Integrity of Data, Immutability). It doesn't have to be that transparent, to be honest. You know, it's not, you know...
19	Privacy is medium. As a possibility to to hide behind the data. Well, that's not, that's critical to high value data. But also versatility need to be high, because you need to be able to inject, ingest any type of data from anywhere. So that concludes that.
20	Interviewer: So we can go to the second driver, then, Safety and Quality. That means like to keep information about the product attributes and process in the in the whole supply chain to reduce the food contamination incidents, the height of incidents and food fraud, and non-compliance issues.
21	Fredrik: No, okay. All right. Safety and quality, high. Transparency, anyone with access to the system can read low. Low. Possibility to for hide your real..I think that's actually as high as well. Because safety and quality, you need to allow whistleblowers as well. An option to have increased confidentiality through. Exactly. Yeah,
22	Interviewer: feel free to change if you want to change but can you explain me how you put, why do you put low and this and high on this?
23	Fredrik: Okay, so transparency, again, here, anyone with access to the system can read every transaction and its associated value. I don't think that is required that anybody can read everything. It's better that you, you create good solutions. When it comes to integrity and reliability of data, it has to be high, it actually always have to be high to be honest. A privacy need to be high as well, because, because when it comes to safety and quality, if there is a quality problems, you should be able to report that and to be anonymous. And then of course, again, I think that one is probably always high because you need to be able to have a system that is adaptable module or flexible and connected rights to everything.

24	Interviewer: I know the privacy, you said that it's important to be anonymous. Is it from the let's say the whistleblowers point of view or?
25	Fredrik: Yeah, yeah, but it might depend actually, privacy, you have to, you have to manage privacy. There might be cases where privacy is not that important, or maybe transparency is more important. But those two are a bit antagonists around privacy and transparency, if that one is high that one should preferably be low.
26	Interviewer: the privacy can be either, let's say you, you don't have your name, you can hide behind the alpha-numerical code. But you can also be let's say, if you reveal it, you have who would be very transparent and connected. Lets say, this is your name and the..
27	Fredrik: Yeah,. Okay. Okay. Yeah. So you have choices.
28	Interviewer: Exactly. So you can be anonymous, or you can actually, you know, be transparent in a way by revealing your address.
29	Interviewer: Ok, so we can go to the next one driver. So this is the third one.
30	Fredrik: Improve the confidence of consumers in their food, reduce doubt in claims and by [inaudible 4:42]. Ok. So again, you know, the given ones, whatever you do with this integrity and reliability, you know, that is, that's a trademark of blockchain. I think. When it comes to social. Of course, that point is high as well. Improve the confidential consumer food reduce...producer social, social, social, you can ingest the property create smart contract. Transaction force versus...I will probably put up as high as well. transparency's probably medium. [inaudible 5:31]
31	and one with access? It probably...a social improved confidence.I think you need a lot of transparency there. And not high, but medium. Possibility to create smart.. I think it's high, maybe I can downgrade, you know, so we get some shades in there, but yeah...
32	Interviewer: Okay. Just to ask, I see these three (integrity of data, immutability, reliability), you consider kind of one characteristic? Because you interpret
33	Fredrik: Yeah, but I think that you, you, of course, you gain integrity of the data, because you cannot tamper with it. Right? And then, of course, you know, the reliability of the data through the redundancy of data, every node keeps a copy.... Exactly. So which means that all three are actually very closely closely related.
34	Interviewer: we can always revisit if you have a change of opinion.
35	Interviewer: So now we go to the economic one. This is like in case of a food contamination, you can find directly the point where the problem happened and reduce the amount of recalls and minimize bad publicity and the damage, just focusing on [inaudible 7:06] the problem.

36	Interviewer: In the literature, at least the economic perspective is, is considered to minimize let's say, or isolate the incident. So if we take, for example, that was the strawberry case where with the needles... by one person, putting the needles and then all industry suffered, because people would not buy any strawberries anywhere. And then the government had to bail the farmers out, basically. So the idea is that, okay, if you have let's say food chain traceability that is very trustworthy, that you can isolate and be very confident about, let's say, outside the...this incident area, so the industry would receive less losses, for example, that's one of the drivers behind the economy.
37	Fredrik: Integrity.. I'll do like this: reliability is, of course, I will put that here, you know, it's probably...the risk here is that you have the wrong data captured
38	Interviewer: Reliability medium then
39	Fredrik: Exactly, exactly. Because it's a disaster. If, if you know, if you're wrong, [inaudible 8:37], it's like reviews on a hotel, if somebody, you know, would put something wrong in there, then you're screwed. So, so dairy could actually be with very rigid governance, you should actually be able to change the notes. Transparency. Do you want everybody to read everything in a..economic driver...I'll put the medium as well. You don't need to have everybody reading everything.
40	Interviewer: This is only who has access to the system?
41	Fredrik: Exactly.
42	Interviewer: So if it's a private blockchain, then of course, maybe individuals can't really read everything, but all the stakeholders are a part of the network, then they can see each other's records.
43	Fredrik: Yeah. The privacy is high. The privacy need to be high. I think, you know, the possibility to create smart contracts and automated transaction for service, I think is a given, you have to have very high but otherwise, you know, it will be very difficult to actually implement it.
44	Interviewer: Alright. And the last one.
45	Interviewer: it's basically the use of technology to improve the effectiveness of the record keeping and the traceability.
46	Fredrik: Yeah, okay, all right. So technology...
47	Interviewer: It's technology development, that drives some improvements of the supply chain traceability, let's say, we used to have maybe the paper than barcodes, and then a RFID that came into the... into the play. And then each technology brings different possibilities. So if it's a more complex, then you can automate certain parts of the traceability. So, from that perspective.

48	Fredrik: okay. Just I don't misunderstand it. So to convert it... to translate then...? The driver is technology, of course. And what is... I don't... Take it again.
49	Interviewer: So let's say the technological driver is the different technological developments that happens in a hardware or software that, let's say, improves the supply chain, food, traceability.
50	Fredrik: Got it.
51	Interviewer: So you can integrate, let's say, between different stakeholders in a more efficient and more reliable way. And then we have our different characteristics, which we think, let's say for this technological development, which would be important, for example,
52	Fredrik: okay, yeah. Now that I think, all of them are important, of course, you need to have, make sure... if you don't have integrity of data, you're dead. If you don't have reliability of the data you're dead. Still, you don't need to have... you know, that (immutability). Immutability actually gives that to that. You know, it is, I think that's a key feature of blockchain - you can't change it, right. So it's stopped there, and nobody can tamper, which means that it gives you reliability and integrity. Transparency, of course, you need a transparency if, when you need it. Privacy is is, you know, you can't do anything. You need to design for privacy. And of course, you need to sorry, but you know, it's rather high.
53	Interviewer: That's good. That's actually good.
54	Fredrik: So all characteristics of the blockchain. Maybe also that, you know, if you need to change your objects or documents, or record, sorry, you shouldn't use blockchain, you should use something else. So I think it is, in a way, is high there (immutability) as well. Because that's why you use that technology, you need to have something... today, you're using banks, because they're trusted. You know that if I put my money in the bank, you know, nobody will tamper because they build trust. Now, the technology is building trust. And why do we have we have trust in blockchain? Well, because we know you cannot change anything, it is impossible, which means that you get reliability, you get integrity of the data, you know that that data.... you need to make sure that you have, you know, a way to actually use the data. versatility.
55	Interviewer: If you go now, just to each characteristic, do you think you would like to add some of characteristics that maybe we have missed? Or do you think we have too many, and maybe you put some together?
56	Fredrik: yeah, one characteristic, that is not here is performance. Because you can have all of that, but if your system doesn't have performance, you're screwed. You can't use it anyway. So I would add performance there as well, where I think, you know, in particular, when it comes to these high volume transactions, I don't know

	which one it is. You need, you need to be able to crunch a lot of data quickly or to create one of those blocks. And today is a problem if you want to use blockchain for for high volume, high volume transactions.
57	Interviewer: that sounds like a challenge and limitation, which we will go through. Characteristics let's say are more from the opposite side...benefits...
58	Interviewer: what defines what is blockchain.
59	Fredrik: Ok, what defines it today? So this is what defines it today: Versatility, privacy, reliability, immutability....alright, yeah.
60	Interviewer: and about the drivers as well. There is some other driver, you think should be added or removed?
61	Fredrik: What about supply chain, standard, safety, social, economic ,technology...[thinking out loud, reading labels]. So if I'm shipping...no, that's food traceability. If I ship a container of goods from [inaudible 16:24] to us, and throughout the journey of how smart contracts... What what drivers? What driver? Is that?
62	Interviewer: Yeah, so it's the either technological or economic, right? It depends what is the driver: to automate the process. Let's say to avoid the manual labor and reduce the cost maybe.
63	Interviewer: I think that all of them are quite included on that. Because you're going to need some some regulations, you're going to get some safety and quality, the social part needs to be cared for food, economic and technology...
64	Interviewer: if the company says, okay, we want to improve, or there's a reason to improve the traceability. So there should be a reason behind smart contracts. Smart contracts is a tool kind of, but is not the driver.
65	Fredrik: True, I think the traceability is the need for all their paperwork. But I think what you want to remove is the work. It is a lot of manual work, which of course costs money because of manual work. But also, it costs quality, because you might have an issue, you know, you might do something wrong. So that's exactly, it goes probably goes into most of them does a lot of safety quality there as well.
66	Interviewer: It's supposed to be quite generic. So you can always add a lot of things, but nothing really clearly pops up that is missing?
67	Fredrik: No, no, I think they're quite good.
68	Interviewer: So now we go through the challenges. We have in total, six challenges. And one of the challenges I think you will see that what you mentioned is throughput and latency. And basically, we will go through them and we think okay, how these

	challenges...how important are they for the adoption? Are they high barriers or low barriers
69	Interviewer: how they can impact the adoption of blockchain. it's the same (labels).
70	Fredrik: I think that one is high (throughput and latency), awareness and understanding is probably medium. The blockchain creates the most value for organizations when they work together in common interests in common (reading the label). Yeah, they don't have to but I think it's a medium.
71	Interviewer: why do you think they don't have to?
72	Fredrik: Organization don't need to... Yeah, maybe we're talking about that minimal viable network in blockchain. So if you're the only one you can still create a powerful blockchain if you have a crowd. So it doesn't...blockchain creates the most value for organizations when they work together on common interest in common problems (reading label). That may be is high. I see two type of blockchains. It's blockchain that connect different organizations, way basically, you have a platform and then you all chip in and then you create a minimal viable products. And the other blockchain is one organization, could be a nonprofit, or profitable. And then the blockchain is created by the crowd, which means that you only have you're not dependent on other organization. You're dependent on that.... That's why it really depends on the case.
73	Interviewer: But for the food traceability do see the crowd...?
74	Fredrik: Yeah, for food traceability. It depends. What cases do we have when I put food on the market, and I'm dependent on the crowd? I should give me feedback on that. Yeah...maybe it is high in food traceability.
75	Interviewer: Yeah, the context is food traceability, so I try to remind.
76	Fredrik: Yeah, culture...
77	Interviewer: I think we skipped the first two, maybe we can elaborate from the first one...
78	Fredrik: Throughput and the latency. Yeah. So this is what I touched, you know, it takes...to create a block can take a long time, which means that the throughput is limited. And I believe if you want to scale the blockchain, you need to make sure that you can crunch more data quicker. You have to. That's why it's high. I think it is.... everything you're doing in IT today requires high throughput, low latency, right? Otherwise you will not survive. Right now, right now, blockchain is a low throughput and high latency, which is, which is actually, you know, by definition, it shouldn't survive.

79	<p>Awareness and Understanding. Lack of awareness of the technology, lack of understanding how it works doesn't really...I don't see it as a big problem. Because, because not everybody needs to understand blockchain. And I think we quickly go into a blockchain discussion when we have another problem and monetize many other solutions. So right now we have a few blockchain products because we wanted to do a blockchain product. But when you look at the problem, we want to solve, in all cases, you can actually solve that with a normal type of data storage. So that's why awareness and understanding... the techie ones need to understand the blockchain. That it's a solution to a problem. Culture, moving away from the traditional way of doing things due to the adoption of the new technology that place places trust authority in the decentralized network, rather than in a powerful federal institution (reading label). Okay, culture is a big... it's a challenge, I think is a big challenge. And that's why some some people say that blockchain is as big as the internet, because it will eventually decentralized governance. Which is just crazy if you think about it. Other than that, when it comes to not only currencies, but anything...Costs and efficiency. Blockchain implemented, require high amounts of energy and storage, that can increase costs, it is difficult to decide how the cost...(reading label). But again,I think it's related to that point. If you have a high volume type of business, you need high throughput and low latency, which means that the costs will go through the ceiling. SO for high intensive, high transaction intensive activities. It's high.</p>
80	<p>Interviewer: So just to clarify these challenges is how likely they are getting in the way of the blockchain adoption. So we say that...</p>
81	<p>Fredrik: Yeah. Okay. That's a good one, as a cost is not getting away from blockchain adoption.</p>
82	<p>Interviewer: Okay. So I think this one there, when we say cost, it's all summarized also, but also there was a highlighted point that it's hard to share the cost. So if you have many organizations in the blockchain it can be difficult to decide who pays for what, who takes the cost of blockchain and for, let's say, what part equally or how much? So this was one of the challenges we identified.</p>
83	<p>Fredrik: Yeah, I don't know actually. cost and efficiency. So the cost of blockchain....Does that.... Is that what hampered the road? Probably not. Because blockchain's not more expensive than any other solutions rather the opposite.</p>
84	<p>Interviewer: Do you think they're cheaper?</p>
85	<p>Fredrik: I think so.</p>
86	<p>Interviewer: if you want to put one more more than one value to each one of these, it's okay. as well.</p>

87	Fredrik: Okay. Regulations and governance. Since it's a relatively new technology, governance and finances are seeking for regulation, especially for crypto (reading label). Yeah. So I think here's the opposite. Regulation and governance would hamper the the growth. And I know that the American banks day they're doing whatever they can to put regulation on blockchain because it is a disruptive technology,
88	Interviewer: But aren't they putting it on the crypto? Because, don't they focus more on the cryptocurrency side, than rather blockchain itself?
89	Fredrik: Of course,
90	Interviewer: So if we think about blockchain technology in a food traceability context for example, it could be that in the literature, they say that there are no, let's say, government bodies that enforces the, let's say, smart contracts, for example. So you know, your paper has a legal legal power while blockchain, let's say, contracts do not really have it, or there is no legal framework that supports, let's say, the blockchain. Not yet at least or not not as popular.
91	Fredrik: Yeah, ok. Because what you...Okay, good point, because I was also thinking crypto. I'm just worried that the regulation, you know, the point with blockchain is that it's free from regulations and governance, because it doesn't need it. You don't need it. And the reason why you don't need it is because of the three right (pointing at the labels).
92	Interviewer: Reliability, immutability and integrity. I'm just saying, so we remember which figures are pointed.
93	Fredrik: But that's the whole point that technology is actually replacing governance and you crowdsource governance, you distribute governance or regulations. And because of the network, well, the network is the governance. So I would put medium there. Because without governance and regulations, these minimal viable networks are blockchain, they will build trust because of the technology.
94	Interviewer: If I may, just to go once more, because I think maybe we have not been super clear. So these challenges, we identify as, let's say, more of the negative side from blockchain, if you will, that might block the adoption, might act as a barrier. And just so we are clear we understand it right, So we think that throughput and latency is not good enough, let's say, for a lot of possible adoption of the blockchain technology.
95	Fredrik: Yeah.
96	Interviewer: If we consider...because we have to understand that also the public... if we take again, crypto, because a lot of literature especially, they confuse cryptocurrency and blockchain. they mash it into one, but let's say if we take private

	blockchains, the throughput is much larger. So for example, the public can be a lower 7-15 transactions per second, and the private can be 3500, which is the same as visa network. Yeah, which is quite high throughput. So do you think, you still think that that's still not good enough, and that so might be in a way for the blockchain adoption?
97	Fredrik: If it is what you say it's fine, but what I've learned is that it is extremely slow. And if I if I think is slow, then of course, a lot of other people believe it is slow. Which means that, you know, there is a challenge. If its perceptual reality that you know... but the perception now is that it is slow?
98	Interviewer: So is it correct to say, depending for which requirement...
99	Fredrik: Of course, yeah...
100	Interviewer: if you record, at the very early stage, a lot of data of the machines that make food, probably maybe blockchain will not be able to deal with the throughput of the data that comes. But if you, let's say, record, the final product, you record timestamps of where it is, at what time and what happens. You think in that case, it would be sufficient enough?
101	Fredrik: Yeah
102	Interviewer: Then it would not be as a high issue.
103	Fredrik: No.
104	Interviewer: It's only if you, what you mean, I guess, in the early stage (food manufacturing) just to clarify
105	Fredrik: exactly, and it's general statement. I just do a sweep and give a general statement. And then you know... Jonas (interviewer 1) probably knows quite a lot better than I do when it comes to reality. My perception is that, you know... but the thing is that everything, everything today need to have very high throughput, you know, the performance needs to be, because that's why I wanted to have it as a capability. Performance on everything we do need to be super high. Because it's exponential curve on needs. So it is a challenge and the key capability in the same aspects. So to say.
106	Interviewer: There is any other challenge that you think if we forgot, and you would like to add?
107	Fredrik: Yeah, challenges... What all the challenges we (looking at the labels)? When do we cover the immaturity of the..technology? Because the challenge today is that that technology is quite immature. And then also the the consultant companies that are delivering blockchain solutions, they're not very skilled. They're doing a lot of r&d. Yes. Well, you know, we have Microsoft and IBM and a few others. And

	and I don't see nobody has a lot of experience. So I think one challenge is...you know, experience, integrating blockchain into business scenario.
108	Interviewer: Okay, that's a good one.
109	Fredrik: Another challenge is that there is a..., well maybe that's not a challenge, but, there is a hype. There's a blockchain hype. And I think many times, blockchain is not the right solution. But still, you know, you're trying to...
110	Interviewer: force it?
111	Fredrik: yeah, so I think in general, there is a lack of knowledge about blockchain. And in particular among consultants.
112	Interviewer: Think it could be related to the awareness of understanding in a way?
113	Fredrik: Yeah. That awareness or technology or lack of...(reading the label). Okay, yeah. Okay. And there, I was more looking at the broader mass. I think the broader mass doesn't have to know that there's anything called blockchain. However, the people work with integrating, you know, business into blockchain, they need to be much better understanding what are the use cases that are actually good for blockchain?
114	Interviewer: So the so called experts are not that good experts, you if you put it simply?
115	Fredrik: Exactly.. And many times they're, using blockchain when something else should be...
116	Interviewer: Is there anything you want to ask? (referring to Interviewer).
117	Interviewer: No, I think we covered everything.
118	Interviewer: is there anything that you want to add? Like in blockchain uses inside Tetra Pak or other context?
119	Fredrik: Yeah, you know we have a few tracks. There is one that is very interesting. And that's one in US with the regulations, food production regulations, which is pretty cool. But we're still trying to find something that can actually bring money.
120	Interviewer: Okay. That's important..
121	Interviewer: Okay, well, then, I think we can close the this interview. Thank you so much.
122	Interviewer: Thank you so much for your time, it was really valuable. Good insights.
123	Fredrik: that's good.

124	Interviewer: Did you have some input for the exercise? You think it's a good format?
125	Fredrik: No, I think it is. It's good, because it's visual. It's very visual. And you can easily go back... and I never done something similar in the past. And I really liked it. Because it is visual, and you can actually go back. But otherwise, you ask questions or you answer questions, right? And then you have no clue what you actually said. Here is very structured, very visual. Very good. Where did you find this concept?
126	Interviewer: We saw some techniques from Agile facilitation meetings and some other techniques that our advisor gave us.
127	Fredrik: Very good. And this is really, this is a good work method when you're actually looking at blockchain scenarios. So what's the driver for your blockchain? What capability do you need? What are the risks? Right? What are the challenges, I will tell you, you quickly can assess the scope and the maturity and so on.

Appendix 5 - Interview 3 [Rsp3]

Respondent: Stefan Akesson - Food Safety and Quality Expert at Tetra Pak

Date: 14th May 2019

Country: Sweden

Interview Type: In Person

Duration: 48:49

Interview Language: English



Figure 22. Card exercise completed by Stefan

Transcription Interview 3 – Stefan Akesson - May 14th 2018 [Rsp3]

Line	<start at 1:42>
1	Interviewer: We made this interactive exercise instead of, you know, just asking you, reading questions from the paper. We use this card game, and the descriptions in the card is very simplified description of the drivers and the characteristics of the blockchain. Which is exactly the same as in this paper (handout of summarized characteristics) whatever is more comfortable for you.
2	Stefan: Ok, and the winner gets....nothing.
3	Interviewer: So now we, the way we do, is we have five drivers, so we go one driver at a time.
4	Interviewer: And then you get these cards and put what do you think is the relevancy of each one of these characteristics for each one of these drivers. And if you can explain a bit why you chose one of the cards. And this is all based on literature, so if you want to tell something about the practical world that'll be really useful and contribute a lot to our research as well.
5	Interviewer: We can go quickly if you want through these blockchains characteristics. It doesn't really matter with knowledge of the blockchain, it's just that what we have identified based on the literature from different sources is that these are the six characteristics that define blockchain technology, as the best way to define with these six. And so if I just go one by one, and you can ask any questions if you have or if it's clear it's fine. So transparency is that the blockchain can be, lets say, considered as a ledger, as a database, and that everyone who has access to this ledger, or the database can see records of each other records. So there's a complete transparency involved in the blockchain.
6	Stefan: Ok, now I think its encrypted then.
7	Interviewer: Yeah, so you'll have a possibility...you will see that to have encrypted it all depends also on what kind of blockchain you have. So you can have a public blockchain or a private. And a private is, lets say, a restricted access that not everyone can see the information.
8	Stefan: Yeah, because normally in a blockchain you have different actors [inaudible 3:55] but they also have to assign who is going to read what content otherwise it will be because that's a lot of...not really secrets but could be information that is not valid for all the stakeholders.
9	Interviewer: Yeah, so this means it can be encrypted, but just the information is there. Some people can access or not.

10	<p>Interviewer: And then the integrity of data - so it's the very little risk of tampering. And it's also ability to verify every transaction, that is in a blockchain.</p> <p>Immutability is that what you put it on the, on the ledger, it stays there. It can be removed. You know if you put wrong information it will stay there, if you put right information it will be there. The reliability is that basically different nodes, different organizations they say can have copies of the ledger. So if something goes down, you know, doesn't disappear basically so it's easy to recover. From the privacy point of view, you have a possibility to have pseudonymity, so you can be... hide behind some identification that is not really your a name, but behind the alpha-numerical identity</p>
11	<p>Interviewer: Your identity is not revealed you can be just the key.</p>
12	<p>Stefan. But anyhow, the key gives some kind of identity.</p>
13	<p>Interviewer: Yeah, so you can be totally transparent if you want, you say okay I am, here's my key basically this is this is me, this random string of numbers. And versatility is the integration you know with the blockchain has been developed, it's beyond the cryptocurrencies, a lot of people see blockchain just as a Bitcoin basically but it's much more than that. So you have now smart contracts that you can automate certain tasks or interactions, based on the different rules set in the code. So if you say transport something from one place to another, then you can get automatically payment once somebody scans the code at a certain point, to just to give it as an example, but basically there are many different opportunities that we see the current new development of blockchain allows. So is it more or less clear the characteristics that we went through?</p>
14	<p>Stefan: Yeah, more or less.</p>
15	<p>Interviewer: So you can take your time, think about it or you can put it and speak as you put it, the labels.</p>
16	<p>Interviewer: This is the one (standards and regulations) that you're an expert in...</p>
17	<p>Stefan: Well, not really, but standards and regulations I think is high. Shall I put one...</p>
18	<p>Interviewer: You just can put one by one...</p>
19	<p>Interviewer: One each, and if you can explain why you put a card after you put it.</p>
20	<p>Interviewer: So for example you think that transparency characteristic is high for standards and regulations and maybe you can say in a few words why you think that.</p>
21	<p>Stefan: I think it should be high here because all the stakeholders or participants in the blockchain should see and understand that based on standards and regulation</p>

	<p>also if they change or being updated it's important to see it for the stakeholders. [inaudible 7:11] That of course is also important. As I said before with reliability in confidence [inaudible 7:28] integrity of data. That one is low (immutability), because it needs to be changed anyhow. Legislation changes need to be updated also if there were standard changes frequently. Reliability, records are kept or copied and due to the changes it doesn't matter that much. Privacy, I think that one is important, so that everybody understands if something pops up - new standards, new legislation - where does it come from. And in this case, this is low (Versatility). Because standards and regulations it's (Versatility) not really important part when it comes to creating contracts and also technology wise...</p>
22	<p>Interviewer: Okay, it's really good feedback, I can already see some similarities and differences compared to other people, but there is no wrong way. You can always come back and change something at any point, maybe some with the next steps, we talk about something...So feel free to change at anytime anything. Okay, so going on, the second driver behind the food traceability is the safety and quality.</p>
23	<p>Stefan: This one of course is high - Transparency very important for safety and quality. Same with integrity of data - also very important. And of course, everything entered in the blockchain should be permanent. If it's going to be changed, it's really important that there is some kind of real information or decision about why it should be changed because of safety and quality. Safety is of course important due to standards and regulations, but quality is highly important for food quality, because in the end a consumer could perceive a bad quality as a safety issue. That's why it's so important.</p>
24	<p>Interviewer: What if, let's say, immutability if so happens, you record a wrong information, would that not get in away for safety and quality?</p>
25	<p>Stefan: Yes, but you said it could be changed.</p>
26	<p>Interviewer: No, I mean, you can change any of the labels, the immutability part is that if something is recorded in the blockchain it's there forever. Information cannot be changed.</p>
27	<p>Stefan: Okay.</p>
28	<p>Interviewer: So how important do you think the immutability aspect is for safety and quality?</p>
29	<p>Stefan: Reliability. I think that is medium also. Privacy is high, I think.</p>
30	<p>Interviewer: Why do you think reliability is medium?</p>

31	Stefan: Well, redundancy of data and copies....I mean, this will change now and then. And there are copies around all the time. That's why I don't think it's high importance.
32	Interviewer: Why do you think privacy is high?
33	Stefan: privacy, well it's about confidence when it comes to safety and quality. And then you have versatility, I think it's high importance for quality and safety, because its [inaudible 11:50] creating contract can increase confidence...[inaudible 11:58]
34	Interviewer: So, the next one, we have Social. So this is to improve, as we touched before, improve the confidence of the consumers in their food to reduce the doubt made by producers and strengthen the brand. There have been some situations where some brands have not been very honest in what they are selling. And blockchain could potentially improve this part.
35	Stefan: Yes. You remember the horse meat issue?
36	Interviewer, Interviewer: Yes
37	Stefan: I mean horse meat...it's quite good, but when mixed and it says beef then suddenly its total breakout around the world.
38	Interviewer: And we use that as one of the examples in our work as well.
39	Stefan: I think this is very important the transparency to gain confidence for the consumers. Also, integrity of data very important to secure. I don't think it's that important.
40	Interviewer: Immutability?
41	Interviewer: Why do you think so?
42	Stefan: Well, records into... its permanent and it's there so I think fully ok with that. I say that this one is medium, because there would be a lot of organizations connected to blockchain, having copies of everything, so that would support it anyhow. Privacy, I think it's quite important because its all about integrity and also the ownership of data and information. Smart contract - I don't think it's really related to social - consumers, but integrations with the Internet of Things device technology I think would be high for consumers. They could scan with the phones.
43	Interviewer: Alright, so we have two more drivers left. So second to last - economic driver. At least in the literature...but we don't have to be just limited...but just as an example. The economical driver basically comes down to, you know, isolate the contamination incident and begin to pinpoint the source of the bad

	<p>product in a fast and reliable way, to reduce the potential volume of recalls, minimize the publicity and the damages. And also the impact on the industry itself. If you remember the strawberry case with the needles in Australia, where the employer was putting the needles.... And because of that, all the industry suffered, even though that has nothing to do with specific place where the incident took place, people stopped buying strawberries...</p>
44	<p>Stefan: Yes, and the similar topic, like 30 years ago with oranges from Israel where they actually put mercury in some of the oranges and it was detected and suddenly it was news around the world and nobody wanted to buy oranges, at least not from Israel. And I think they contaminated one or two perhaps, but [inaudible 16:00]...thinks gonna happen. So, from economical point of view, transparency is of course always highly important. Also when it comes to the integrity of data.</p>
45	<p>Interviewer: Can you elaborate a bit more why do think?</p>
46	<p>Stefan: Transparency? I mean,if there is a crisis and something happens, transparency is highly important throughout all the chain. Because you have to look into the issue, you have to talk to everybody, and you have to be quite open to authorities etc, to communicate. Otherwise, people would think that, okay they are hiding something...And then it will be more and more activity looking into this. One small issue could be very very big if they see that there's no transparency. So that's whnt to be very open, as open as possible. Data tampering. Of course I think it's high here as well. You have to be able to rely on the data and... here I think I would put medium.</p>
47	<p>Interviewer: Immutability</p>
48	<p>Stefan: Yeah, records entered are permanent and that is of course is important from economic point of view. Reliability, I think it's medium here as well. Because, focus on [inaudible 17:31] And of course, again, I think this is very important also.</p>
49	<p>Interviewer: Privacy as high. I'm just repeating so we later have easier time to follow.</p>
50	<p>Stefan: Versatility, yes I think it's very important also. Because they trace everything and you have full confidence that you have recalled a certain batch and things like that...</p>
51	<p>Interviewer: This is the last driver, which is - Technological. So basically the technological driver is when the new technologies are developed or becomes cheaper and better, and it can be used to improve the food traceability.</p>

52	Stefan: Yeah, I think I can put high here as well, transparency. Because I think it's very important as I explained before to be fully transparent. Integrity of data is of course even more important in this case.
53	Interviewer: Do you think if I just may challenge a bit, or not challenge, but put a question out there.
54	Stefan: You may challenge me as well.
55	Interviewer: In some cases, let's say, does it really pay off for the companies to be super transparent? Because, let's say that if some incident happens. They get the coordinated very fast. And, the downside is that they will still be... the name will come out in a bad light. And let's say if it's not so super clear. If you cannot pinpoint may be very fast or with a huge accuracy to that specific source, maybe that would from the company's point of view be better? So maybe they would not be so interested in adopting the blockchain solution, because it might be too transparent in a way.
56	Stefan: Yes, but with transparency I see it as...when something has happened and you are investigating data and root causes etc., then it's very important to be fully transparent as a company, because otherwise, as I said before, someone would think that you are hiding something and have secrets and so on and then there would be news media, they will talk about your company in a bad matter, that for example like [redacted company name as an example] they are not open. We have asked, but they won't say anything and then consumers will be more and more questioning [redacted company name as an example] if they have milk contamination and suddenly perhaps the consumer won't buy their cheese or something else, because it's the same brand. I think it's highly important, but of course it's very important, as I said that when you have information in blockchain you have to encrypt something so it's not open for everybody, you have to select what should be open to what stakeholders, because there are sometimes organizations like Greenpeace, which is they'll sometimes doing a really good job. Sometimes they are taking information and highlighting it, take it out to of the context. And then it will be misleading information that is not very good.
57	Immutability, I think that is something in between medium and high. I think it's very important with...[inaudible 21:34]. Reliability, we take medium here as well. Privacy, same here, highly important also when it comes to technological aspects. Versatility, yeah, I think it's highly important.
58	Interviewer: And you think versatility can contribute greatly to this (technological) part?
59	Stefan: Yes, absolutely.

60	Interviewer: Okay, so we're done with the drivers. And as the final step we have the challenges. So the characteristics maybe shines from more of a positive light of the capabilities of what blockchain can do, but there are also certain challenges that can act as a barriers to adopt blockchain solution. And we want to get your opinion, how do you think each challenge weights against the adoption. Is it a strong barrier or is it a low barrier and it's not really important. And we will classify from low to medium to high, the same way as we did with the characteristics. Yeah, so we have six challenges, so the first is throughput and latency. And I can go through each to describe a bit in more detail. So the throughput and latency is basically the limitation of the, how many transactions per second can blockchain process. And in some cases, it can be a bottleneck. Of course it depends on which blockchain you're looking at if you look at the public blockchain it will be much slower.
61	Stefan: 15 transactions per second.
62	Interviewer: Yeah, well that's for Ethereum network - the public blockchain
63	Stefan: How they measure that?
64	Interviewer: Well it's in a blockchain network, you can see this data, it's open.
65	Stefan: Very few transactions per second...
66	Interviewer: Yeah, compared to VISA 3500 or 3000 transactions per second. So, from your opinion. So you think okay this feels kind of low and I think this challenge of the blockchain can be as a high, medium or low...
67	Stefan: At least medium. Because I think transactions are very few. Because, I'm thinking about bigger blockchains, with a lot of different stakeholders, there will be a lot of information, all the time circulating, sometimes it could be real time data from a food production entering up in the books in a blockchain. And that will count... I mean... 15 transactions per second is nothing, is nothing. So that will be medium or perhaps even high. They need to speed up the transaction..
68	Lack of awareness...(reading label) I think it's quite low. Blockchain will come, to start with it might be a little challenging to understand it, but it will be just like having a new phone, you will not [inaudible 25:14]
69	Interviewer: So to use blockchain you don't really need to understand. I mean people that implement the solution, according you, needs to know of course what they are doing, but people, that lets say make a decision to use it or not....
70	Stefan: I think it's low. I mean, blockchain technology and in different ways, have been used from the 70s. But they didn't call it blockchain. So it's old technology. But suddenly digitalization, industry 4.0 - everything is new, but some of these [inaudible 25:55] have been used in our industries for decades, for example,

	reliability of the bearings, measuring bearings as a precautionary actions. Has been used in paper milling industries since the 70s. It's not new, but for Tetra Pak it's new.
71	Organization.
72	Interviewer: So creates most value for organizations that they work together, but some organizations just like to do their own thing, develop their own solutions. So the blockchain solution can only be fully utilized or the potential realized if many organizations work together.
73	Stefan: And if they add on, what is necessary, they might just add on few items in the blockchain then it's no value. So I think it's medium or even could be high. So it's important that all stakeholders are adding on all the necessary information.
74	Interviewer: Culture. Moving away from traditional central authority thinking and putting the trust into the decentralized organization, where no one entity is responsible for the data. Changing the mindset.
75	Stefan: I think that it's at least medium because there will be everybody...all the time there will be someone saying, oh well, 1984. Also, it depends on the actors, how they are using the blockchain. I mean you could have a blockchain for example in their democratic state, or Russia for example, I don't think a blockchain would work the same way in Russia as in France, for example, so it depends...And also when there is something new popping up, for example - GMO, there will be public debate [inaudible 28:11]
76	Cost and efficiency.
77	Interviewer: So you know the blockchain solution might require high amounts of energy and storage, and it can be may be quite costly compared to other solutions. And it could be a challenge, since blockchain usually means that involvement of many different stakeholders to decide who takes the cost and how the costs should be split. So this could be a challenge that blocks the implementation of blockchain.
78	Stefan: I will put it as a medium also because I think it would be really good for Sweden, when it comes to energy and storage, because up North a lot of...[inaudible 29:00] But I see also that lot of actors in the blockchain might not benefit as much as it costs. Just like being a member of EU. Sometimes you pay a lot and you don't get it back, sometimes you pay less and get a lot. It will be the same here. So that will be a challenge of course to get everybody involved because if you miss one or two important stakeholders, then the blockchain won't work.
79	Regulation and governance.
80	Interviewer: So, the idea is that a lot of focus from the government's point of view is really focused on the crypto currencies on the financial markets but if we, since

	we talk about food traceability context, there's not really that much governance happening. There's no legal framework in place that says, okay, the data on the blockchain is rather binding or so to say, and you know, what is on paper maybe has much more legal weight than smart contract on the blockchain. If smart contract happens and the transaction happens. and they say it was wrong, it should not have happened. Will there be legal entities...
81	Stefan: Yeah, I think that could be some implications because legislation has not fully gone into digital world. They still apply part of it, but not fully and also a lot about who is the owner of information in blockchain. That could also be a challenge. So I will put medium here, because I think that could be a problem, also sometimes in the blockchain might be that a state would say: our food safety authority should have full access to the content of blockchain. That's not really good, because [inaudible 31:05] of the documentation and nobody knows how the authority will act upon it. So, yeah, this is...
82	Interviewer: Ok, so this basically it.
83	Stefan: So it's totally different from other stakeholders.
84	Interviewer: I would say a lot of points what you think are very similar. Some are a little maybe different, but it all depends from different perspectives that every person sees and that's what makes it interesting.
85	Stefan: Okay then I have to ask you, where does it differ.
86	Interviewer: Well now if I would remember exactly which points was...
87	Interviewer: Immutability was something that was quite high.
88	Interviewer: Yeah, not for all of them I think.
89	Interviewer: And privacy was quite low sometimes, because it's actually companies wanting to protect themselves from leaking information about things.
90	Stefan: And they can do it by encryption as I said. That's always a possibility to assign what stakeholders should have access to and if someone else is looking into that information they can't read it.
91	Interviewer: And one of the downsides in that regard is that If encryption key gets leaked or stolen or maliciously revealed, then it's gone forever and there's nothing you can really do about it.
92	Stefan: But I think, anyhow, there is the back side and all this kind of sharing information that it could be used in a wrong way, someone could tamper with information etc. Always like that. I mean, look at internet, look at wikipedia. Is it

	reliable? Nobody knows. A lot of articles perhaps 90% are reliable, 10% might be fraud.
93	Interviewer: And it's quite a challenge to keep them reliable.
94	Stefan: Yes, exactly, exactly.
95	Interviewer: Do you think, from your opinion if you would like to add something or remove something when it comes to the drivers or characteristics or challenges. You think we might have missed something that you feel should be here or maybe you think some points are very closely related it could be as a one point instead of two/
96	Stefan: well, you have done this in a certain way with this setup. I would like to add that the most important for food producer is to secure inhouse traceability. Because if something goes wrong, they could try to correct it, if it's just a quality issue before it's released, or if it's a safety issue, they have to stop it before it's released, so inhouse traceability is highly important and most important is of course to have different kind of sensors and measuring equipment that could measure in real time. Not for example like [inaudible 34:11] tests now would take 2-3 days. Oh, the cheese is already out of the market.[Inaudible 34:20] Then you would have a problem you have to make a recall. Most when you have traceability, to have surgical traceability you have to have computer system, you have to have really fine-tuned methods to recall just infected batch, like 200 packages. If you don't have this system, you might have to recall thousands or ten thousands. There was an issue long time ago in US, where the consumer, told the FDA, that there was some kind of strange smell in the bottled water, and they detected the bensin. I don't know why. And they told [inaudible company name 35:00] to recall the infected batch. And they said, whoops, we don't have any traceability system so we have to recall millions of bottles. [Inaudible 35:12]. So the sale of water went down to very low levels and they haven't recovered, not yet. [inaudible 35:24]. Lot of competitors took over the market shares.
97	Interviewer: And I think that economic one was what we talked about to isolate contamination incident.
98	Stefan: It's so important. Within Tetra Pak we have plant master and it's a quite good system compared to other systems on the market. And problematic situation is to actually acquire sensors [inaudible 35:50] to measure in real time to have relative [inaudible 35:57]
99	Interviewer: If we think from the blockchain point of view, when we have the...it's very important for food traceability to have internal food traceability and every company of course wants that but you know today's supply chain can have so many different stakeholders and I think one of our interviewees gave us avocados as an example that can change 30 hands, from the beginning to the end. And if

	<p>everyone of course has their own traceability but it's kind of can take time to connect. So, with... by the time you go through all the stages to identify where the contamination happened. Did it happen in transit, did it happen in some intermediaterry process or it happened in the very beginning? And that can be a challenge. With all the internal systems of course every company does their own thing, their own standard. And it doesn't necessarily communicate maybe far off, maybe just one step up and one step down. So the blockchains point of view, let's say, if you manage to get on board all of the stakeholders. Do you see some potential in that regard to have... to be able to connect full chain.</p>
100	<p>Stefan: Yes, of course. The challenge will be, if you have a lot of different stakeholders. Downstream to the actual consumer. I think 30 as you mentioned is a little too many, but anyhow, even if you have five or six, it could be problematic situation because mainly... I think the main root cause sometimes is depending on the product of course, but, the distribution system. Sometimes you don't have the cold chain in place. For example, I know that some of the retailers in Sweden they are having all cargos in one truck. Frozen food, chill food and dry food. And of course, if the right dry food is close to the frozen food or the water. It will be frozen, there will be moisture and somebody told me: Okay. On the [inaudible 38:13] we actually removing those packages because [inaudible 38:20], but have they removed all of them? If they haven't, there will be microbiological contamination with the dry food. So, many of these topics that we have. So I think a distribution system is the major challenge. Also while the consumer itself go to the shop, it's 36 degrees on the outside. They have 1 hour at home from the shop, and it's quite hot in a car perhaps [inaudible 38:46]. Put the food out on the table, put it in the fridge, out again, in a fridge, out again...</p>
101	<p>Interviewer: Just in your perspective, do you see blockchain as a supporting solution to the current internal traceability systems as a tool or do you see more as a supporting role or actually as something that could replace what the companies are using now.</p>
102	<p>Stefan: I think that, in some sense, it could replace what's used today. But I think it's quite good addition, because blockchain is not used in many places today. In some industries as I said this be used in the 70s but in different ways. Not called blockchain but i think, i think it's a really good tool if all the stakeholders are in the system, if they have transparency, and they feel using the data as it supposed to be used. Then I think it will be quite beneficial for stakeholders, including the consumer.</p>
103	<p>Interviewer: Do you have any feedback about this exercise, that's something that you think that could be changed or what you liked about it. What you disliked?</p>

104	Stefan: It was a little bit different. And, I mean you have 3 values low, medium, high, and sometimes it's something in between. So, no, I think it was an interesting exercise. I hope you get something out of it.
105	Interviewer: We hope so too. Ok, well I think that's that and we can close the meeting.

Appendix 6 - Interview 4 [Rsp4]

Respondent: Anonymous - Food Safety and Quality Expert at Tetra Pak

Date: 16th May 2019

Country: Sweden

Interview Type: In Person

Duration: 47:47

Interview Language: English

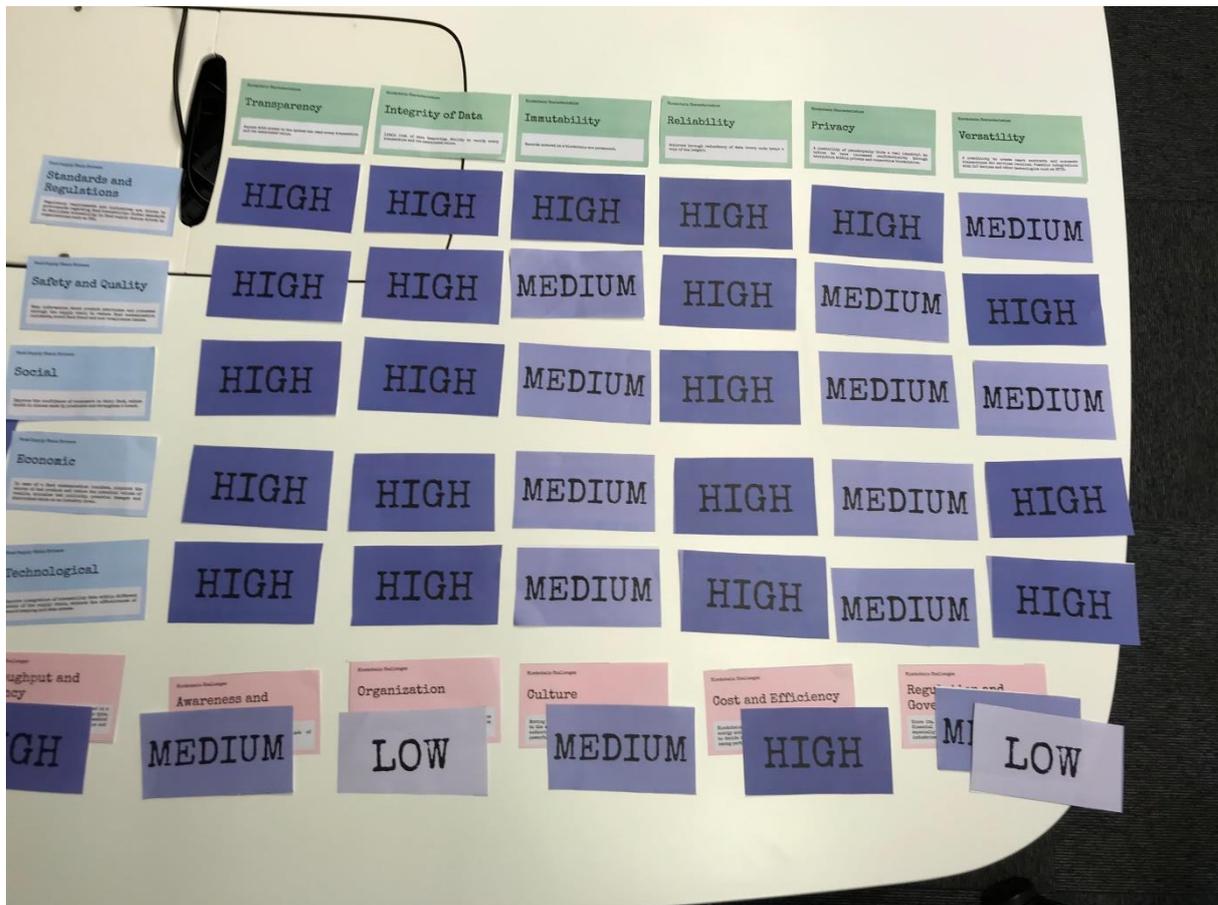


Figure 23. Card exercise completed by Respondent 4.

Transcription Interview 4 – Anonymous - May 16th 2018 [Rsp4]

Line	<start at 3:19>
1	Interviewer: So we will start by going through each driver. And then I would like to ask you to evaluate low, medium, or high. These are the same description as on the cards, you can read it on the card, or you can read it on the paper, whatever is more convenient. This is very summarized. I mean, in the of course, in the paper, there is much more nuances about each. But we tried to simplify as much as possible. So it's kind of easy to understand what to talk. So when you rate it, if it's a you think is transparency is highly important on medium or low. And then just give you some words on why do you think so. And then we just go through each and once we're done with the drivers, we will go through the challenges. And that will be basically it. Okay, so here are the labels for you to put what you think.
2	Rsp4: So related to stand on regulation, I should then rate the dependency?
3	Interviewer: Yeah. So one of the drivers is standards and regulations. So that, let's say, European law, or US the FDA law that comes in, you know, bring some requirements for the companies to follow to improve, food safety and quality. And to do so maybe they need to do some investments in the food traceability. And from the blockchain perspective, we have these characteristics. And we want to get your opinion. So do you think, let's say, the transparency in the blockchain is that anyone with access to the system can read every transaction and its associated value. And then you can put either high, do you think it's very important and maybe explain in a few words, why do you think so?
4	Rsp4: Yeah, I think it's a little bit... When it comes to regulators, I will probably put it medium, but if we go to the standards, and that's because the standards are driven by the customers today, so then I would say it's high. So probably put it high, then.
5	Interviewer: If you're unsure between, you can do both.
6	Rsp4: Yea, so it's depending...standards high, regulations I would say due to confidentiality, and so maybe then it's medium.
7	Interviewer: Just to explain on the regulations, let's say on the confidentiality part, let's say in the private blockchain it can be restricted access. So not everyone can have access. So it's only the ones that has access to the system, sort of like internal system. So if you get granted access to these different organizations in the supply chain, only, they can read it, so average Joe, or some other competitor cannot see what's happening.

8	Rsp4: So that's like a key systems, then let's put it high, then that's probably the most...Integrity and data....
9	Interviewer: Yeah, so it means that it's a very little risk of tampering, so that you are able to verify every transaction that it's a correct, you can't falsify It.
10	Rsp4: That should also be high. Immutability, when it goes into your permanent...(reading label).
11	Interviewer: So once you enter the information, you cannot change it, you cannot delete it.
12	Rsp4: Yeah, It's important, you have to maintain that for five years at least.
13	Interviewer: it's for the audit purposes, from what I understand?
14	Rsp4: Yeah, from a legal context that will ensure that this data is available for... Yeah, there is a lifetime This is the demand we have usually from big customers like Coca Cola and Nestle that we should maintain this traceability and also production data for a long longer time. Five years is what, we commit to. reliability...
15	Interviewer: basically, everyone who has the, let's say, the blockchain has its own copy of the database, you can think of blockchain as a database. It's not wrong to think this way. So basically, every part, every organization who has the blockchain has their own copy. So if something happens to one organization, you know, the building burns down with the service, it can still be used, because a lot of other organizations have the copies of that.
16	Rsp4: Yeah, that's the demand as well. So we put it as high importance. Privacy (reading label)...
17	Interviewer: So in blockchain, you can be private, you don't have to necessarily reveal your real identity. But you can also reveal it if you want to be fully transparent.
18	Rsp4: Yeah. I mean, it's now... I'm thinking now of course, area I'm working, but also have on the consumer part, you will need to have some public basically, transparency for some information. Because business to business then, of course, that's important that you have set, you keep some information. I mean, this is confidential information between two parties. And it's not... so of course, it's...it's also important. I mean, there's a lot of information that we only share with the authorities. It should not be shared, even with customers. So we have different levels of authorities, you have customers and then you have the public. So it would say it's high importance. Versatility.

19	<p>Interviewer: So you can create the smart contracts. You know, a lot of people know about blockchain only as cryptocurrency but it's much more than that. Yeah, so we don't even touch cryptocurrency. But we talk about versatility, you can make smart contracts at the moment. So you can automate let's say a transaction. So if you ship a product, you scan it when it's outgoing, and it's incoming, you scan it, and then it programmatically can already validate some rules in the contract, it can be payment, for example, or issue some other maybe customs paper or something like that without any manual intervention. So you can integrate blockchain with the IoTs, or even RFID technology. So different kinds of technologies can work in synchronized manner.</p>
20	<p>Rsp4: there is a lot of legal data, linked to product, or not only legal but also certification, certificate to analyze it. So this type of course...because that this what's building up on if you want to have through good manufacturing practices, you need to have all this documentation behind an approved products. In our case, it's food contact material. So if this is what we mean with sort of smart contract and automatic...</p>
21	<p>Interviewer: smart contract is more of you create, let's say automate transactions between two entities or more.</p>
22	<p>Rsp4: I don't know if a standard and regulators, that's probably put as a medium.</p>
23	<p>Interviewer: Okay. So we're done with the... and you can always come back if we talk about something.. you can change as you wish. Yeah. And from the safety and quality point of view, basically, the drive is to keep all the product attributes and the processes through the supply chain to reduce the contamination incidents, avoid fraud and the non compliance issue. So safety and quality is one of the drivers behind food traceability. So transparency, I see you very confidently put high and the same for integrity of data.</p>
24	<p>Rsp4: Immutability,</p>
25	<p>Interviewer: can you expand a bit more why do you think transparency...</p>
26	<p>Rsp4: This is, if you look on what is on the top of agenda in the food supply chain, when it comes to our key, customers and also retailers. This is coming back in every, I mean, if you look into the annual conference they have on global food safety initiative, which is all the big industry players, like Coca Cola, Nestle, Danone and also the big retailers like Walmart, but also Amazon and Alibaba, this type of new ... not new, but you know, they also selling this type of products. We [inaudible 11:43] their platform, so...and also food fraud has been...so traceability, in the need of avoiding food fraud, any type of adulteration of food is, is very high on the agenda. I know this transparency, there's a lot of companies also working with these solutions. So making already a lot of money in this area. So if there is a high need and the high dependency. So I think it's more, even if I'm not deeply involved in blockchain as such, but to have</p>

	solutions that are transparent and quick and safe and available so to say, to track this type of fraudulent behavior. And then this is a high..
27	Interviewer: And with the integrity of data, I guess you mean to trust the information?
28	Rsp4: Yeah, it's also linked, I mean, if you want to have this, some, system, that you can detect fraud, you have to trust the data, you should not be able... for the criminal subset to go into the system and fake, fake data. That goes in line with what, what their intentions are.
29	Interviewer: Immutability
30	Rsp4: What we mean with permanent...[inaudible 13:00]
31	Interviewer: So what you put in it stays there. And it's a double edged sword. If you put correct information perfect. if let's say maybe something malfunctions and you enter wrong information, it will stay there as well.
32	Rsp4: It's important...[inaudible 13:18] to say if it's high or medium, but I think for from a regulation point of view, it's, that's more critical probably than for general...Of course, it has to be....
33	Interviewer: There are no wrong answers.[inaudible 13:38] Reliability.
34	Rsp4: That, that should always be important I guess. You have to trust the information, otherwise, it's worthless. So I think this is probably the question that is raised when it comes to blockchain as well can we really trust this way of work?
35	Interviewer: I mean, reliability is more of redundancy of data that it's very little chance of losing this data, from that perspective. If you keep your paper archives, if there's a fire, it burns down, and then, okay, it's gone. With the blockchain, let's say it's very unlikely for to lose the data. Privacy.

36	Rsp4: Yeah, of course, you should not be able to tamper with the data, but it should be more available. In this case, because it's coming out to the public arena, let's just say when it comes to contamination issues or food fraud issues, so...yeah, I don't know, maybe that's the medium.
37	Interviewer: privacy medium, I'm just saying, so I can later recognize, little later the feedback. And versatility....
38	Rsp4: Yeah, probably for, for companies, that will probably be more important than for legislators.
39	Interviewer: Okay, so then we have social driver. So the social driver means that, from the consumers point of view, improve the confidence of the consumers in their food, reduce the debt in the claims made by the producers and strengthen the brand. For example, there was a case,
40	one of the examples where they used to buy the horse meat, and then they were relabeling it as beef. And then when it gets out, the consumers maybe lose the confidence, and then....okay, you can say whatever you want. I don't really trust maybe that much, if you know, claim to be the super responsible, socially responsible food from renewable sources or whatever. So from consumers point of view, they have to trust this. And blockchain could be one of the opportunities that could enable this, if the customer (Tetra Pak customer) says we're using blockchain to ensure that the data integrity is correct. So we want to let's evaluate and the different characteristics, how do we think they are important from the social aspect of the drivers.
41	Rsp4: So it's more consumer...if you think more...
42	Interviewer: consumer, brand strengthening....what kind of social implications....
43	Rsp4: I think, as I understand this, I mean, transparency will always be of high importance...
44	Interviewer: That's totally fine.
45	Rsp4: Also, in this case, I think transparency is the name of the game. So I'd say if you want to be able to find out the information, it has to be available for all the stakeholders and even the consumers. integrity of data, I guess it's everything... I was struggling a little bit. So maybe I shouldn't put high on everything. But I think it's...
46	Interviewer: It's not wrong. If you feel it's high, it's high. It's perfectly fine.

47	Rsp4: Immutability... [inaudible 17:30] I mean, that will be more... here with standards and regulators, then you have the demand of a long, long time, so to say. But in this case, I guess it is medium. Reliability. Must trust... it's coming back to the trust. Privacy. Maybe not that important.
48	Interviewer: Medium on privacy.
49	Rsp4: versatility. That shouldn't be...coming back to the brand. I guess that's also...
50	Interviewer: Could you elaborate a bit on that part?
51	Rsp4: For automation of transactions out to the consumer base, will also be...I guess important for the consumer, once we are more aware of that you can find out the information you can check or tend to see...for product by maybe scanning and coding, really trace it back. So once we have that solutions on the market, that could be...then it could have more versatile solutions I have to say, that could be an option. Today, I'm not sure as a consumer, I'm not looking for that when I go buying stuff on, in a grocery market.
52	Interviewer: So you don't care about....
53	Rsp4: I scan it to get the price, but I don't check what's behind the product, these type of, you know... QR codes and so on. But I think it's more, I'm not saying I'm an average consumer, but I think it's more that you're not aware...if you don't have it everywhere you don't really check it. Maybe it's 1 out of 10 packages, or even less today, but if it was available everywhere, maybe we would be even more used to checking this type of information.
54	Interviewer: So it's just forming of habits...
55	Rsp4: I think so, yeah.
56	Interviewer: And at the moment we don't have big habits to utilize versatility.
57	Rsp4: But once we have it, then it will be available and consumers will be aware of it and use it. I think it's definitely at least medium importance.

58	<p>Interviewer: Yeah, very good. So we're halfway now with the drivers. Yeah, from the economic point of view. So the economic side, why companies would invest in the food traceability is to remove the food contamination incident, pinpoint the source of the bad product and reduce the potential volume of the recalls, minimize, also bad publicity related and potential damages. Also, on the company and industry level, as well, a couple of examples: One of the Rsp4s gave as the water bottle, water company, I think in United States that had...or not the United States, or some other country, they had some contamination, and they couldn't identify the batches. So they had to recall basically everything. And they lost the market share because of that. Other example, with the strawberry case in Australia, with a needles that they were put, all the strawberry market died, basically, because people would never buy any strawberries anywhere, just to be on the safe side. So at least from literature point of view on the economic driver is to avoid potential losses more than anything.</p>
59	<p>Rsp4: Yeah, so I fully understand this is a big topic as well in the food industry, how to manage this in this in a smart way, any type of recall, let's say its ability. So again, link to transparency, to economic impact, link to traceability and blockchain on and...this is high importance that anyone with access can read every transaction. Yeah, I mean, it will help, it will help you, if you consider a recall, of course, then it will help, you can basically... because what is happening now is that you have an issue, let's say with the 1 million boxes of some defective food, and then you make a public recall, but you cannot block the product so to say, but what you could do then is you can actually block, if you have a unique code and traceability, you can block every single box of that food. So once you scan it in the supermarket, either the consumer in the checkout desk... this will not be able to...you cannot buy this...let's say that the FDA has this mandate, that they can use this code and force recall and blocking of that product, you could actually use it very efficiently.</p>
60	<p>Interviewer: So the government would issue the recall.</p>
61	<p>Rsp4: they have already that mandate today, the new FISMA legislation, Food Safety Modernization Act that was now enforced by FDA. So they can... in the past, it was like, they said, okay, you should recall that and then the food manufacturer has to... But today they can go out public, say that food manufacturer A has a contaminated product, is this production date is these type of products. And they can publish a recall, enforce a recall. Then of course food manufacturer is in deep trouble. But [inaudible 23:09] if they also have a tool, then they can enforce blocking in the supermarket and these specific batch that will be quite forceful and efficient. Because now we are relying on the consumers. Sometimes also you hear..you get meat from that day, please do not use, but you know, most consumers do. And they don't even read the newspaper or watch the news on TV. In reality, sort of, they tell you that you shouldn't use it, but in reality people... it's difficult to manage that. But in this type of system, it could actually block it completely.</p>

62	Interviewer: Okay. Yeah, very interesting.
63	Rsp4: And if you have a smartphone at home, you can shake as well, even if you have bought it...they have recalled two days after, you could actually...[inaudible 23:55] fully transparent, so I think it's high. Linkage between that as well. The way I'm considering it, at least. Yeah, I think these will always be integrity data, I think it has to be...again, if someone could go in and tamper the data, it will be worthless. So it will always be high. In such type of system. If you don't trust the system, data, you will not use it. So it might be sort of...disqualify itself. If you don't trust it.
64	Immutability..permanent. I don't think it has to be...permanent, if you think consider a long term perspective, but has to be there for one or two years. But not...
65	Interviewer: that's really great comment, especially because we talk about food context, and you know, some food, you know, does not have very long expiration date. So, if you take, let's say, 5-10 years, do you care about the bananas? That happened...
66	Rsp4: Yeah, from legal point of view the producer to producer you may need to have that, but I don't think you need to have them.... But that's also explained in some of the standards, how long time you should maintain the records. It's different for fresh produce, compared to.. if you have a can of course, then you can have the food maybe for three years. Then you have to have 3+ years...
67	Reliability.... Yeah, I guess it has to be high as well.
68	Interviewer: I see the reliability is very closely for you related to the transparency and integrity of data. Why is that? Why do you see similarities? Do you see them in the same kind of category? From your point of view.
69	Rsp4: Transparency is sort of the availability for all the stakeholders and reliability and integrity...I agree that that's probably fits together, doesn't it? I mean, if there is no risk of tampering the data, it will be reliable. And vice versa.That's how I understand it.
70	Interviewer: From this point of view, there are liability specifically mean on the redundancy. So that you are many different copies in the around stakeholders, basically.
71	Rsp4:But that is how blockchain is built up. Otherwise cannot trust it. So yeah, yeah, I think it makes sense to have it as high. All right. Privacy possibility...(reading label). Yeah, I don't think...this case, I think because this is public...this has to be public the available information to be able to catch all of these issues at marketplace. I think it's little bit less...critical compared to if you have... for the regulators. Because you will not... here you have to exchange more critical data. This is just saying that now it's a defect, you have to take it back. You don't have to go into it exact details of the

	composition and so on, that is maybe confidential information for a specific company, that is only available for...
72	Interviewer: As long as you can trace it reliably, you don't really need to disclose...
73	Rsp4: All the details? Yeah. IoT devices. Yeah, this will also be...contracts... I'm not sure about automated transactions for services, possible integration with IoT devices and other....(reading label).
74	Interviewer: This is just kind of just an example. But basically, you can make a...
75	Rsp4: I think it's high because if you want to have this, and in the consumer base, if you want to integrate consumers into recall, then you have to have a very high versatility as well for that functionality. It's not really fitting with a text, maybe with smart contracts. I'm more thinking about to have to have availability of these IoT devices, scanning techniques or whatever we call it, in the consumer base, has to be sort of a publicly available device.
76	Interviewer: I mean, this is just as an example. But it's very interesting to hear your perception.
77	And the last driver, I think we're on schedule here. From technological point of view. So all the technology developments, new technologies coming into play, and becoming cheaper, motivates the companies to use them to improve the food traceability. So let's say, if we go in the older days, everything is on paper than the barcode introduction, you can scan it, and then the RFID, as well, you know, becoming more popular and cheaper to use. And the sort of...so from this point of view.
78	Rsp4: (reading label). That will be the sort of the driver for...(thinking long time)
79	Interviewer: So let's say, the technological allows, you know, integration within different stakeholders within supply chain. So let's say that, maybe by using technology, we can have more steps upwards and downwards to be able to trace the food.
80	Rsp4: Yeah, you can connect all those different parts of the supply chain in a good way. So if you want to have transparency, yes, there is high dependency on the technological levels of same system. For sure. (thinking long time). Yeah, I guess that is also high.

81	Interviewer: Integrity of data is high as well.
82	Rsp4: not really sure if I can fit it into technological and immutability....I mean it will make it possible to have that. So if you say that, yeah, you need to have that you need, then you need to have a certain technological level. In these cases, it was more the need from that aspect. But in this case, this will be...
83	Interviewer: You don't much need?. You see them kind of correlating, or them being the same kind of thing here (technological driver and blockchain characteristics).So you immutability put as medium? Why is that? And also an integrity I think you didn't expand maybe too much.
84	Rsp4: Yeah, I think we need to have we need a certain technological level of the blockchain system to have integrity of data. So it will be sort of the it's a must need, if you want to have that. In these cases, the other cases it was more linked to that...the expectation or the need from that, but in this case, this will be the vehicle?So it's a little bit different dependency as I see it.
85	Interviewer: Yeah.
86	Rsp4: [inaudible 33:17]. (thinking long time).
87	Interviewer: So privacy is medium and versatility as high.
88	Rsp4: Yeah. Again, I think this is really important thing and all the other aspects as well, if you want to have versatile functionality, you need to have a certain...there's high dependence on the technological level and implementation necessary different levels of the supply chain.
89	Interviewer: And privacy is not so important from your perspective on the technological context?
90	Rsp4: No, I don't see the direct link in that. Think this is more linked to certain aspects, standards, legislators, customers and consumers, but linked take the technology as such....I'm not sure...
91	Interviewer: okay, that's perfectly fine. Okay, we're almost done. Now, we just go through the challenges . So in addition to characteristics, we identify different challenges, let's say that could block the implementation of the blockchain, and we will evaluate whether do you think it's highly likely that it might block or not very likely, or doesn't matter the challenge for the adoption of the blockchain. If we go through the first one...

92	Rsp4: So I put one on each of those now...
93	Interviewer: Yeah, just one of each, exactly. And on the other side of the paper, you have the same description, but you can read it from the cards as well. So the first one is...
94	Rsp4: Throughput and latency.
95	Interviewer: So you know, these days, we have a lot of data going in and going out. and if we talk about the public blockchains, which are more like Bitcoin currencies using, it's very low, it's only up to 7 transactions per second, or Ethereum network - 15 compared to VISA over 3000 transactions. But on the other hand, which is more likely that businesses are using the private blockchains, because they are blocked from the public. So you can only have information shared is between who has access to this blockchain. So those are much more efficient and can have 3500 transactions per second. So in your opinion, do you think this throughput and latency limitations, you think would get in the way of the adoption? Or do you think it's not that relevant for the food traceability?
96	Rsp4: It's difficult for me... I see you mean...if all... let's assume that all of consumers start to use this? Now, if you think about the grocery market...it's difficult for me to understand if that would be an obstacle, I mean, the system as such. can assume so, but you know...
97	Interviewer: But for the, let's say, writing information, it's hard for you to estimate if it's...
98	Rsp4: Yeah, as I understand it, you want me to to evaluate if the throughput in the system could be...
99	Interviewer: Yea, it's a bit more technical... this challenge is from the technical side.
100	Rsp4: And the reason why I cannot respond to it is that I don't understand really the need, once we have this implemented everywhere, say that we have it in all supermarkets. And possibilities. Is the possibilities up here or down here? That will influence...if let's assume that I knew that, okay, we will need this amount of transaction, and the system is only capable of that. And of course, I will put a high risk, but...

101	Interviewer: But to clarify, the limitation is only applying if you add, let's say, information, or if you do transactions. So if you're a consumer, just want to look up transaction, it doesn't really matter in that regard. So it's only if you start recording for our (Tetra Pak) equipment, let's say the filling machines or something that has extremely large data of the...lots of sensors collecting lots of data. So if you would try to put that in the blockchain, maybe that would be a limitation.
102	Rsp4: Yeah, if you want....
103	Interviewer: but if you maybe choose, let's say, only choose put the data, the average per hour or something like that. So it can be quite different from that regard.
104	Rsp4: But as I understand it, I think there is a high, because now I should put the risk that this will stop the implementation.
105	Interviewer: Yeah. Do you think it would be a showstopper kind of, is it highly likely or not at all, it's good enough already with the transactions.
106	Rsp4: But again, I'm a novice in this area. But I think based upon what I read, and so on, I think there's still some hurdles to...
107	Interviewer: There is no wrong opinions, we are asking different experts, we ask a bit more who are more into IT...
108	Rsp4: IBM [inaudible 38:57] promoting solutions, but then we look into into reality seems like they're struggling a bit. But if that this, then depending on the throughput, or if there are other aspects, I'm not really sure,
109	Interviewer: yeah, that's fine. But we're listening to both sides. So you provide really good input on maybe some aspects and others.... No one is expert in everything.
110	Rsp4: Other experts have much better understanding
111	Interviewer: But then the remaining challenges are a bit more soft. So maybe you can relate to this. So the other one is awareness and understanding, basically, lack of awareness of technology and lack of understanding on how it works that prevents organizations to adopt blockchain. Because if people might not really understand how it works it can be you know... it's a black sheep.
112	Rsp4: I think it's for big companies, it will not be...for mature companies, technology oriented companies, it will not be a problem. But for for small, medium sized companies, it might be issues, it's depending on where we are, also in which, what area, I mean country or the global...

113	Interviewer: Why do you think smaller companies would have easier time? Or a harder time as you said, sorry.
114	Rsp4: Because I think there is a need of competence. Just taking the first step into it, and of course, money as well as, resources for the competence. But that's also I mean, the maturity of this system, once it's sort of a turnkey system that you can use, you don't need to understand what's behind it, then maybe it's easier. But I think as it is today, as I understand it is quite a lot of in house development as well. So as I see it, but again, so I put it medium. Some cases easy, some... But in the general public, I think it will be sort of you don't have to consider the blockchain that much if it's publicly available information, you can access this just by scanning a code or something and get access to the data. So it will more be on a company level
115	Interviewer: to implement the solution, so which of course would be companies implementing something so they might stay away because they don't really understand the technology. Yeah, from organization point of view, the blockchain point is to have a network of organizations that work together toward common interest and common problem. So just to have many stakeholders, if you are just building blockchain alone, you know, you're in control of this whole blockchain.... So it loses all the advantages
116	Rsp4: You should think about industry now.
117	Interviewer: Yeah, absolutely. We're talking in the food traceability context.
118	Rsp4: I haven't seen any resistance to this, in the food industry. So I think low. if we talk about the food...
119	Interviewer: Absolutely. This is all about food traceability. Moving away from traditional culture, moving away from traditional way of doing things. So trusting the authority of decentralized network over a centralized institution. So instead of relying upon the central institution to make a decision, you trust on a decentralized network.
120	Rsp4: I think it's medium, it has... It's becoming more open also in authorities like FDA in the United States, they are more interested in this as well, because they're interested in a quick
121	alert system when it comes to recalls. And they of course, they are aware about this technology.
122	Interviewer: So you think culture is maturing already towards being open to decentralized...

123	Rsp4: Yeah so I think today it will be medium, but I think in certain areas, it will be easier than others to implement. Cost and efficiency. I have no idea to be honest. Is it expensive?
124	Interviewer: Well, uh, yeah. basically they say that it's a... it requires high amount of energy to store the more stakeholders involved. And it the challenge here can be that if you have, let's say, 10 companies, how do you split who pays for what and how much? So do you think this, you know, coming to, you know, agreement with the stakeholders, on who shares the costs and how much would be a big challenge or...
125	Rsp4: I'm probably guesstimating, but I think it's probably high, because when cost, of course there's always a lot of resistance.
126	Interviewer: And the final one, regulations and governance, basically, currently, the regulations are mostly interested in towards the cryptocurrencies, a lot of focus on that. But outside that, so far, there hasn't been many listed legal frameworks who could focus, you know, into the blockchain technology and they say, okay, if you use blockchain, or smart contracts in the blockchain, records on the blockchain instead of paper, for example, that it will have a legal binding value. So maybe there are not so many legal focus to enable the same power as you have it maybe on a paper or some other document.
127	Rsp4: But again, what I understood also Codex, Codex Alimentarius, who is the United Nation, body working on food safety, they also think more open... because they also see this issue with fraud and recall issues in a supply chain. And also this, you know, could have just a simple case today can consist of maybe 40 different ingredients from 10 different countries. So it's a, it's a very costly, you know, supply chain we have today, it's fantastic in one aspect, but it's also a nightmare. If you want to trace and you want to really find out where the issue come from. So I think it's coming from high resistance to low but today, I think we are in the medium. Once they realize the potential of a transparent system. I think they would be very much...because the regulators is consumers, they should work on behalf of us consumers. That's sort of a reason why we have laws in food, because it's protecting us as consumers. So once they realize that this is a big opportunity for the consumers to support and traceability, recall, and actually feedback issues, I got this bought his meal today, and it was sour and then I can report that directly into a rapid alert system that is managed by the government, they can then issue, push out, okay, there seems to be some issue with this. And can imagine if this, you can basically bypass standard producers, companies. Instead, you can have a direct link between the legislators or the country legislators and people buying the product, which I think they could be quite in favor if that is when...they don't have to go through the company that's actually causing the issue. So I think it's... it could even be low, the resistance in this one, they can even be the drivers maybe.

128	<p>Interviewer: You can put medium and low if you wish so. We have some people who put the put all: high, medium and low. [inaudible 46:26] It's interesting how people think because, we didn't say that it's possible, but some people do it. So that's interesting approach. But that sums up the exercise. I know we have to close it. But as a final comment do you have any feedback? Do you think this is a...you find this exercise an interesting way to get the feedback? Or do you have some advice? Do you have some maybe missed characteristics or drivers that maybe we didn't touch, in your opinion?</p>
129	<p>Rsp4: No...you catch the regulators.... Usually when I look into stakeholders, safety is the... authorities on the regulators... is the customers, the consumers. And of course, the standard owners, which is now more and more industry standards. And then you have our ambition as a company in Tetra Pak. These are the main five stakeholders... I think you covered all of this. Maybe a little bit from a different...and then of course the technology drivers, maybe more the companies that actually developed it... the IT solutions so to say. Yea, that's good.</p>
130	<p>Interviewer: Okay, thank you again, so much for coming. I really appreciate it for you squeezing me in your busy schedule.</p>
131	<p>Rsp4: Okay, you're welcome good luck.</p>

Appendix 7 - Interview 5 [Rsp5]

Respondent: Anonymous - Food Producer at Fisheries and Aquaculture Production

Date: 20th May 2019

Country: Brazil

Interview Type: Skype Video Call

Duration: 51:28

Interview Language: Brazilian Portuguese

Translation to English: Soraya Hossain

Translation Revision: Dalton Pinto

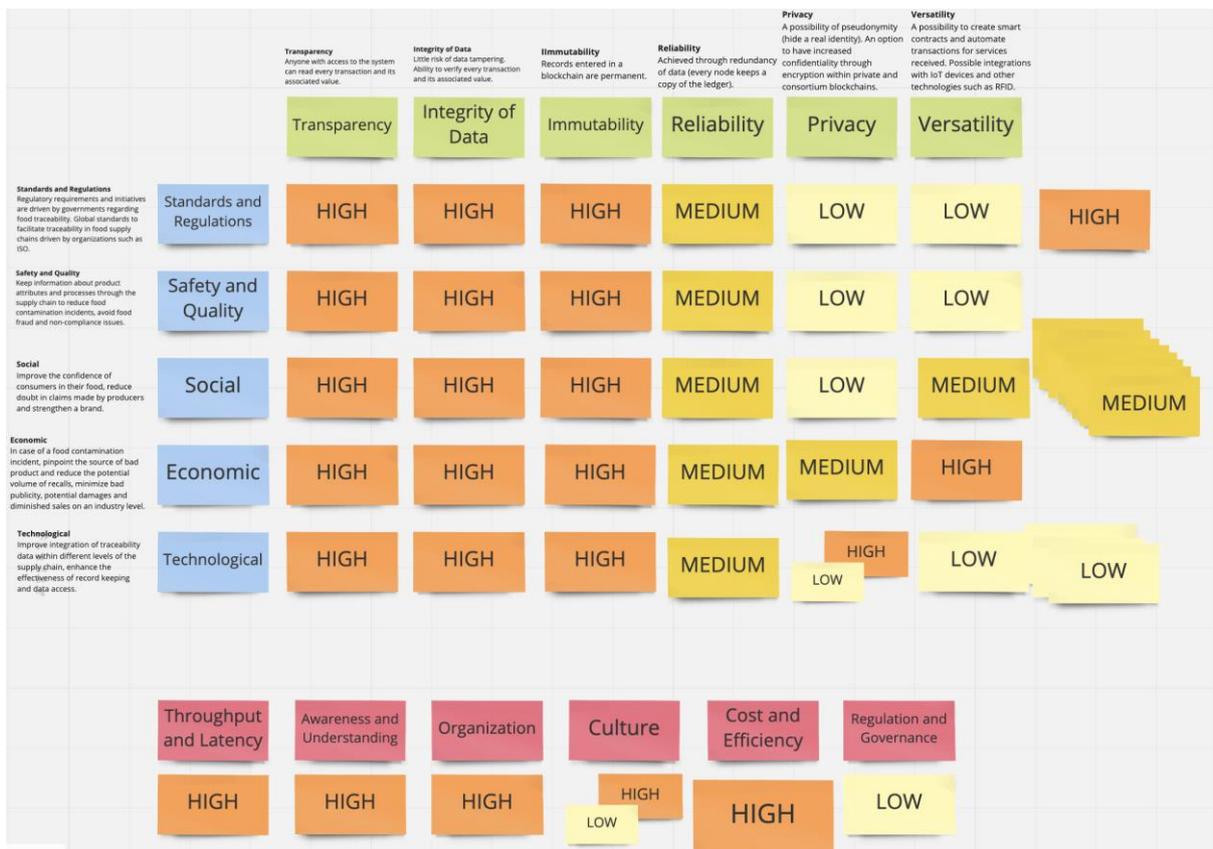


Figure 24. Card exercise completed by Respondent 5

Transcription Interview 5 – May 20th 2018 [Rsp5]

Line	<starts at 08:38>
1	Interviewer: I want you to tell me about every feature in green those cards, how much relevant it is regarding standards and regulations?
2	Rsp5: Transparency, for sure [high]...
3	Interviewer: And tell me why... Then you can drag the cards... Let me see...
4	Rsp5: How can I drag the card?
5	Interviewer: Something is wrong... Why can't I drag it...?
6	Rsp5: I'm moving the screen...
7	Interviewer: Yeah...
8	Rsp5: I got it, need to click on the mouse icon there...
9	Interviewer: I think that I changed configuration... Sorry, that's it.
10	Rsp5: Are you seed the same screen as I in this app?
11	Interviewer: Yes, the same screen.
12	Rsp5: Integrity...
13	Interviewer: Are you dragging it? I dragged one here...
14	Rsp5: Yes... As you said I need to answering regardless of blockchain right? Just about the feature itself of a given system right?
15	Interviewer: Yes, for example, on the first feature Transparency, that everyone that could have access to data available on the ledger could be important concerning standards and regulations. As well the same for Integrity, Immutability, and so on... So you need to say how much important it is high, medium or low and why...
16	Rsp5: Ok, I am already dragging the cards here...
17	Interviewer: Oh, really? Nice. I am not able to see it yet...
18	Rsp5: Aren't you seeing the same board? I am in one with title in portuguese.
19	Interviewer: Ah... you joined in one with title in portuguese... let me open this one here. So, you can go on dragging and explaining while I open it... Perfectly, now I see it. I saw that you chose high on transparency, data integrity and immutability... can you tell me why you chose high?
20	Rsp5: Right... On transparency I believe that should be high because of the easiness to get information until the end of the chain, so at end customer you should be able to prove that if followed all standards like printing an ISO label on your product.

21	Interviewer: Right.
22	Rsp5: Integrity, to ensure that you must ensure that no modification is done all along the chain, avoid any possibility to, at end, do any small changes. Same for immutability. About reliability is medium to low, because you don't need to... Maybe a centralized system could work in the same way, you know, like a centralized authority, it doesn't make much difference. It's nice to have redundancy, but it is not required to be a redundancy of millions of nodes.
23	Interviewer: Ok.
24	Rsp5: Any system with high disponibility is better that needed.
25	Privacy is low, because the more open, the better. We should not need much privacy regarding food products...
26	Interviewer: Right.
27	Rsp5: Versatility... "...to create smart contracts and automate transactions for services received. Possible integrations with IoT devices..." Right, this is nice. You could handle stock, do... You could manage contracts, like, I forgot the name, like... future markets... option markets... those folks who works with contracts about food products and commodities creating financial products tied to production and movements all along the chain and more...
28	Interviewer: Right.
29	Rsp5: But wait... I am answering it thinking about everything, it was supposed to be concerning only regulations right?
30	Interviewer: Yes, because we will go through all the other drivers, to do the same, and then, the second is safety and quality, so thinking about reducing the risks of contamination, fraud, or avoid cases like the one that caustic soda was added on milk and reached end consumer, so it is about detecting where it happened and how to fix it as soon as possible.
31	Rsp5: Right, right... Here transparency is important as well... But wait, when you say transparency here, it is about everyone or just between involved parts... Because if it is just for involved parts, maybe it could be low right?
32	Interviewer: The idea is that it depends on the context of what is inserted there, as well to access it. Because you could keep it transparent to all people, or just for some specific people.
33	Rsp5: Yes, because regarding safety and quality is important, but only for involved parts, in the end, I am not sure how much it is relevant to end consumer, so I put low or high?
34	Interviewer: If you can say that is important for a given context, you could put high and just say what is this context.

35	Rsp5: High, just for parts involved is very relevant.
36	Interviewer: Why do you think it is high?
37	Rsp5: Because of the easier it is to track the product all along the chain, the easier to detect if there is an issue with your product. Because if you have an issue with your product, and another producer have it as well, and another one have it too, so instead of being accused, you could realized that the same three went through a same given factory in a given city, we could imagine that this factory maybe have an issue.
38	Interviewer: Right.
39	Rsp5: They could have some refrigeration issues, or something like... An unbalanced scale used to measure conservatives.
30	Interviewer: Yes, perfect.
41	Rsp5: Immutability... Interesting as well, because it is needed to be guaranteed...Then medium again [about reliability]... Privacy low... Doesn't make much sense privacy neither smart contracts, integrations and alike regarding safety and quality... At least not today, when we don't have IoT everywhere measuring food... But it would be awesome if we could put a thermometer in the product, until the end consumer.
42	Interviewer: Perfectly. So, tell me when we could continue to the next.
43	Rsp5: We can go now.
44	Interviewer: The social side is related to how end consumer recognizes a given brand, industry or product... So a given brand that had an incident of food contamination could lose credibility, like, there was a case in Australia where a strawberry producer inserted needles inside strawberries and that collapsed strawberry market in australia for a long time...
45	Rsp5: I remembered that...
46	Interviewer: Yeah, very bizarre. So, in regarding this, how much do you think these features are important?
47	Rsp5: Looks like it goes the same way, everything due to same reasons... It is interesting to have transparency regarding social, it is important to guarantee integrity to ensure data is true, immutability as well. Reliability medium as well. Privacy is low. I would just increase versatility, because it would be nice to have some integrations to provide real feedback.
48	Interviewer: Perfect. Next then, economic driver is very tied to safety and quality, but related to costs like those involved in recalls in case of contaminations or some

	other incidents and how much this could propagates one next steps of the product's chain.
49	Rsp5: Regarding this, I think that the main differences is that here [versatility] it goes to high, exactly because we could have integration with sensors and other stuff that could help to detect issues earlier. Privacy should be high to avoid image risks, so having a better control over privacy could guarantee that you should inform about issues only after identify it, to avoid "witch hunts". For the others features, I keep the same as before.
50	Interviewer: Perfect. And with same arguments?
51	Rsp5: Yes
52	Interviewer: If we run out of cards, I can copy more of them. Now the last one is a bit confusing, because we are already talking about technology. But the main idea is how much technology could help tracking food in general. When thinking like that, do it in a more general way possible, covering every possible device and how those devices could help regarding traceability.
53	Rsp5: You say like accessories that I could include in my process?
54	Interviewer: Yes, could be anything like an IoT device or a system that you can input data, whatever you can imagine that involves technology that could be part of this context. I will copy more cards for you, so you can go on putting those.
55	Rsp5: But when you are talking about it, you are thinking about the blockchain right? Not about the things that I could include right?
56	Interviewer: It would cover the things you are adding, what they are measuring and how it end up in the blockchain in the end, and you may need some of those technological assets. This driver is tricky, it added a lot of confusion in previous interviews, even for us it looked a little bit weird, because we are already working with some technology, but think like anything technological, if it have any of those features, how much it could help or not.
57	Rsp5: This is exactly what I am asking, these features like transparency concerns this technology or your blockchain?
58	Interviewer: Yes, could be related to your blockchain. Or any other context that you may suit.
59	Rsp5: Then it gets worse...
60	Interviewer: Yeah, it is a bit weird... Could be both, whatever you want.
71	Rsp5: I will keep the same as before, but the only things I would change is regarding privacy, if you consider caring about the privacy of the device itself, but not what is going to the blockchain.

	<p>Then it requires more privacy care than blockchain, it should be private until the point where it goes to chain.</p> <p>So you would ensure that only what you want to go to the chain, goes to chain.</p> <p>I will put medium then. But it is weird.</p>
72	<p>Interviewer: If you want to put more than one because you are not sure about contexts, feel free to do it so.</p>
73	<p>Rsp5: So I will put high and low then.</p>
74	<p>Interviewer: Nice, in this UI is prettier, nice. Finishing this part, we just talked about those features and how much they could be useful. Now regarding blockchain implementation, I will ask you to classify as high, medium or low depending on what do you think about every challenge. The first one is related to throughput and latency, because depending on the implementation, it could be very high, let's say you need to keep data that is generated in a rate of a lot of records per second and how much that could impact your implementation, or handling it differently you could have better results. So in your opinion, how much this impacts, depending on your implementation of blockchain?</p>
75	<p>Rsp5: I didn't understood very well, for example, for cost and efficiency, I am answering that how much this is important or how much I think that cost is high?</p>
76	<p>Interviewer: Wait, right now is about latency, now it is not a table like previously that you could follow. What do you think, is high medium or low?</p>
77	<p>Rsp5: Again, I didn't understood if you are question how much important is latency or if the latency is high...</p>
78	<p>Interviewer: Oh... Sorry, how much these characteristics could be a blocker to blockchain implementation for traceability? Sorry for not being clear before. I am doing this so many times in english that I am a little lost in portuguese...</p>
79	<p>Rsp5: Right... [chose high]</p>
80	<p>Interviewer: Ok, you chose high, why do you think that way?</p>
81	<p>Rsp5: Because it depends on how you are dealing with information. If you are tracking a batch it is fine, but if you track until each consumer, concerning each given unit... Hundreds of thousands... Imagine tracking a fish, each fish... Then you have a problem there.</p>
82	<p>Interviewer: Going to awareness and understanding, how much understanding of this technology could be a problem to implementation?</p>
83	<p>Rsp5: I think this is high, this is one of the biggest issues. Because you need to convince everyone that it is important, after that you need to make people to understand how that works, how relevant it is. Because today you have QR codes all around the places, but it doesn't add much value, it just keep track of farm name. But this technology you need to explain that you are following way more</p>

	information, you must convince people that this cost worth, and the need of all the layers for everyone, and that is not nice...
84	Interviewer: Right, nice. Regarding organization is related to standards between multiple companies, so multiple companies could follow different systems or they must have to agree on a given standard to for being able to work together? I don't know if you are reading the document that I sent you with the definitions, but there we are saying that blockchain generate more value when companies works together on common problems and have common interests. If they don't follow this, how do you think that it should impact?
85	Rsp5: If companies don't participate... Well, I was thinking about a government leading this, because if it comes from a company, I believe that changes to adoption are very low, at least here in Brazil. Most people would say that "the way I work just works, why should I change to do all of this". I believe that it works only if it comes from a government or a JBS-like company that forces all their suppliers to comply. Then I think that my answer to this is high.
86	Interviewer: Now about culture, it touches a little the understanding, but now is more related to organizational culture. Today we are used to centralized culture, where someone centralizes data, and this is not transparent for most people, so how much interested people would be comfortable trusting in a decentralized network instead of a centralized one?
87	Rsp5: I see how much people would trust to store their data to an uncentralized storage and how much people would trust that data stored there reflects true nature without any audit without a third party. So how should I classify this? High or low?
88	Interviewer: You can put both and explain why. What do you think about both of them.
89	Rsp5: It is exactly that, what I just explained to you.
90	Interviewer: Ok then. Now related to cost and efficiency. Depending on how many nodes you have, you may have a high cost of energy, storage, data replication and even implementation, learning. How much do you think that it would impact on implementation?
91	Rsp5: The maximum possible. I think that it should be the biggest because people would ask why not do it in a centralized way? They are already used to it? Why everyone running nodes instead of just using a server from someone else, why distribute it?

	<p>Maybe there [in Europe] when you have a lot of countries dealing with each other, with their own sovereignty is easier.</p> <p>But here, with only one government, I don't see much gain on that, we just need to care about what is needed to export.</p> <p>So I think this is the biggest issue, justify all of this cost that would be lower when everything could be centralized.</p>
92	Interviewer: Perfect. Until now it looks like a consensus, most interviewed people set this as high on this.
93	Rsp5: Yeah, based on that, I could, maybe, lower all other to medium, but then I would keep this as high.
94	Interviewer: Perfect, so I will make this card bigger just to remember.
95	Rsp5: Yeah, maximum.
96	<p>Interviewer: To finish, now let's talk about regulation and governance.</p> <p>It follows what you were thinking regarding organization, about how much government could regulate it use and how this technology that today is very well known for cryptocurrencies, that most countries already know a little, but as financial assets, but not much is discussed out of this context.</p> <p>Do you think that regulation could impact the use of this kind of technology for food? or not?</p>
97	Rsp5: No, I don't think so.
98	Interviewer: Nice
99	Rsp5: Something like this could be forced by a government or a big company, and I believe that regulation to traceability would have negligible impact.
100	Interviewer: Perfect. That is it. Now I would ask you regarding everything, features, drivers and challenges, there is something that you would like to add or something that you think that doesn't make much sense there?
101	Rsp5: No, I think that it is good like it is, but maybe you could consider, for regulation purposes, the localization issues. If I am selling in my neighborhood is something, for another state is different, to Mercosul is different and to every other country is even more different. Standards between those layers are very different.
102	Interviewer: Nice. Is there any final considerations about the exercise itself, any feedback to do it better?
103	Rsp5: No.

Appendix 8 - Interview 6 [Rsp6]

Respondent: Anonymous - Blockchain and Food Specialist at Aetler Blockchain Consulting

Date: 22th May 2019

Country: Singapore

Interview Type: Zoom Video Call

Duration: 41:28

Interview Language: English

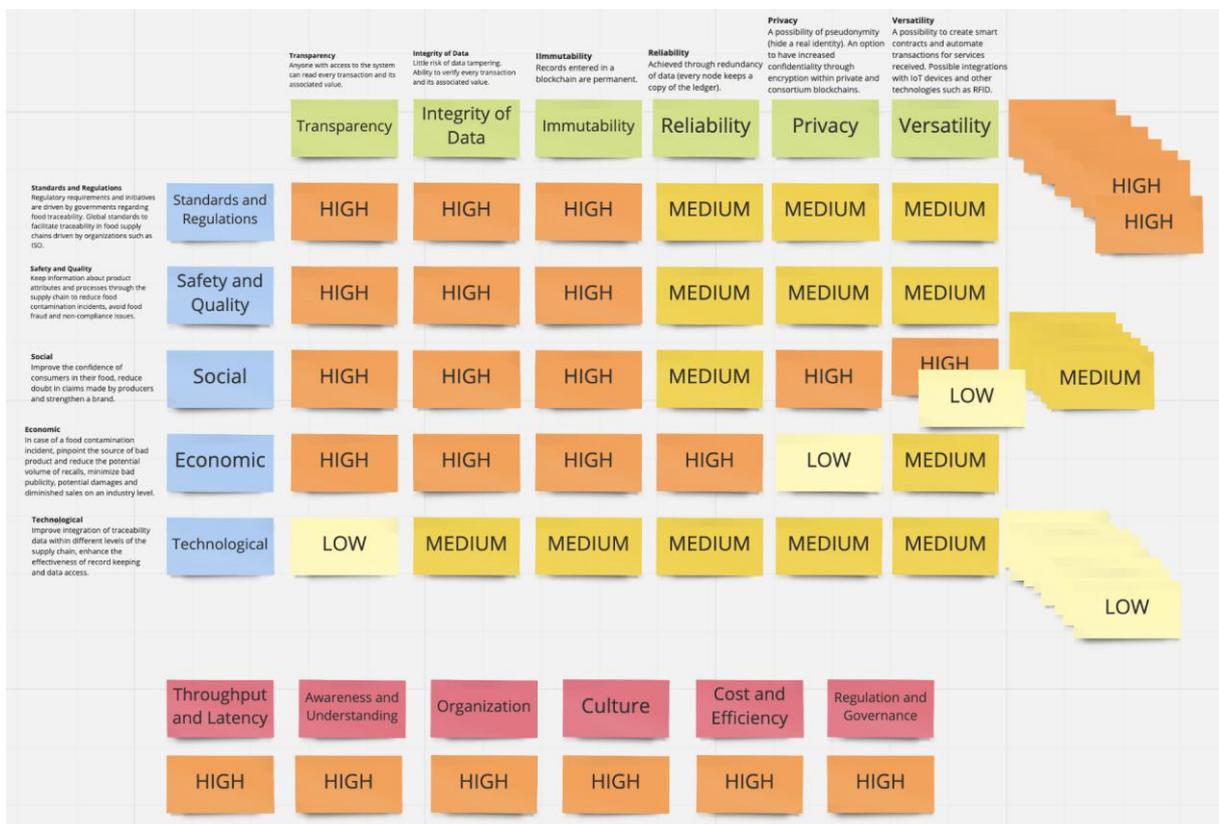


Figure 25. Card exercise completed by Respondent 6

Transcription Interview 6 - Anonymous - May 22th [Rsp6]

Line	Interviewer: Hello.
1	Rsp6: Hello, hello. Hi there.
2	Gediminas : I'm Gedis. I'm a partner with Soraya for the thesis.
3	Interviewer: Okay, hi, I don't know if you can see me. Yeah, so first of all, thanks for having the time to talk with us.
4	Rsp6: Sure
5	Interviewer: I'm just gonna present myself really quickly. My name is Soraya from Brazil. And now I'm doing a study, a master's thesis, in Lund University in Sweden, together with Gediminas that's in the room. And we're doing a research to see how suited blockchain is for food traceability. And since you are an expert in that area, we wanted to gather some input with you. And if it's possible, do a small card exercise, I can share my screen with you or I can send you the link of the cardboard, just to gather some answers and some feedback of what you think about some specific drivers in the food supply chain for some characteristics and blockchain and talk about the challenge of blockchain as well?
6	Rsp6: Sure
7	Interviewer: So first, if you, you mind, if we use your answers, it doesn't need to be with your name. It can be anonymized. But just I wanted to get a confirmation to use the answers in the board. And can I can share my screen and see... how can it... okay. I think I..., let's see if it works.
8	Rsp6: Yeah I see it.
9	Interviewer: <explains exercise >
10	And so first, if you could talk a bit about yourself, just to know, I know that you have a lot of experience to your LinkedIn profile. But I want to know you a bit more if it's possible.
11	Rsp6: Of course, Yeah, no problem at all. So yeah, basically, I'll just make a very brief introduction. My background comes from the startup space. And I've started two startups previously. One was a content management system. And the second company was called 'Salary report' where we use machine learning to make predictions on salaries in Singapore. So I've been involved in the blockchain space for the last two years, part of the technical committee, that posts on issues that will become the blockchain ISO standards, which is an international standard, as well as living or working for the national blockchains budgeting platform that Singapore government is gearing up to digitize trip documents, specifically electronic bills. Leading up from

	that I'm also an instructor for blockchain workshops at General Assembly. We started an enterprise blockchain consultancy last November. So yeah, that's about the whole general idea about myself and my company. So and the reason why I'm interested in the agri-food space is because I'm also looking to start a new project in the equity side of the food systems space, with blockchain or other technologies in the last year and a half. So that's something that I'm looking very closely at and looking at.
12	Interviewer: You're really the expert that we wanted then. That's really good. So feel free to say anything else, like, if it's not what we are talking about in the board, feel free to add anything else. It is a free discussion. There's no right or wrong answers. I just want your opinion and your experience in this topic.
13	Rsp6: Sure.
14	Interviewer: So I'm just going to start with the first slide that is vendors and relations. So the first blue card? This is some small explanation about each driver. I can, I don't know if I can create the thing. Yeah, I think. Can you see the video?
15	Rsp6: Yeah, no worries. I can see it.
16	Interviewer: Yeah, we just did a brief description of each one of them to keep this hopefully quite short.
17	Rsp6: Understood
18	Interviewer: Because of the research, but if you want to add anything that is not here, just to feel free. So for standards and regulations, how do you think the transparency characteristic of blockchain is useful?
19	Rsp6: Yeah, that probably be a higher standard.
20	Interviewer: Why do you think it's high?
21	Rsp6: When you talk about standards and regulations, especially in the food space, a lot of the times you're talking about food, safety and security issues. So having the transparency to understand the origins of food, we let them be able to understand and have a clearer picture of the safety they're getting it .
22	Interviewer: Okay.
23	Rsp6: I think that's regulations, yeah
24	Interviewer: I'm going to do that for every characteristic. So if you want to group them together, it's fine as well, or give more than one answer, that's also fine. For integrity of data. how do you think it's important for standards and regulations?
25	Rsp6: Yeah, high.

26	Interviewer: That's high
27	Rsp6: Traceability will be high.
28	Interviewer: Also for the same reason?
29	Rsp6: yeah, pretty much.
30	Interviewer: Okay.
31	Interviewer: Can I just ask a question, because we had some other interviews that provided interesting input, and maybe provide some different perspective. Because we interview blockchain people and interview food safety people that may be not fully aware of the blockchain, but some commented that for food specifically with the benefit might actually not be as a good thing, or not looking at the long term. For example, if you talk about the food that expires in two weeks, some foods for example. So no, it's not going to be a relevant record in the blockchain after some years. Since knowing the blockchain that once the record is there, it will stay there forever, so after five years let's say, it will end up with a lot of records on the food that doesn't exist anymore that is eaten and processed and gone. So from that perspective, do you still consider it to be quite high in this aspect? Or how do you think it should be dealt with, this problem?
32	Rsp6: Yeah, it's a, it's a trade off at the end of the day, right? Like, the whole premise of blockchains, or the promise of blockchain is that information cannot be changed. And this, this provides you with a source of trusted data and if information can be changed or removed, then you remove the whole promise of this technology in the first place. And if you look at, let's say, I think it's brought up a lot of times that the Moore's Law, M-O-R-E-S law, says the cost of data, the cost of, sorry, the cost of storage doubles every year. And so storage is not going to be an issue for us moving ahead. So it really depends. I think what the main issue is probably to understand what are the [inaudible] stored in the first place on the blockchain? Because blockchain is not tdata, it's not exactly a database, you don't store all the information there, you store funny, very specific information on it. And to be able to design a system that can last that can be sustainable and last. That, I think that's the key aspect. Does that make sense?
33	Interviewer: Yeah, I think so, yeah.
34	Interviewer: That was a good answer.
35	Interviewer: So moving on for reliability.
36	Rsp6: Actually, for standards and regulation, maybe not so much. I think make it medium.
37	Interviewer: Okay. Why do you think it's medium?

38	Rsp6: I don't think it's really relevant to the standards, they don't really need to care about how, how the data is stored. What they care about, what they should care about what is the quality of data on it.
39	Interviewer: Okay.
40	Rsp6: Yeah. And same thing with privacy, to medium. Traceability medium for the same reasons, because I don't think it's so relevant.
41	Interviewer: Okay, so we can move on for the next driver, that is safety and quality. So, the same for each characteristic. How do you think it is useful or not for the driver
42	Rsp6: That would be high.
43	Interviewer: Okay. Transparency?
44	Rsp6: High.
45	Interviewer: Why?
46	Rsp6: I think, I think in the [inaudible, 10:53] transparency is important for the safety and quality so that we can make, get a better picture
47	of the food quality.
48	Interviewer: Okay.
49	Rsp6: And integrity same, same reason as well.
50	Interviewer: Okay.
51	Rsp6: High, high
52	Interviewer: Okay, so for immutability
53	Rsp6: High as well
54	Interviewer: [inaudible]. For immutability, you think it's for the same reasons as well?
55	Rsp6: Yeah. So if information can be changed easily, then it's not a trusted source anymore. I mean, if you're talking about safety, safety and quality, then, then talk about [inaudible 12:01]
56	Reliability, I think it's medium for this tree as well. Because, yeah, again, like the how the technology works shouldn't be a factor.
57	Interviewer: And for privacy?
58	Rsp6: Same. medium, medium, medium.
59	Interviewer: And so can you just give a brief explanation why? Is it the same reason?

60	Rsp6: Sure, um, privacy, privacy and versatility. Yeah, it shouldn't really matter for the safety and quality? I think. What they really need is the information, right? What you really need is information and not how this technology, blockchain, functions.
61	Interviewer: So we can move on to the next one.
62	Rsp6: Sure.
63	Interviewer: So the next driver, that's social, that's about the confidence of consumers in the food and the brand.
64	Rsp6: Transparency in social will be high. Because, yeah confidence in consumer. So I mean, consumers want more information from their food, I think that is quite established. And having that transparency, more often than not sends that sense of trust. Ah, integrity of data. So, important, is high for social.
65	Yeah, I mean, because simply because, again, that's the promise of blockchain. If there's no integrity of the data, then you might as well just use a database.
66	yeah, [inaudible] high as well.
67	I'm not sure if I understand reliability as well. Well, again, I think it's also a medium, because consumers don't really care about the technology. Privacy, maybe a high for social, because, yeah, consumers want, they don't want people to collect data on them.
68	Interviewer: I just may ask a question from the privacy point of view on the social. So if we imagine and I assume the companies let's say, keep the data on the blockchain maybe the consumers can somehow access some of this data to confirm the origin of the product, let's say like that, and know that's trustworthy. So in theory, it does not mean that consumers will have any information on the blockchain, right?
69	Rsp6: No. So most, most blockchains are designed, designed in an encrypted way like you, there's no way to be able to access information. There's no way to be able to translate the data on the blockchain into information unless you have the right key, let's say a private key, for example. Yeah. So yeah, it highly depends on how the system is designed. [inaudible, 16:24] if the system is properly designed, I mean, of course, you can find there are some products out there that are not designed as well. And maybe easily, I don't know if hacked is the correct word, but you will be able to get information from that. And but that's, that's on the company itself, because then they have to comply with in Europe, like the GDPR regulations right. Yes. So, I think that that's my answer to this.
70	Interviewer: Okay.
71	Rsp6: Versatility? [inaudible]

72	Rsp6: Well, it highly depends, I think it highly depends on... I think, for the versatility for social, it can be a high or a low. Because it highly depends on the customer. If you're talking about a producer, then maybe you're like, if it can create a smart contract, and ultimately a transaction that could be very helpful for them, but for majority of the mass consumers, like, this is not something important.
73	Interviewer: okay. [inaudible 17:36]
74	Rsp6: I would say that's a high
75	Rsp6: Economic transparency, high.
76	Interviewer: Why do you think that's high?
77	Rsp6: I think this economic card ,is quite targeted, which food traceability, right, like an example with the Walmart project. So yeah, the whole point of, the whole point of having this system in the first place is to be able to have that transparency, to be able to communicate with customers.
78	Rsp6: Integrity, same reason, integrity, and immutability same reasons, for communication purposes, as well as, like, internal audit or checking.
79	Rsp6: Economic reliability will be a high. We really need to ensure that the information that we have is safeguarded and cannot be brought down so easily.
80	Rsp6: Privacy... I would say a medium
81	Interviewer: Why do you think it's a medium?
82	<communication problems>
83	Rsp6: Okay, I think it's because it really depends on how the system is built up. For Walmart's example, I think they do have information of all the suppliers. So the privacy factor doesn't really matter in this case, because they want to have a system where they, they know who, who they are dealing with. It's more an enterprise. Actually I would even go as far as to put it as low.
84	Interviewer: Versatility is low?
85	Rsp6: Yeah, no, sorry. privacy is low.
86	Versatility, I think that's a medium. I think there are plenty of, without versatility in this use case, there's already a lot of value for that. But having that versatility can allow them to do a lot more things, get a lot more value out of the technological integration.
87	Interviewer: Technological can be a bit confusing, we realized after we added. Because essentially, what we meant when we did the literature review was that the

	illogical driver, you know, all the new technologies coming into play. It starts with paper, then barcodes came in and then the RFIDs became a thing and more cheaper to use. And also, blockchain can be a part of this. So some people are confused. And I understand why because [inaudible] magical development against the blockchain, which also in a way technological. So maybe we can consider it from other systems point of view. Let's say how blockchain can integrate let' say with the other technologies that are used in the food traceability. Kind of ID or bar codes or some other software systems
88	Respondend: That will fall under your chart, the versatility right, and integration?
89	Interviewer: Exactly, yeah. So we understand it's a bit confusing this part
90	Responden: Yeah, I think. Let me just try to digest it. Integration of the technology...
91	How important is transparency? I think that will probably be a low, right?
92	Again, I think because it's so broad. Like, there's so many different technologies out there. Unless I know like, which specific technology is not really specific concern? Like, IoT, for example? Like, is it required for that to be transparency?
93	Interviewer: Makes sense
94	Rsp6: Integrity of data? Maybe a medium? Maybe a medium as well?
95	Interviewer: For the same reasons?
96	Rsp6: Yeah. I think for the reason because all of these, you're the top row, right? transparency, integrity of data... is all properties of blockchain. And the reason why then the reason why there is a blockchain in the first place is because the rest of the technologies that we have today aren't able to fulfill all this technology. So what happens is that it will be an overlap. So you know, like, complementing each other's...that these technologies would be overlapping or complementing with each other. Let's, let's give an example of like, let's say, machine learning, right? Machine learning doesn't have all of this doesn't have that transparency, integrity, because that's not the way that they function. But machine learning can work with blockchain as well. Now that I think of it I can't really think of an example.
97	I think the most common use case with blockchain today is really IoT. As well as in the food space. If you talk about traceability, there's also the Oracle problem which, is the trusted source of information to be put put into... okay, now I recall a example for machine learning and blockchain. There's the company, insurance company called [redacted name]. And they did a pilot project called [redacted]. And what they do is that, because they have the database of all the flights, incoming flights in the arrival and departure, they set up an automated insurance policy, so you pay five pounds If your flight is delayed for more than two hours, it's automatically transferred to you because on the blockchain gets this information from this point [inaudible 26:21]

	Oracle, which is a trusted source of database. And in this Oracle, I believe there's also so much machine learning aspect that is implemented in that. Does that make sense?
98	Interviewer: Yeah. Do you think that plays more into the versatility, maybe a characteristic or? It makes sense. Yeah. Sure. Just trying to see if it fits into this. specific characteristics or not.
99	Rsp6: Okay. Integrity of data. Yeah, I'm not really sure. To be honest. I don't have an answer.
100	Interviewer: No problem. We can keep just a medium. And reliability.
101	Rsp6: Still medium as well. Same thing for privacy and versatility.
102	Interviewer: There's a reason why you chose medium medium for this?
103	Rsp6: Which column?
104	Interviewer: First for reliability.
105	Rsp6: I chose medium because they don't have an answer for all of them.
106	Interviewer: Okay, no problem.
107	When we take the technology aspect in our discussion. Also, we took these characteristics. When you say the first three, that is what defines the blockchain. It's very interesting, because for people who knows blockchain, it comes naturally. But let's say for people who don't really know what blockchain is, so they see these characteristics that they can be a value added on a different level. And that's why we split it so that we can talk with people who have no understanding of technology, and then maybe they are, you know, the transparency is important, but maybe immutability is not so important. So, from that perspective, assuming if you can get the same trustworthiness from the system, without immutability, it could be as useful as blockchain in theory.
108	Rsp6: Definitely, yeah. I think blockchain is doing a very [inaudible 28:44]. And there's a lot of exploring to be done on where it's best fitted, to be used. And if there are other ways to solve this problem... there are a lot of claims out there like for example, partly due to the ICO space on a lot of the use cases are very muddy in a way, because there are huge claims that has no wrong things for...having said that, I think the reason why technology has gotten so much interest is because people do realize the potential for that. But it still takes time to find out where it truly belongs [inaudible 29:26]. That's my personal take.
109	Interviewer: Make sense. So for the last part of this exercise, we're gonna ask you about some challenges. I don't know why the explanation is not showing here. So I'm

	just gonna document so we can go through each one of them and explain it a bit for you.
110	<explaining challenges>
111	Interviewer: How much do you think throughput and latency would get in away of the adoption of blockchain? Would it be highly limiting factor or not limiting factor at all?
112	Rsp6: Can I look at organization and culture?
113	Interviewer: So organization challenge is that... you know, a lot of companies make their internal traceability systems and they don't really collaborate with many other organizations. They just [inaudible 32:00] traceability. And for blockchain to work you have to involve all the stakeholders in the supply chain. Otherwise if you are alone running the blockchain it's kind of database right? So the challenge could be that organizations might not collaborate to make a blockchain. And the culture is also to trust in a decentralized way, as you said, for example with airlines automatic payments. So in that similar regard you can make some rules and trust in a decentralized network to perform some predetermined actions.
114	Rsp6: Well, I think it will be high for everything to be honest.
115	Interviewer: You think that will impact the adoption of blockchain in a high way for each one of them?
116	Rsp6: I think yeah. There's a lot of combinations of things that needs to happen in order for this technology to be pushed through. And I think for every of this problem that you mention, I can give you examples on what's happening at the moment and why it's needed in order for the technology to advance.
117	Interviewer: that would be interesting to hear, if you have some time still left maybe [inaudible 33:33] a little bit opinions on the the most important aspects in your opinion.
118	Rsp6: I've got one in five minutes, but can I give you a very quick brief.
119	Maybe you can go back to the document previously.
120	So for throughput and agency, this is a major problem for blockchain. Every platform today is trying to solve this latency problem, because this is one of the major drawbacks of this technology compared to other technologies that we have in the market today. An example would be Ethereum trying to move to proof of stake. Again, it depends on the use case itself.
121	Even with today's existing latency, we can already start putting it into some use cases. But the higher the latency, the the more we can start doing that. But it really depends on the use case for currency, latencies highly important because people always

	<p>compare it with. Let's say VISA, [inaudible 34:39] maximum, Ethereum is seven transactions per second. And VISA is 24,000. So people are always trying to bridge that gap. For awareness, again, yeah, people need to understand that the information that they get from blockchains different from the information that they get from a data database, because information from blockchain is coming from a source that cannot be manipulated. Sorry, maybe i've put that incorrectly, it comes.... once people are aware what blockchain is about, they will start thinking in a different way on how they view information. So let's say if they they look at a database that says, this information came from a particular organization, versus if they look at the blockchain and say, this information came from a particular organization. For a database, it can be manipulated, for blockchain, it cannot. So I don't know how these dynamics going to play out in the future. But I think that people will start changing the way that they view information..slowly. Organization. Yeah, this is a major aspect, I think this is one of the major problem that is preventing adoption. Because companies, I mean, also work quite closely in the shipping space, and [inaudible 36:11].... It's a very traditional industry, and everyone works in silos. It is a competitive market. So in order to change on how businesses function together, they need to change the entire business strategy, they need to change our business model. And this is a long process, and especially with industries like shipping, people are not going to change their minds that easily.</p>
122	<p>Cultural new, a traditional...Yeah, I think it's also the same, quite similar to organization in a way that business strategy needs to be changed people are..your top management mindset needs to be changed to think in a decentralized way. And right now, these guys are simply not doing that. This needs to be changed in order for them to start experimenting with the technology and adopting it. So it's highly important.</p>
123	<p>Cost and efficiency. Yeah, as a business...this is no brainer. To adopt the new technology it needs to make business sense.</p>
124	<p>Regulations...regulation is also highly important. Not just on cryptocurrency, but also on the governance of blockchain platforms. Because blockchain platforms relies on different people to come to work together. There needs to be some kind of regulations to ensure that how it will work out in the future. And we are not there yet. Today, there's a lot of trouble getting our blockchain governance to work. Let me give you an example. Let's say Bitcoin. Who develops Bitcoin? And who decides what gets developed? These are all critical issues that are generally not spoken about. But this highly important when you look at it from a business perspective, and to increase adoption, because, let's say... let's give an example of hyperledger. If hyperledger is developed by a group of Linux team, and [shipping company names] decides to join together computers, to come together on a blockchain platform, and [shipping company name] being a much more resourceful company, they can influence the development of this Linux Foundation, either by putting people, their own developers in there or influencing them one way or another. So these are, these are issues that is very hard to solve without regulations, stepping in, so I think regulations will play a</p>

	very important vital role in this regard. So yeah, I think that that's about my, my thoughts for all of this.
125	Interviewer: Okay, thanks a lot. That was really valid inputs. Really interesting ones. It's a pity that you don't have more time, I would like to answer ask you more questions, but thanks a lot for your time and for answering.
126	Rsp6: Feel free to write me on LinkedIn and I can try to reply as much as I can.
127	Interviewer: Okay, perfect. Thank you so much. Wonderful.

Appendix 9 - Interview 7 [Rsp7]

Respondent: Rodrigo Zuchi - Senior Food Supply Manager at BRF Brazil Foods S.A.

Date: 22th May 2019

Country: Brazil

Interview Type: Skype Video Call

Duration: 1:04:48

Interview Language: Brazilian Portuguese

Translation to English: Soraya Hossain

Translation Revision: Dalton Pinto

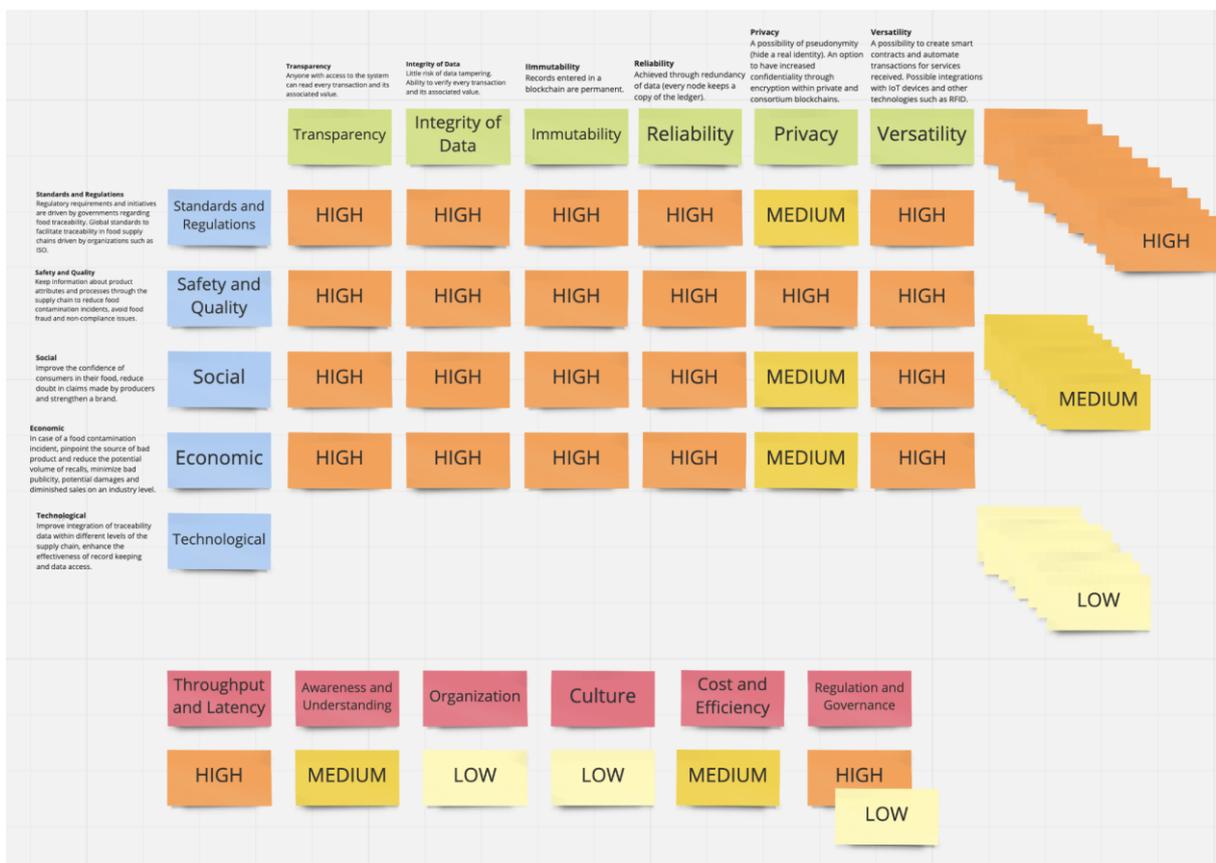


Figure 26. Card exercise completed by Rodrigo

Transcription Interview 7 - Rodrigo Zuchi - May 22th [Rsp7]

	[00:00 to 20:11 - explanation about our research, Lund University, blockchain technology, and the card exercise]
Line	[transcription started at 20:12]
1	Interviewer: First of all, I would ask you about an overview of your experience and your work at your company regarding logistics, so I would ask the questions more directed focusing on your context.
2	Rodrigo: I work at secondary logistics. Main logistics have two branches [in my company]: The primary one, that is the branch responsible to deliver the final product from factory to distribution centers; And the secondary, the one I work at, that has the goal to deliver it from distribution centers to the end consumer, e.g. grocery stores, restaurants, etc...
3	Interviewer: Nice, so let's begin. These green cards represent the features of the technology that we are studying. I will start with the first one: It relates to transparency in the sense that every person in the system is aware of everything, and it's important to highlight that it's not everyone in a generic sense, but is about everyone that has access to the system. This awareness means that this person could read every transaction in the system and, for example, can track everything that happened with a given product, in the avocado case [explained before 20:12], it is possible to track who is the producer of the avocado, which pesticides were used in it and so on. How much do you think that this feature is relevant regarding standards and regulations? High, medium or low? And why?
4	Rodrigo: I think it is high because we have a lot of factories, a given sausage could be produced in Marau, Rio Verde... so details regarding the place, or the SIF of the factory, are very important to locate the product immediately and identify why an issue was generated.
5	Interviewer: Perfect! The idea is to follow this process with all combinations of cards. Looks like a lot, but it will get faster since a lot of those are related and have the same answers.
6	Rodrigo: Ok.
7	Interviewer: For example, that is exactly the kind of response that I expect from you, so that is why I asked you previously if I could use your name or if you prefer to be anonymized, or at some given answer you could just say: "I don't want that to be discussed because it is privileged information or I am not allowed to say".
8	Rodrigo: Perfect.

9	<p>Interviewer: Going to the next one, we will talk about data integrity, the second feature of this technology.</p> <p>We could say that this technology has negligible risk or even no risk of overwriting data since it has ways to ensure that a given data is reliable or not. It verifies that every transaction is consistent as well as every value related to it.</p> <p>Do you think that this feature is how relevant to standards and regulations? High, medium or low? And why?</p>
10	Rodrigo: Could I read again the definition of data integrity in that sense?
11	Interviewer: Sure.
12	<p>Rodrigo: I think this should be marked as high, because when you can overwrite it is possible to risk all the chain, our company invests a lot in quality and integrity regarding our food and business, so if you could overwrite something, it raises questions about company integrity, since you didn't have a reliable chain.</p> <p>That is why I think this feature is very important.</p>
13	<p>Interviewer: Perfect, great answers!</p> <p>Now concerning immutability. All records are permanent, so any information could be deleted, how much do you think this is relevant regarding standards and regulations?</p>
14	<p>Rodrigo: A lot! Because today we can't work with a technology prone to errors, we are currently using a SAP system, I think may you know it, from Germany, and on that you are not allowed to change or delete data.</p> <p>The reasons follows the same as in latest answer.</p>
15	<p>Interviewer: Perfect. Now concerning the next feature: reliability. Information is not stored centrally in a single node, it is replicated in other nodes, so if some node malfunctions, or is turned off, is still possible to retrieve the same information from another node. How much do you think this is important?</p>
16	<p>Rodrigo: I think this is very important as well. Because if you have a data, and don't have any backup or security copy or maybe even at a BI system why do you get it?</p> <p>Given our company as example, we are very frequently audited, from internal audit, customer, then we audit, government audits, so if you could hide data an audit has no value.</p> <p>Then it is very important.</p>
17	<p>Interviewer: Perfect. Next one is about privacy.</p> <p>This technology allows pseudo-anonymity in a way that you can hide your identity, but still can provide some information.</p> <p>As an example, I don't need to know the names of all companies that were part of the chain that a given food went through, but I am able to know what happened to the product.</p> <p>How much do you think this is relevant to regulations and norms?</p>

18	Rodrigo: You are saying about the end consumer? Where he would have access to all chain of the product?
19	Interviewer: The context you can set. Could be the end consumer or in the context of any company that is part of this production chain.
20	Rodrigo: I classify it as medium... Because today we need to... Now I am talking my personal opinion, it is not enough to have a quality product or being a trusted company, but need to have partnership with trusted companies, suppliers, service providers, so only in that way you could have a truly trusted product in the market. So what's the point if you have a great product, audited company if you have a partnership with someone who practices slavery?
21	Interviewer: Sure.
22	Rodrigo: I think that all the chain [must be trusted], that's why anonymity I consider as medium.
23	Interviewer: Ok, Perfect. Lastly, versatility. This technology provides integration between devices, there is also the smart contracts, that are programmed rules that could used measured information, for example, imagine that the temperature of a given product should be at most 10 celsius, but it crossed this limit, so it should trigger [an event] that will be registered on the blockchain, so, I would know that a given avocado in the past were not in proper refrigeration conditions. As well, other control mechanisms could be available. How much do you think this is important?
24	Rodrigo: Extremely important. I work exactly with frozen products.
25	Interviewer: Nice, perfect.
26	Rodrigo: So, it is not enough if we have a chain that begins on the farms with a lot of standards, more standards in the factory, where we are constantly audited from a lot of big players all around the world to be correctly stored in the distribution centers to be loaded on trucks to deliver if we don't have a proper care concerning temperature. We should throw away all this pipeline if we can ensure that care were taken in our 90% of the process until delivery, but wasn't properly handled by others previously. So this have extremely high importance.
27	Interviewer: Perfectly, now we finished out first driver. Now we will should do it with all the next 4 drivers, but the last one we will not spend much time on because from other interviews we realized that it was confusing in this model, so we will mainly go with the next 3.

	<p>The idea is to go through again over all features, if you want, you can follow directly without me stopping you, but you can ask me anytime you need about it again, I can leave this window open.</p> <p>Then, asking you about the second driven, which is safety and quality. This [driver] is concerning keeping all information about all attributes and process of the products all along the chain to reduce incidents like food contamination, to avoid fraud issues and non conformity of food. Basically, what you are experiencing with auditing processes there. Because this is one of the biggest issues around food supply today.</p>
28	Rodrigo: Right.
29	Interviewer: So, how much important do you think that all features are? I will leave open all of those, so you can tell me how much the are, like high, medium or low, and I will place the cards for you.
30	Rodrigo: Ok, then now I need to talk about transparency regarding...?
31	Interviewer: ... regarding safety and quality. So how much important transparency is to ensure safety and quality?
32	Rodrigo: Ok, I just need to read again the description of safety and quality. "Keeping information about attributes and processes of the product..."
33	Interviewer: "...through the supply chain". I don't know how clearly you can read it from there.
34	<p>Rodrigo: Ok, "Keeping information about attributes and processes of the product, through the supply chain, to avoid food contamination incidents, avoid fraud and non conformity of food".</p> <p>So I still think that transparency relevancy is very high, because the consumer, especially regarding food, that will be given from a person to his entire family... So [consumer] needs to feel safe, that what is being bought did not suffer any contamination, that all companies are trusted all along the chain as I said before. What is the next one?</p>
35	Interviewer: Data integrity. I kept it highlighted.
36	Rodrigo: Just wait, I need to read it to remind...
37	Interviewer: Sure, it takes time to get used to definitions, I can explain again if you want.
38	Rodrigo: I still consider as high, because all information that is written in the label must be true...
39	Interviewer: Perfect.
40	Rodrigo: ... they can't be overwritten at any given point in time, so I consider it high.

41	Interviewer: Nice. Now regarding immutability, the impossibility of deleting records...
42	Rodrigo: Is high too. Same reason of the previous item... Nothing could be overwritten or hidden, and all of this should be handled in a transparent way. The next feature is...?
43	Interviewer: Reliability. So you could retrieve data in case of loss or unavailability of any data center.
44	Rodrigo: Too [high]. Because you need to have all information about producer... "through data redundancy..."[reading]. Then I consider as high this feature because we are talking about food, so we always need to know the origins of it, so imagine a contamination incident in a given product that have a shelf lifetime of one year, but the issue was known after 2 months of production, so it already reached the market, could be consumed by end customer, then it is needed to ensure that, no matter that it was produced months ago, all those data should be archived somewhere, because if some contamination happens, it should be able to track and investigate, no matter how old is it were produced, so those data should be always safely copied and available.
45	Interviewer: Perfect. The next is privacy, about hiding the identities of companies in the chain... Let me show the description again.
46	Rodrigo: Ok, privacy... I still consider it as high. As I said before, in the same sense of the previous comment. You need to have all your partnerships with trusted partners to ensure that the last company [being trusted] could offer a trusted final product. Integrity of partners should be high.
47	Interviewer: Perfect. Now the lastly, versatility. That is the ability to use other devices to control things like temperature and keeping it stored in the network.
48	Rodrigo: High as well.
49	Interviewer: Because of the same reasons as previous driver?
50	Rodrigo: Exactly, same way of thinking.
51	Interviewer: Great. Now we can speed up a little bit, it will not became too much repetitive.
52	Rodrigo: Nice, it is fine.
53	Interviewer: Now the next is the social driver. What it means? It means that we could improve consumers trust your food products or of a given industry to reduce doubts and complains to producers, to strengthen a

	<p>brand. And it could work for producers as well, because you can show that your information is trusted and consumers could trust on it.</p> <p>I will leave it open here.</p>
54	<p>Rodrigo: So, let me read it again "improve consumers trust your food products or of a given industry to reduce doubts and complains to producers, to strengthen a brand.", ok. So here it involves a little bit of customer services, right?</p>
55	<p>Interviewer: Yeah</p>
56	<p>Rodrigo: Ok</p>
57	<p>Interviewer: And as well as the way society recognizes a brand. How the society, final consumers and producers recognizes that brand.</p>
58	<p>Rodrigo: So, transparency first of all, high in this feature.</p> <p>I can take our company as example, we the market leader, have a lot of trust, and because we are the market leader, sometimes even more expensive as other products, the consumer, when goes to buy a product... if he have an issue with that and needs to solve, it expects a fast resolution, right?</p> <p>Especially because he is buying that, paying more... not only because of the product, but as well because all of the experience that this product could bring to him.</p> <p>Then if he opens the product and realizes that it need to file a complaint in customer service, he expect that resolution must be fast because he paid more for that.</p> <p>I am not saying that a bad experience could be turned into a good one, but even with a bad experience, with a fast resolution, the consumer could consume again the products from that brand.</p>
59	<p>Interviewer: Perfectly! Great. Now regarding data integrity, following what you said, I think that you will follow the same as before... Regarding data overwrites...</p>
60	<p>Rodrigo: Exactly, it should not buy a product believing in something, then it turns out that it another...</p> <p>Product should be trusted, that's why I think we don't need to go deeper to realize that.</p>
71	<p>Interviewer: Yes. And I can tell you a case that we read during our research, in Australia there was a case of a company that sold horse meat instead of cow meat and that destroyed the brand afterwards, looks like it was an error when labeling the products that reached end consumer, It was very bizarre...</p>
72	<p>Rodrigo: Yeah... How long you are in Europe?</p>
73	<p>Interviewer: It should be counting 9 months now...</p>
74	<p>Rodrigo: So you were here in Brazil when there was the "Carne Fraca" [flesh weak] scandal, right?</p>

75	Interviewer: Yeah...
76	Rodrigo: It was something weird... ok... then what happened? There was a misreading error during federal police investigation, because they did the investigation with non-experts, then the issue of the meat on cardboard paper was incorrectly misread, and then they had to publicly apologize. It was a case that, if it wasn't about a solid well established company, that could make the company close its doors.
77	Interviewer: Yes...
78	Rodrigo: That's why this is important.
79	Interviewer: Going to the next one: immutability. Regarding not deleting records...
80	Rodrigo: It's the same...
81	Interviewer: High...
82	Rodrigo: Must be high, because it involves consumer trust. He wants to know that what he buys is the same today, tomorrow and without changing information. So keep it high.
83	Interviewer: Now regarding reliability... To keep data, retrieve it later if needed, ensure that is true...
84	Rodrigo: As well is high.
85	Interviewer: Same reason?
86	Rodrigo: Yes.
87	Interviewer: Privacy. Possibility to hide identities for involved.
88	Rodrigo: I think that it is related to hide involved parts in process, right?
89	Interviewer: Yes
90	Rodrigo: You can classify this as medium.
91	Interviewer: Why do you think this one is medium?
92	Rodrigo: Because we are thinking about the social area, about the consumer, the community that the product is involved, so the consumer will want to know about the transparency and the origin of the process. So keep privacy of the involved I don't think that is so much important.
93	Interviewer: Yes. Perfect. And regarding versatility. To keep track of information like the ones of temperature or integration with other technological devices?

94	Rodrigo: Is important to know, in food industry, that quality was ensured... And that it wasn't unfrozen then frozen again... Need to be able to keep safe during all process.
95	<p>Interviewer: Perfect. Now the last driver is regaining economical. That is, in case of contamination incident, being able to identify the origin or what caused that, to reduce the number of recalls, getting back all products from where it were distributed to minimize bad publicity and risks of lowering sales. For example, there was a case in Australia, that in the beginning of the production chain of strawberries, when those were being selected to delivery, a employee, that had issues with his contractors, put needles inside strawberries and those were packed, reached end consumer, a lot of people suffered from health issues because of it and that caused a collapse in the australian strawberry market for months, because no one felt safe buying strawberries.</p> <p>If someone could discover where and stop that person to put needles on strawberries, that could avoid that the product could reach market, damaging a brand and a whole market for the consumers.</p> <p>It brought large economical losses, social losses as well, but thinking in economical it was a huge market collapse.</p> <p>Then as economical driver, how much do you think transparency is important?</p>
96	Rodrigo: A lot, because following your example, let's say that we need to do a product recall.
97	Interviewer: Yes
98	<p>Rodrigo: When we talk about food, the number of customers, and now I am not saying end consumers but companies, one of the most common companies on the streets are grocery stores, right?</p> <p>Then we need to interact with all of those to find who have this product on stock, then you need to pick them up immediately to avoid its consumption as soon as possible. So it is very important.</p>
99	Interviewer: Perfect. Now concerning data integrity, verifying all data and attributes related to it.
100	Rodrigo: Very important, so you could verify where to find the problem.
101	Interviewer: Perfect. Now regarding immutability, so not being able to delete records?
102	<p>Rodrigo: My cellphone is running out of battery here...</p> <p>But I think we will be able to continue here... So, again, what's the last one?</p>
103	Interviewer: Regarding immutability, so not being able to delete records?
104	Rodrigo: Very important because if you erase something, how could you fix an issue? So very high.

105	Interviewer: Perfect. Now regarding reliability, so distributing this data, so you ensure you can retrieve it...
106	Rodrigo: Too [high]... Safety of data must be high, so you need to investigate properly.
107	Interviewer: Yes. Now regarding privacy.
108	Rodrigo: For involved?
109	Interviewer: Yes.
110	Rodrigo: I take it as medium, because in some cases, you need to made it clear that the issue happened in a given step of the process that maybe involved only supplier X and then if X doesn't fixes it, it should not be part of the chain again. So, privacy should be taken as medium, it's not necessary.
111	Interviewer: Now about versatility, that is the possibility of action on changes like temperature end location?
112	Rodrigo: High as well. Because identifying that something went wrong, the product could be contaminated. Let's say a that a whole container that was exported to somewhere, if it not kept his temperature all the way, it could be contaminated during logistics.
113	Interviewer: Perfect. Now we finished first part, now we have a second part that is way more fast. I will send to you to here through Skype chat, the text that I was sharing with you. This is about the challenges regarding the adoption of this technology, it is quite new in that market, it born in the field of cryptocurrencies, in financial market is more used, some banks are using it as well for some financial transactions, but for food and agriculture it is brand new, so we are learning its potential. It still have some challenges to its adoption, that are the ones that I am sending here. The first one is the rate of transfer and latency, so it means that to provide all features that we discussed before, depending on how many organizations or entities are involved in the process, that information could delay a little bit to be stored in the network. I will give you an example that I received from another company: when they are packing milk, they need to keep track of, I don't remember right now exactly, but given that at each 5 or 10 seconds they need to track temperature on a given conveyor and that information should be stored, depending on the implementation, it should be hard to store information at that rate, so this could be a challenge to adopt this technology in your case?
114	Rodrigo: Yes, maybe. I was in a meeting recently where people were talking about a property called "Safety... something", I don't remember exactly but it is regarding an ISO standard... Sounds familiar to you? Is about an ISO...

115	Interviewer: No...
116	<p>Rodrigo: It is being implementing here... It is "Safety...", aw.... [vocalizing], there is a banner near here... is "Safety something"... That concerns about tracking, we just had an audit recently about it a few months ago...</p> <p>But it is a challenge, yes. In my chain, what we must measure and ensure is that the same temperature that a product leave here, on the distribution center, should be the same on arrival there, where should be measured with another thermometer, and it's a challenge to keep it until there.</p> <p>But I didn't understood the context of this challenge, it hard to me to answer this...</p>
117	Interviewer: Yes, these ones are very focused on the technology itself, so it have some limitations...
118	Rodrigo: It should be something like having a QR [code] which the consumer could read the temperature all along the process?
119	<p>Interviewer: Not exactly, not it is not related to end consumer, imagine that you are in a factory, following the milk example, you need to track the temperature of the milk each given period of time, storing that milk was passing there and at those times what were the temperature of it...</p> <p>So there are a lot of milk boxes going, and that information should be tracked fastly to be stored, and if delayed, you could not be able to store this information for a given box, and it will not be available to end consumer.</p> <p>This could be an issue... I can't bias your answer and maybe I'm doin't it...</p>
120	Rodrigo: In this case you need to measure every single box?
121	<p>Interviewer: Yes, every single box, could be boxes of milk, avocados...</p> <p>All products, could be very wide...</p> <p>So this ability to transfer a lot of information could be high on these cases.</p> <p>This is a hard issue on technological solutions, everything that needs to handle huge amount of information have challenges to handle it fastly and optimizely, and this is something that is under research on this technology, to being able to find better ways to achieve it, then depending upon implementation, you could be more fast or slow, depending on how much you will validate your data.</p> <p>I am not sure about your time, detailing could take long, so if some given point is out of your knowledge, you could skip it, but I could explain more if you need.</p>
122	<p>Rodrigo: Yes, I am kind of lost here.</p> <p>I know that identifying and measuring every single product each would be a huge challenge no matter what technology, because there are a lot of products, both in weight or unit, and regarding kind of products...</p> <p>I work with here with something between 350 and 400 SKUs, then it would be very hard to get all of these information for each...</p> <p>I can't give an useful answer for this question.</p>
123	Interviewer: Well, you just gave me a good answer, that's great.

124	Rodrigo: Then it's ok... The other [guy] that works here with me in the factory, maybe he could have a better answer for that.
125	Interviewer: Perfect. I will follow to the next, about awareness and understanding. This is a new technology in the market, so the lack of knowledge of how it works could be a blocker to implement it in some industry. Do you think that it really could be blocker or not?
126	Rodrigo: I think that for bigger companies, that already have complexity for its own chain.... it could be easier because they already have some investment on technology, then when it is under the radar of the company, some new technology like that, could be seen as a bigger investment. I believe that in the future this could be achieved.
127	Interviewer: Perfect. Another aspect, it is ideal that every company on the chain uses the same technology, so it requires some standards to it. If almost all companies uses it, and a few don't, maybe all benefits that the technology provides could not be achieved, some will be, but not every possible one. Do you think that it should be a blocker to its adoption?
128	Rodrigo: Probably not. Something like this should be pushed by big companies, that have their R&D, they have their IT, and all of this would require some governmental regulation. Since this have demand, at some given point the government would regulate and even impact some legislation... Who don't comply would be in trouble... So this kind of technology should be under the radar of all companies.
129	Interviewer: Perfect. Now we will talk about culture that involves this technology. Because, unlikely other solutions, it changes the way of doing things. In traditional way, you have all data centralized in a given point, and this technology allows you to decentralize and share more of this information, like you may have noticed before. Do you think that it should be a challenge in adoption of it? or not?
140	Rodrigo: I didn't understood, what could be a challenge?
141	Interviewer: This technology forces companies to work together in a different way, it changes culture...
142	Rodrigo: Every change faces resistance, its breaks paradigms, in companies there are that "one more thing to care"... But this change of culture today is needed, so I don't think it should be a great blocker to it.

143	Interviewer: Perfect.
144	Rodrigo: Those who doesn't complies are cut out... So one way or another people need to comply.
145	Interviewer: Perfect. Now regarding cost and efficiency. Every new technology adoption requires increase of initial costs, in this technology specifically, there are increases particular to it, like energy consumption to run all data centers and storage... Apart implementation costs, training and else. Do you think that this could be a blocker?
146	Rodrigo: No... Let me think how to answer... I believe that it should not be a blocker or something like a "no, it will not happen because of it", companies must work out to do... There is an issue around costs, and today the whole market is too much competitive, so end price could be impacted, because it should be an increase of cost along the chain, but something like that would force companies to cut other expenses to invest on it. Could bring an resistance, but not blocker due to costs.
147	Interviewer: Now lastly, as you touched before, about regulations and governance. Since it is a new technology, it already don't have a governmental regulation yet for food market, maybe in the future something could begin, in Europe there is a movement around it, but this didn't broadcasted all around the world yet, do you think this is a blocker?
148	Rodrigo: When you talk about government, well... I think that regulation is required, to ensure that everyone must be trusted, must be regulated...
149	Interviewer: Yes.
150	Rodrigo: But when you are in Brazil, and you talk about government... [laughters] Where government put its hands, it screw it all... So I don't think this as a blocker, but they could ruin it all. But... I personally don't trust in the government so... I trust much more on private sector than the public. So when it is involved, I see that with caution.
151	Interviewer: Perfect. Then, basically it is done. I would like to ask you about your experience of it, if there is something that you could add or some feedback that you could provide?
152	Rodrigo: It was nice, is a subject that I have interest as well because of the cryptocurrencies, like bitcoin...

	<p>I wish I had studied more about it before, mostly because of it, but unfortunately due of lack of time, and a little bit of laziness as well.</p> <p>Then we put it aside, but now it just raised more curiosity for me to study more about this technology, specially because you gave me some knowledge about some points that I didn't had enough understanding.</p>
153	Interviewer: Perfectly, nice!
154	Rodrigo: You raised a lot my curiosity about it.
155	Interviewer: Nice, feel free to ask me anything anytime!

Appendix 10 - Interview 8 [Rsp8]

Respondent: Mireille van Hilten - Lecturer and Blockchain in Food Supply Chain Researcher at HU University of Applied Sciences Utrecht

Date: 23th May 2019

Country: Netherlands

Interview Type: Skype Video Call

Duration: 56:36

Interview Language: English

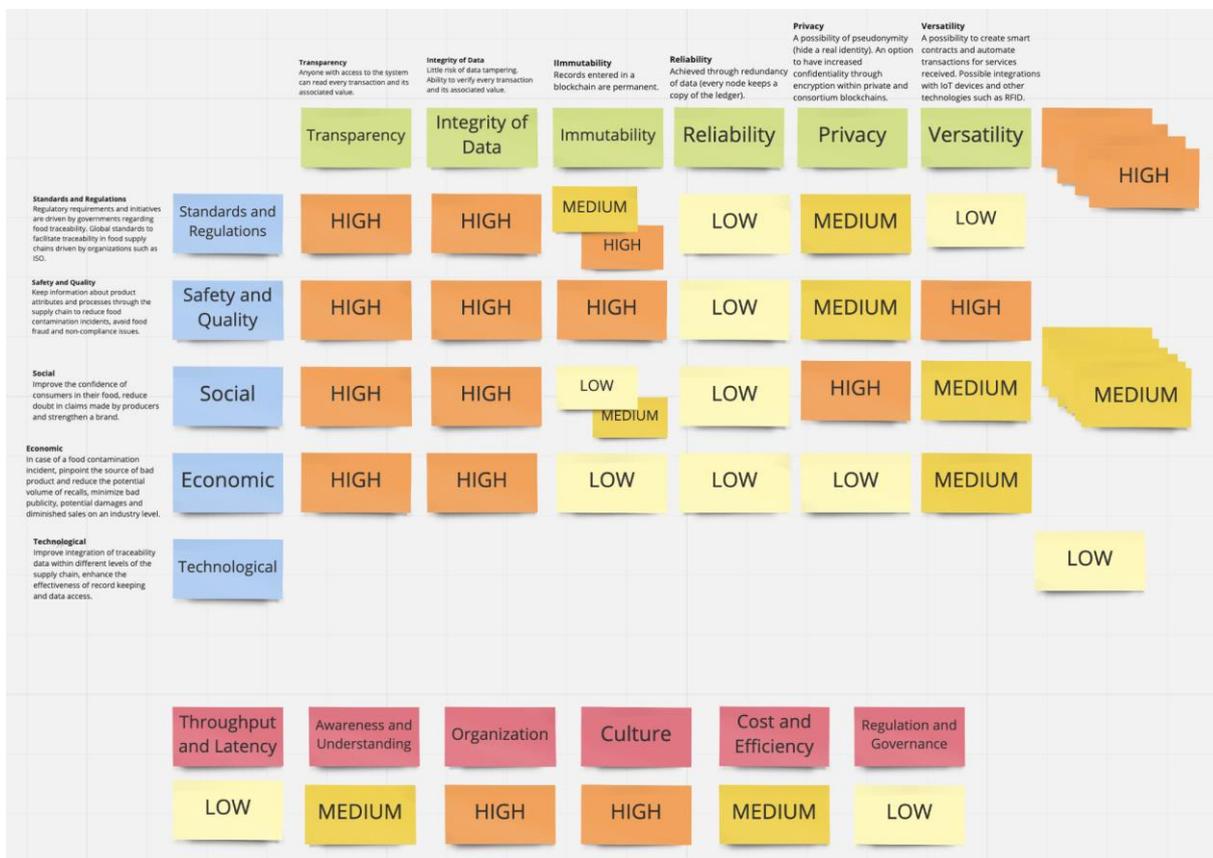


Figure 27. Card exercise completed by Mireille

Transcription Interview 8 – Mireille van Hilten - May 23th 2018 [Rsp8]

Line	<start 3:47>
	Mireille: So my background is in information technology, I have a bachelor degree in information technology with a specialty...specialization for user interface design. But I never became a UX designer, I became a teacher right after I finished my bachelor, then I stayed in education for seven years, then moved to software industry and worked there for 10 years in international environments and I became a Lean Six Sigma process specialist working on improvement projects that always have an IT component. And then, well, I took some sideways and now I'm back in education, and doing my master's degree. So but I work as a teacher actually, and I, I teach business, IT management courses. So mostly process oriented also.
1	Interviewer: That's super nice. So we have exactly the backgrounds that we wanted, it's like business and IT. We can start, I mean, just to note that the descriptions in the paper that we sent is super summarized, instead of reciting a paragraph, we try to condense information and just make it the one or two sentences as an example for people. So when we talk about standards and regulations, and that means that there is a lot of nuances from that point of view. But in our description, we try to keep it very short for this exercise.
2	<Describing the exercise>
3	Mireille: Okay, I think you have to cut me off sometimes, though, because I think I, my scope is quite big. So I don't want to elaborate too much. But..so if I start on transparency for standards and regulations. How important is that? So you're asking how important is the transparency characteristic of blockchain on the standards and regulation, and we're talking about food traceability, right?
4	Interviewer: Yeah. That's the scope. Exactly.
5	Mireille: Okay. It's a big scope. It is. Yeah. I think it's high. Because what standards and regulations aim to do, as far as food traceability is concerned, is to create visibility, from.. visibility of food information, or product information throughout the entire food chain, from the moment that the food is produced, or the crops are harvested, or whatever, to the moment that the customer buys it. So that's a big, important aspect of blockchain technology.
6	Interviewer: Okay. And then the integrity of data. integrity of data means that there is a little risk of tampering of the data and that it stakeholders on the blockchain can verify every transaction and its associated value.
7	Mireille: So the risk of data tampering is if we don't use blockchain?

8	Interviewer: It's actually that the data in blockchain...it's quite easy to verify if it's true or not, if it's it has integrity or not, because of the...there's a lot of mechanisms that can be used to verify this data. And depending on the implementation that you do, you can say that the reliability of this data is can be considered quite big.
9	Mireille: Are you talking about the consensus mechanisms of blockchain?
10	Interviewer: yes
11	Mireille: All right. So how important is integrity of data when you talk about standards and regulations? I would say it's always very important to have high integrity.
12	Interviewer: And why do you think is high?
13	Mireille: Because the reasons we have standards and regulations is to have an audit trail and have partners in the chain working together, be accountable for the steps that they perform in the produce of food, production of food. So it wouldn't really have any added value if the data is not in fact... isn't that of high integrity. Because we then wouldn't need blockchain if it would be the situation that we have now. Similar.
14	Interviewer: Perfect. Okay, so moving on to immutability. It means that the records that you enter in the blockchain are permanent. So you can't delete any records, basically. Yeah, there is some like some ways to do it. But for now, we're like going through this...we're fixing the scope for the blockchain.
15	Mireille: So how important is immutability? Let me think. it depends. So..
16	Interviewer: if you want to give more than one context, or more than one answer is fine as well. Like if you want to put one card and explain one context, and then another card in another context, it's totally fine.
17	Mireille: Okay, yeah, I would say it's medium initially. So the advantage of blockchain is that in larger or lengthier supply chains, perhaps the chain partners have less trust in how the chain works and how information flows through the chain. So in those cases, the immutability is very important, because they may not work closely together, or for whatever reason, they haven't really properly discovered that the entire chain. In that case, I would say, high. And I would say medium, if we talk about shorter supply chains, where partners already work closely together, and they trust each other. So the aspect of trust comes with the fact that it's immutable. And, yeah, and those two scenarios, I would say it's different.
18	Interviewer: Okay, so moving on for the reliability. That's about the redundancy of data. So depending on the implementation, you have a lot of different nodes that keep copies of the ledger. And for that, if you lose any of the nodes, you can retrieve the information.

19	Mireille: So I would say that's low.
20	Interviewer: Okay. Why do you think it's slow for this one?
21	Mireille: there are other ways to make sure that we can have copies of data that can still be centralized database. And the objective of standards and regulations is that everybody follows the standards and regulations and that they can provide the information even on paper, they can provide the information about traceability if they want. So there are ways to make sure that data is properly stored and retrievable.
22	Interviewer: Okay, so moving on for the privacy one. The privacy, means that you can hide your identity in the in the blockchain providing only the information and not who you are.
23	Mireille: Yes, let me think. So as far as standards and regulations are concerned. Well, according to...I mainly looked at the European Union regulations. And actually, if a company or a chain partner stores its data, I think there's even bylaw, there is a confidentiality that it doesn't even have to share their information. But I'm not sure that's what you're talking about. So I don't know, I think you can either make sure that privacy is in the blockchain or is not in the blockchain, you can also make sure that...I've studied cases where individual farmer information is locked on a blockchain. So there's no privacy there. I wouldn't say that's for standards or regulations.... I think it's more...each chain, its link in the chain needs to be visible and shouldn't be that private. It depends, is it a public or private blockchain?
24	Interviewer: If we talk about the food context, most likely it will be private or consortium blockchains. If we talk about food traceability context, for the companies that the food manufacturers or farmers as well could be...so from the organization's point of view.
25	Mireille: So from the organization's point of view, if they want to have privacy or not?
26	Interviewer: yeah, it depends and you can talk about organizations point of view, or any part or any entity that you want is just...you need to provide us the context so we can consider that in the answers. But you if you have experience in any other context, that's totally fine.
27	The Privacy basically means that you can be private or you can also reveal your identity within blockchain, if you wish so. So it's both that you can do.
28	Mireille: I've seen both situations. But if I relate to standards and regulation, I'm not sure it's that important. Except for the fact...let me just say that... It's medium as far as standards and regulations are concerned and that at that level companies in the the supply chain...in the food supply chain need to be accountable for what they do. And they need to provide information.

29	Interviewer: So moving on for the versatility, one, that's the possibility to create smart contracts and automate transactions or automate actions inside the blockchain. Like if you have your controlling specific food that it needs to be refrigerated and it reads, a temperature that shouldn't be reached, you can send a message inside the blockchain record a message saying yeah, this food went over this temperature that it was not supposed to. Or even integrate with IoT devices or other technologies like RFID to create more more intelligence inside the blockchain.
30	Mireille: Yeah, standards and regulations. At this point, what standards and regulations into control, I would say the importance is low. But if you turn it around and say, if we live in a technology driven world, so if we are able to detect or sense or store information, that means capture and get it into the blockchain, then standards and regulations may start to adapt those technologies and start to require more information from companies in the blockchain...in the supply chain.
31	Interviewer: So in this other context, you want to put a high or medium or...
32	Mireille: it's like in a context that doesn't exist yet. It's a future. O
33	Interviewer: So we can move on to the next driver. So the other driver that pushes companies to improve food traceability is safety and quality. Which states that safety and quality is all about keeping information about the product attributes, in order to reduce the food contamination incidents and food fraud incidents, or non compliance issues as well.
34	Mireille: Okay. Transparency is very important.- high. At least keeping information is a little vague, but if I translate that into storing it, and being able to share it throughout the chain, for me, end to end, whole chain traceability is important in my research. So that's my perspective. And in that sense, I would say transparency is very important, because you can keep it but if you can't share it, then there's no value in it. So I would say high.
35	And the integrity of data is also high. I would say. There would be no reason in having any statements about safety or quality if the data isn't of good quality as well.
36	Immutability. Yeah, I would say it's..difficult. I would say it's a medium I guess.
37	Interviewer: Any reason why you think it's medium?
38	Mireille: Yeah, I'm thinking about just... I'm comparing it to other systems that are used now. So if you would use an ordinary ERP system in the supply chain, would you be able to keep this information? And would it be...it would be immutable maybe? So, you would have some role and access rights structure for people to alter this information. So...put high. Yeah, the advantage of blockchain is is that it cannot be muted. changed, altered. And yeah. This is better.
39	Reliability. Let me check what that was, again,

40	Interviewer: Its the redundancy of data, that it has the different nodes, keeping the data of the ledger.
41	Mireille: Yeah, I would say low again. That's not the main advantage of blockchain as far as I'm concerned. But that's just the way they use the consensus mechanism is because everybody has information so that they can check it because everybody has it. But it's not.... I don't... I haven't heard about this [inaudible 22:13]
42	privacy. So safety and quality. I guess it's medium again. In cases where safety and quality is not guaranteed, and maybe comes to light. companies would want to keep their data private, maybe. But that's not the objective of transparency and traceability. Does that make any sense?
43	Interviewer: Yeah, there's no wrong answer. So please feel free to give your input and later we can share...
44	Mireille: It's a very difficult exercise actually. Versatility is like IoT applications.... Yeah, I would say, very important - high for safety and quality. Because there is no validation of the data going into the blockchain anymore. If we use IoT setups. So if we would scan individual apples for the levels of pesticides or whatever is what I'm researching. Then we wouldn't have to do any sample testing or have any certification processes in place. So the safety and quality would be like, very, very high, maybe six sigma level compliance. It's like utopia. I don't think it's possible... in theory in theory, yes.
45	Interviewer: Okay, then moving on to the social driver. And the social driver is about improving confidence of the consumers in their food, they're reducing the doubts in claims made by producers and strengthen the brands. You know, there's some situations that, you sometimes read the news that I think one of the recent was with the horsemeat that when company was buying horse meat and reselling it as a premium brand, by falsifying records. So these kinds of news makes consumers lose confidence in the producers, and then maybe you don't take it so seriously any big claims made by producers. So blockchain potentially could contribute in that regard to, build trust in the products.
46	Mireille: And then you specifically zoom in on the consumer confidence or also other partners are elements in the chain?
47	Interviewer: Which elements do you mean?
48	Mireille: Well, confidence in the food supply chain itself, for example, retailers that have more confidence on the start of the chain, where products are being produced, or...
49	Interviewer: They're all connected in the end, I mean, you know... it's very hard to differentiate these drivers. But if you look more detailed, they're always connected, as

	<p>you say, retailers, you know, maybe they get pressured from the consumers, which then they pass this pressure towards the food manufacturers. And then if you talk with the food producer, they feel the pressure is coming from the retailers, and the retailers want to avoid, because they have white labels. So they want to avoid losing trust from the consumers. So that's why, they focus on this aspect.</p>
50	<p>Yeah, just to give an example, like yesterday, I talked with one of the food supply chain manager from Brazil, who was explaining about: we had a really big scandal in Brazil, about people putting paper card in into meat, that collapsed the whole meat market. And that was just because the producers didn't provide the right information for the people that were working with the [inaudible 26:48] and reselling it to the final consumer. So it became like a really big scandal. And just because of the information in the beginning of the chain wasn't right.</p>
51	<p>Mireille: I think if we talk about confidence in the food, it's not just the customer. For me, it's also one of the most important stakeholders, but also the other actors or partners, or links in the chain should have confidence in the process. So for me, that's also part of the social...is it the driver...yeah a driver. And then I would say, transparency, again, is of high importance. Because each actor, the more transparent it is, the more confidence it creates. So if everybody is aware of what's happening in the process, where is the product? But also, where did it come from? What happened to it? Even you can go into a deeper granularity level and say even what foodstuffs are inside? Or what conversions did the product have? There's an enormous detail that you can get into this case. But in all cases, I would say, the more transparency, the more confidence.</p>
52	<p>So integrity of data. Yeah, I would say that's the reasons why these scandals...[inaudible 28:30] recently, here in the Netherlands, there was a case where the media got ahold of information from our certifying body that's officially appointed by the EU for organic food, because I only look at organic food. And it was kind of a scandal because they followed the right procedures... And maybe there was like a farm that was in between certification or waiting in certain status and these products were still legally... they were still legally able to keep selling those as being organic. So it was all according to the rules. I mean, those rules are there, so that you cannot have 100%, tightly closed system, nothing is ever 100% organic. So but then the media got ahold of that information, and they completely blew it out of proportion. And so what happens then is that customers lose their confidence, in this case in an organic label, or in the process of certification. And yeah, that's like, big issues, like similar to the scandal that you described with the meat. So on the customer side, I would say the integrity of the data needs to...it's very important, so it's high. And did the same for other chain partners? Yeah, I would say high as well. Because if it's not, if the data isn't correct... even if the data is correct, it can be blown out of proportion.</p>

53	So. Yeah. And the immutability. I didn't get to that point. I don't think...I don't think it matters at all. Actually, it's low. For the customer, especially... maybe a medium the the actors in the chain that produce the food, so that are involved in the process? I would say maybe it's medium. But for the customer, it doesn't matter if it's immutable or not. I mean, the customer just wants the information. And if it's through blockchain or not, I don't... in the end. I don't think that matters to the customer.
54	Gediminas: So put like a small medium for this and just a big low for the context that you said..
55	Mireille: Thanks. Reliability, by the redundancy...I'm having a difficulty with the reliability one,
56	Interviewer: You can put low, it's totally fine.
57	Mireille: Yeah...But low? Yeah. It's for the same reasons...
58	Interviewer: It's redundancy of data, but also it mentions that a lot of data recording happens automatically. So you avoid some manual input that also could, result in the less mistakes made. So the data will be more correct. Let's say as well.
59	Mireille: Yes. But that's only if it's not manually enter. Yeah, I studied cases where were farmers. In a fair trade situation where farmers or fishermen have to add, enter data into blockchain with an app on their smartphone, or even to SMS, they have to confirm certain transactions to validate whether or not it happened according to the criteria, for example, fair trade payments, or fair payments. Um, so in those cases, it's still very manual. So the most important thing to to validate through the blockchain is actually still manual in the cases that I saw. But I can also see where transactions going through the process or through the entire chain from one company to the other company, if it comes from their systems automatically. Yeah, it's still low, because we can already connect their systems, we just don't do it because it's too complicated. So yeah, we can use EDI, or we can use any other XML or web services connections to make sure that this is stock to each other. We don't do it. So now we... blockchains like another layer. And maybe at a higher level, where we only pick the certain processes that we think need to be traceable. And then...yeah, to the people involved in the chain, I would say it's not that important. It's still low. Long answer. Privacy. Yeah - high. I think if you, for example, consider...let me think so...
60	I'm very worried about privacy in general, in any applications of information technology. So for each actor in the chain, even the customer, I think privacy could be an issue. As soon as a customer scans a QR code and views information on certain products. There's probably already ways to see who that customer was. And I'm worried about how the data is going to be used. And on the beginning of the chain, at the beginning of the chain, we have the farmers or the farmers associations, or the fishermen or whatever. The customer wants to know where the food comes from, in my research. That's important. And so, yeah, we now see that information about the

	origin of the food is important and is being shared more and more, which is good for the customer. But it is good for the farmer.
61	And versatility. Medium. It really depends on the application and how we connect the devices to blockchain. It can be very convenient. Can create more trust and more transparency, but can probably already be done If the partners in the chain work very well together and share information.
62	Interviewer: Yeah, that's fine. Okay, moving on to the economic driver. In the literature, basically, the economic driver focuses on reducing the, let's say, in the case of food contamination incident, the goal is to pinpoint the source of the bad product and reduce the potential volume of recalls, which could minimize bad publicity, potential damages and diminished sales on an industry level. And we mentioned, with the beef in Brazil, if there's a major outbreak, and as you mentioned, if the news blow it out of proportion, it can ruin all the industry. So if blockchain allows from the food traceability perspective to be more accurate and trustworthy to isolate the incident. So we would like to get your opinion to see how blockchain could contribute in that regard.
63	Mireille: Okay. So we're talking about traceback of products. less cost in traceback?
64	Interviewer: Yeah, identify the lot size, reduce the recall size...and identify really quickly the origin of the problem. So you don't need to go to the other steps of the chain and just stop at the step that had a problem.
65	Mireille: Yes. Okay. Then in that case, I would say transparency is again, of high importance. Transparency is just at the heart of traceability, I think so. It can be just sharing of information without the blockchain as well. But..yeah, so even for economic reasons. It's still high transparency I think you can...If you share information through blockchain...the trace back of a product can be faster, maybe. Which can save costs.
66	And then the integrity of data. Yeah, it's also high importance. I think if you can, maybe in those cases where bad publicity occurs, if somehow blockchain could be more trustworthy, or can be experienced as more trustworthy information. Yeah, then it can maybe minimize those bad publicity cases. But that depends on how customers... I mean, I don't think many customers will understand blockchain or will understand how that works. So why would it be more trustworthy than any other information system? They don't..i don't think most customers would understand that. Depends.
67	Immutability. I would say low. And you are going to ask me why. Yes, it's difficult to vote event sometimes. So immutability. I'm not sure how that has any economic advantages. I mean, it creates more trust, to the fact that we cannot change it. Then in that case, maybe again, the bad publicity or that could get less cost. But other than that effect compared to the situations where most companies are in now. With their

	systems that are now, for example, ERP system. No. It's difficult for me to motivate this one. Get to the next one.
68	Interviewer: Yeah, it's totally fine.
69	Mireille: Okay. reliability. I would say it's of low importance. Well, what comes to mind for me now is that if it is a public blockchain where we have many, many nodes that can actually be more costly in terms of the energy use of blockchain, but not sure if that's part of your research.
70	Interviewer: Yeah, we're gonna actually we have some questions, in the second part, that's going to be quite quickly.
71	So these characteristics are from the benefit side, and then we will discuss from more negative side.
72	Mireille: Yeah, I would still say low. Privacy I would say it's low. Maybe perhaps, if you talk about GDPR regulations, maybe it can be costly if you don't follow the regulations. But other than that, I didn't see a big importance, there. Versatility. Maybe medium, maybe, you can have less recalls. I think the traceability... If we use more sensors or more machines on an IoT network and have that connected with blockchain, then we would initially be investing in that. But in the end, maybe it would reduce recalls or other costs by having bad publicity.
73	Interviewer: And we will skip I think technological. And the reason of that is because after interviewing, we realized that technological is basically talking about technology as the driver for improved traceability. And in a way the blockchain falls into that. So we then we realized we are comparing blockchain driver with blockchain characteristics.
74	Yeah, that's the one about how technology can help the supply chain traceability, and we are already talking about a technology. So I think it's, it doesn't make sense to include that in. Actually, we don't have much time and I don't want to keep you that long. And I think the second part is more important in that regard. That's the challenges, it's not going to be as long as this first one. It's just the six ones. And with the same exercise, like he can say, high, medium, and low for each one of them. So we are gonna explain you briefly about each one.
75	And I'll move into the challenge then. So blockchain also has a lot of advantages, but also has a lot of challenges in adoption in the industry. And the first one is the throughput and latency. So depending on the implementation of blockchain, that you use, you can have a really high throughput and latency like really low number of transactions being recorded in the blockchain. Or if you have a private blockchain, that number can be really high instead. But it's also a challenge that sometimes it's hard to convince people because people have the view that the throughput and latency

	is low because of Bitcoin and other known blockchains. So do you think that could be a challenge to adopt blockchain in this industry?
76	Mireille: I would say low, I know, I haven't run into that in my research stuff [inaudible 44:07]. Not at all, I think. Oh, yes. during one case, that was an issue, but it was not the time for transaction. It was more the storage of data that was too expensive to store a lot of data. So they used like a snapshot and start that in the blockchain. So I would say low just because of my experience, I haven't run into that, but doesn't mean that it's true for the rest of the world.
77	Interviewer: But it's totally fine. Okay, the next one is awareness and understanding. Basically, what we state is that the lack of awareness of the technology and the lack of understanding how exactly it works could hamper the adoption of the blockchain.
78	Mireille:
79	Medium. I think in order to use it, by different types of users have different experience levels. It's not necessary that they understand it. Previously, I mentioned it myself. [inaudible 45:25] I think customers will understand it or have to understand it. They just have to trust the information. So if there's a blockchain... if there's a supply chain with already not a lot of transparency and not a lot of collaboration, and that information, if you put it on the blockchain, it will still be bad information. And so it depends on how you implement it, it can be a very big importance. But if you do it very well, then it doesn't have to be a limitation.
80	Interviewer: Organization. So the blockchain creates most value if organizations work together towards common goals and problems. But in reality, sometimes organizations like to focus on their own internal traceability systems, and they do not collaborate that much through the supply chain. So we think that this collaboration, the lack of collaboration, could get in the way of adopting of the blockchain.
81	Mireille: Yes, I would agree. The first step to implementing a blockchains solution is to... I use the words discover the chain, or, yeah, make sure that you know who is in the chain and how they work and what they do and then you can start building information, and maybe putting it in a blockchain. So do I use high or low in this case?
82	Interviewer: So if you think that there's the lack of willingness to collaborate, is high. And it's highly to get in the way of adoption of the blockchain, then we put it as high. But if you think companies will find the way and you don't think it's a big problem for them to find a way to collaborate to implement blockchain solution, and we put it as low
83	Mireille: depends on how many links in the chain there are. So I've...interviewed cases, people working projects that have a limited amount of partners in the chain. So maybe like five, sometimes they were even integrated. So there was like one producer,

	<p>who was located right next to the farmers Association. And it had like, the big company had like three chains, three links in the chain, it was in their management. So it was easy to share information. So in the examples that I saw, there was none...no chain yet that I investigated that was long or very complicated. And even participants shared that they selected change that were fairly simple. And there was an overview and they already worked well together. So yeah, it's... it can have a high impact. But maybe you can implement blockchain without having a good solid collaboration. But then is the information reliable in that case?</p>
84	<p>Interviewer: So do we keep it as high? Or do you want to..?</p>
85	<p>Mireille: Yeah, we keep it as high.</p>
86	<p>Interviewer: Okay. The culture aspect basically tells us that we need to change the way of thinking and the way we trust the authorities, and move this trust into the centralized system instead of a central institution.</p>
87	<p>Mireille: Let me just reread it (reading label)...Oh, yeah. So if people.... oh, difficult. I have such a strong opinion about this, and I cannot put it aside. So well, in my personal opinion, I would be very, very happy to not be trusting any central authority anymore. Just let change supply chains themselves, show how transparent they can be in what they do. In decades, we will need less regulations, less certifications and there will be a better world in my opinion. If we look at the culture in the world or in the supply chain or the customer side, then I think there's a lot of work to be done. I would say it would possibly inhibit or it would not be beneficial to blockchain adoption.</p>
88	<p>Interviewer: So in this case, you think it's going to be a high one?</p>
89	<p>Mireille: Yeah. Somehow they're difficult with the advantages to use the high and low.</p>
90	<p>Interviewer: Okay, cost and efficiency. Basically, the blockchain implementation requires high amounts of energy and storage, that can reduce costs. And it's difficult to decide how this cost should be distributed amongst the organization's.</p>
91	<p>It's like you mentioned before with the cost of energy and maybe the data storage.</p>
92	<p>So it could be difficult that if you have different stakeholders, in a chain, it could be problematic for them to decide, okay, who takes how much of the costs to pay for the blockchain solution?</p>
93	<p>Mireille: Yeah, I would say it's medium. I stumbled upon different blockchain projects, like open source, private blockchains, some of which... you can call it the supply chain lead, the one who starts a project and is the main investor. If that's an organization in a commercial chain that has a lot of funds, and is easy to start those kinds of projects, then it's less of a problem. In case of smaller organizations. I hope that open source type of blockchain platform horizon that they can start to work on</p>

	<p>those kinds of platforms. I think it's medium, because it really depends on how you implemented. And what I see is that cost is less of an issue now, because of the fact that the organizations that are taking the lead into projects around blockchain, they really want to pioneer and they really want to profile themselves around the latest and newest blockchain projects. So it's kinda like a marketing kind of thing as well. So they don't mind putting the costs in that.</p>
94	<p>Interviewer: And the last challenge, since it's relatively new technology, the governments and financial institutions are seeking regulation, especially for cryptocurrencies. So that has been the most focus in the news. But outside the financial industries, there has not been much focus on regulation. So do you think this lack of regulation framework or regulation rules could be in a way of adopting blockchain?</p>
95	<p>Mireille: No, I think it's the opposite. The lack of regulations and rules makes it possible to innovate and...[inaudible 52:55] blockchain projects, there are no rules. So just do it.</p>
96	<p>Interviewer:</p>
97	<p>So it's going to be a low?</p>
98	<p>Mireille: Yeah, it's going to be a low unless a company or a supply chain says, the regulations are that important. So with any new technology, you have the early adopters, and you have the laggards at the end, you know, the curve? And so it depends if a company is like an innovator, they already have a blockchain solution in place right now. The ones who are further behind, they're more focused on regulations, they would maybe have a higher medium here in this case, but that's not consider them because I think it's the emerging technologies. Mostly for those who start with it.</p>
99	<p>Interviewer: Perfect. Sorry for the rush. In the end, we were just worried about her time. <saying goodbyes></p>

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