Master's degree thesis

LOG950 Logistics

Blockchain-Traced Seafood in Supply Chains:
A Case Study of Norwegian Salmon for the Chinese Market

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Abstract

In a dynamic and highly globalized world supply chains are complex and demanding to manage, and it is difficult to achieve full transparency and traceability. In China, a nation with substantial history of food scandals, the outbreak of covid-19 has recently increased the attention toward food safety and traceability.

This thesis aims to identify supply chain and traceability challenges Norwegian seafood is faced with in the Chinese market, the potential instruments that can meet the challenges, and how blockchain technologies potentially can meet the challenges. In order to accomplish this, there has been conducted a literature research that has examined the seafood supply chain, the Chinese market, traceability and blockchain technologies. Furthermore, for the primary research, there has been conducted semi-structured interviews with five informants with expert knowledge of Norwegian seafood, the Chinese market, and/or blockchain technologies, and a supply chain map has been constructed.

The findings identified 14 challenges related to supply chain, traceability and political areas. In order to assess how blockchain can improve several of the challenges, the challenges *"policies", "participation",* and *"tampering"* were selected to illustrate how blockchain technology can contribute to solving these. It was concluded that the unique properties of blockchain technology has the potential to meet several of the challenges identified related to supply chain management and implementation of traceability.

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1.0 Introduction:

As the world is becoming more globalized, many modern supply chains has become increasingly more complex and often comprise of many different actors (Aung & Chang, 2014; Jæger & Mishra, 2020). The involvement of many suppliers and customers makes it difficult to share and collect data across the supply chain. Because of this, it can be a difficult and resource consuming task to determine where the product has been, if it has been manipulated, what the true origin of the product is, and what materials a product consist of. This is important for ensuring quality, authenticity, ethical aspects, complying with legislations, or product recalls (Cook & Zealand, 2018). Food is of special concern, especially following the outbreak of the covid-19 pandemic, where it is believed that the origin of the outbreak was a seafood and animal market in Wuhan, China (Mohan & Nambiar, 2020).

During the last decade, China has experienced several substantial food safety incidents, which has weakened consumer trust toward the food industry (Liu, Gao, Nayga Jr, Snell, & Ma, 2019). One of the more recent incidents, the covid-19 pandemic, has drastically impacted consumer behavior, and has caused severe disruptions in the global supply chain, especially within the food retail industry (Norwegian Seafood Council, 2020a). Due to the recent events, food safety and traceability are topics that are currently highly relevant.

Norwegian seafood accounts for 11,4% of the total value of Norwegian exports (SSB, 2020), and in 2019, China was reported to be the second largest growth market for Norwegian Seafood (Norwegian Seafood Council, 2020c). Recently, there has also been incidents that has caused harm to the reputation of Norwegian farmed salmon in the Chinese market. One example of this was when the covid-19 virus was linked to fresh salmon at a wet-market in Beijing (Pang et al., 2020; The Norwegian Government, 2020). There has been found evidence of the covid-19 virus to persist in cold conditions, and there has been implemented specific cold chain measures (World Health Organization, 2021).

2.0 Research Problem

Seafood is a commodity that has global supply and demand, and the supply chain can be very complex (Cook & Zealand, 2018; Horsu, Malcorps, & van der Heijden, 2019). From a fish is caught or harvested, it may undergo different types of processing, packaging and transportation. During these processes, the fish may be exchanged between many different intermediate actors in the supply chain, and arrive at a final market at the other side of the globe (Cook & Zealand, 2018). Because information is retained in silos, it is often a difficult and complex task for supply chain members to trace the product or the production inputs to the original source or end destination. Lack of supply chain transparency can create room for fraud that can cause food safety challenges (Blaha & Katafono, 2020). Controversies regarding fish farming, overfishing, or unethical practices highlighted by global media, results in criticism and declining consumer trust in the seafood industry (H. Kendall et al., 2018). Companies striving toward maintaining ethical and environmentally sustainable practices are often not recognized for their efforts, as people often associate and assume that the companies are operating similarly as less ethical companies. Therefore, end marketers are requesting mechanisms to ensure that all supply chain suppliers adhere to regulatory, ethical and environmentally standards as a mean to reduce risks associated with brand reputation (Cook & Zealand, 2018).

Seafood is an important segment of the Norwegian export economy (SSB, 2020), and the Chinese market has immensely large potential future demand for seafood due to its size and the large, continuously growing, middle class (McKinsey & Company, 2020).

The Chinese consumer market has many unique characteristics, such as quick adoption of mobile technology, mobile payments, being the largest e-commerce market, and high degree of using social media to drive social commerce and consumption (PwC, 2020). As previously stated, food safety and food quality has been a substantial issue in the Chinese society for a long time (Lam, Remais, Fung, Xu, & Sun, 2013). It has been suggested that Chinese consumers lack trust toward government food supervision and food labeling (Liu et al., 2019). As Chinese consumers increasingly become more concerned about health risks, more consumers than before are willing to pay a premium for better quality, and customers loyalty is centered around brands they trust (Liu et al., 2019). Therefore, building trust is an opportunity to build strong brand loyalty. However, due to small margins and high

competitiveness in the Chinese market, making large investments in building trust remains as one of the largest challenges facing the food industry (PwC, 2020).

It has been reported that blockchain technology could revitalize the trust in the seafood industry by improving transparency in the supply chain. Seafood supply chains that are fully transparent and traceable, enabled by blockchain technology, can improve the confidence of the industry and its products (DNV GL; Deloitte, 2019). It is therefore very intriguing to investigate challenges Norwegian seafood is faced with in the Chinese market.

Benefits and challenges of traceable food has been discussed in the media and in literature in the context of ensuring food safety and adding-value for customers in China (Global Times, 2020; H. Kendall et al., 2018; Liu et al., 2019). There also extensive literature and research covering the application of blockchain in seafood value and supply chain (Blaha & Katafono, 2020; Cook & Zealand, 2018; DNV GL; Deloitte, 2019; Horsu et al., 2019; Jæger & Mishra, 2020; Norwegian Seafood Council, 2021; NOU, 2019; Olsen, Borit, & Syed, 2019; WWF, 2018).

However, there is currently a lack of research that specifically describe the supply chain and traceability challenges Norwegian seafood is currently faced with the Chinese market. This is highly relevant, especially following the covid-19 pandemic that has caused significant global supply chain disruptions due to strict import policies and logistical challenges (Guan et al., 2020).

Based on this, the main research problem addressed is: How can blockchain technology contribute to trace seafood in the supply chain of Norwegian salmon for the Chinese market?

2.1 Research Questions:

In order to guide the investigation of the research problem, the following three research questions are defined.

RQ1: What is the structure of the seafood supply chain from Norway to China?

RQ2: What challenges is Norwegian seafood faced with in the Chinese market?

a) Which instruments can be implemented to meet the challenges identified in RQ2?

RQ3: How can blockchain technologies contribute to meet the challenges identified?

In order to achieve the objectives, the seafood supply chain from Norwegian fjords to Chinese end-customers will be described and illustrated. It is also necessary to identify which type of challenges that can occur in the supply chain, potentially where, when and how they occur. In addition, it is necessary to gain an understanding of the Chinese market and the Chinese consumer in order to understand what drives demand and how it is driven.

Information will be gathered through literature research and primary research using semi-structure interviews with informants within the Norwegian-Chinese seafood industry and/or blockchain technologies.

3.0 Literature Research

The purpose of the literature research is to identify concepts and areas which already has been researched. Reviewing the literature will increase the author's level of knowledge and understanding of relevant concepts and areas of research. The literature reviewed can be applied as a framework and foundation for future research. This will benefit the author's ability to conduct relevant research that may provide a meaningful contribution to the field of study. In addition, an extensive literature review will enable the author to identify knowledge gaps, areas that has not previously been sufficiently researched, and this data can then be gathered through primary research.

3.1 Traceability and Transparency in Supply Chain

Topics such as health, transparency, sustainability, environmentally friendly, and social consciousness has increasingly gained the attention of consumers. Correlating, the concept of "traceability" has often been proposed as the solution to support mitigation of these issues (Kurt Salmon, 2017). The concept of *traceability* can simply be explained as *"system of records designed to track the flow of a product through the production process or supply chain" (WWF, 2018).*

The food sector is an example of a sector in which it is highly beneficial to implement traceability throughout the supply chain (The Food Integrity Project, 2018). It is nowadays not unusual for food products to be shipped across continents to be consumed at the other side of the globe. Maintaining the safety and quality of products through a complex supply chain can be a significant challenge (Aung & Chang, 2014). The trust in the food industry has several times been questioned due to various food scandals striking around the globe (H. Kendall et al., 2018; Liu et al., 2019). This has resulted in customers calling for quality requirements and increased supply chain transparency. Due to this growing concern, traceability systems can be used to gain the confidence of consumers by being able to provide verifiable evidence of ensuring food safety, quality, and origin (The Food Integrity Project, 2018).

Traceability is especially relevant for the live-stock industry, as there are several unique aspects of this industry that must be considered. These aspects include ethical challenges related to animal-welfare, genetically modified animals, or extensive use of anti-biotics or growth hormones. Additionally, animals can be a source of bacteria, transmittable diseases or viruses, and require hygienic handling (Aung & Chang, 2014; Lam et al., 2013; The Food Integrity Project, 2018; Xie, Huang, Li, & Zhu, 2020). This was the situation and the origin of the COVID-19 outbreak. All research has showed that this virus originated in bats, and has either directly been transmitted to humans, or through an intermediary animal. The virus was first reported in humans in Wuhan, China, and the initial outbreak was then tracked to a wet-market in the city (Mohan & Nambiar, 2020; Xie et al., 2020). China has been troubled with numerous large food scandals in the recent years, such as the infamous milk powder formula scandal, and consumer trust toward food safety has as a result been affected because of incident like this (BBC, 2015; Helen Kendall et al., 2019).

Through interviews with stakeholders, key challenges within the global seafood supply chain has been reported to include challenges related to data and information flow, reputational risks, and transparency and consumer engagement (Deloitte; DNV GL, 2019).

3.1.1 Traceability in seafood supply chain

Seafood traceability is increasingly attracting the attention of customers, authorities and the seafood industry itself. It is regarded by many to be the solution to illegal or unethical production, export, or import of seafood (NOU, 2019; WWF, 2018). In order to create fully transparent seafood supply chain, there are certain principles that must be followed (NOU, 2019).

NOU (2019) describes these principles in more detail;

In order to achieve traceability, it is required that information from various supply chain members can systematically be collected and interpreted. This starts with every unit of raw material must contain information that allows it to be identified and separated from other units of raw material. Finished products must include information that allows for identification and separation of all physical production inputs and transformative processes.

This also includes processes such as transportation, export of finished goods, and movement within the supply chain. It is crucial that the stored information can be retrieved when required, even when the product has left the company.

Furthermore, there are specific components that is required to make a seafood supply chain traceable. First, each batch of fish is required to have a unique identification number in order to connect information to the specific batch and separate it from other batches. Second, when splitting and mixing a batch of fish into sub-batches, it is essential for traceability to register this in order to be able to trace it back to original batch or harvest. Third, traceability is dependent on the desired information about the fish is available and retrievable, as facilitated by having a unique identification code, and registering split and mixing.

Figure 4 illustrates how traceability is achieved in a supply chain from harvest to end-consumer. Harvest "A" is split into A1 and A2 when received/slaughtered. Batch A1 is then split into A1-1, A1-2, A1-3, A1-4, during fillet processing. A1-1 is being shipped to repackaging/wholesaler which then split A1-1 into A1-1-1, A1-1-2… etc. A1-1-1 is received at a retailer and finally sold to the end customer for consumption.
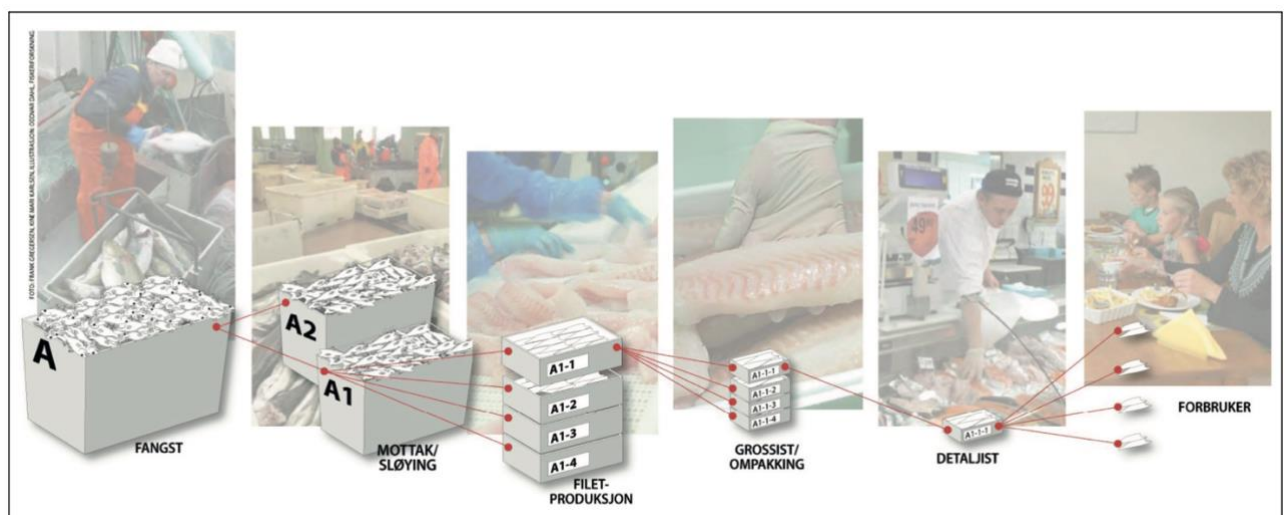

Figure 4 (NOU, 2019).

For company-internal traceability, each company can choose to accomplish this differently by independent methods. However, when fish is shipped to another external company, it is an advantage that the identification markings and sharing of information is standardized. If a company in the supply chain does not have all three components previously described in place, there is an information loss in the supply chain, and full traceability is not achieved. A common infrastructure for information collection, registration, and sharing is therefore an advantage (NOU, 2019).

Traceability takes place in both the virtual (information) and physical world (physical processes and alterations). A challenge for traceability authenticity is that data that is collected and registered manually, is not quality assured, and is thus only a claim that potentially may be inaccurate compared to the actual physical reality of a product. In order to facilitate the virtual reflection of the physical conditions, and assuming initial registrations are correct, an automated documentation system can be implemented (NOU, 2019).

One of the major bottlenecks when implementing full traceability on products has been described to be the lack of interoperability between the different systems in a supply chain. While it is technically possible to achieve interoperability between different systems, it is still regarded to currently be one of the most significant obstacles in achieving full product traceability from farm to fork (Olsen et al., 2019). As previously stated, it is an advantage that the sharing of information is standardized (NOU, 2019). However, a traditional electronic traceability system can be implemented in various ways and the databases can be structured differently from each other. For traditional digital traceability systems to become more interoperable, it would be dependent on a widespread adoption of a common standard, but currently there are too many competing standards, which in practice results in low interoperability between traditional electronic traceability systems (Olsen et al., 2019).

3.1.2 Automated documentation systems

There are several challenges associated with current methods and procedures regarding reporting and registering data in the seafood supply chain. Fundamental data is not accessible to control authorities, control points in the value chain is lacking, and the majority of reported information is often manually registered. Inaccurate information, either as a result of

conscious or unconscious errors, is an issue with manual registration. Additionally, there are often not any requirements for documentation of the registered claims, and the information can thus not be verified and quality assured. Development of technologies is providing new possibilities within reporting. Automation technology can serve the function as a third-party, and can collect and register data digitally. This has the potential to eliminate the risk of errors and inaccurate manual registrations. NOU proposes the concept of reporting all data to an information system that can make specific data available to authorized actors that require the relevant data. This is described as an infrastructure for exchange of data between different actors. It is proposed that this infrastructure can also be used for traceability purposes such as tracing a product back to its origin. Given that the essential elements for traceability is fulfilled from harvest to the end-consumer, a complete record of all relevant activities can be achieved (NOU, 2019).

3.2 Blockchain Technology

In simple terms, blockchain is a technology that can be characterized as a platform that allows peers to perform exchange values using transactions without requiring a central authority in order to create trust. As a result, blockchain functions as a decentralized consensus mechanism that does not rely on a single actor to be in charge of the database, such as a network administrator (Girasa, 2018). It has been described that the main features of blockchain technologies involves building trust and confidence between actors without a central authority. It achieves this by ensuring that the information stored on a shared, distributed ledger, is authentic and tamper proof (Hua, Wang, Kang, Wang, & Wang, 2018). Some unique benefits of blockchain technologies has been reported to be immutability, security, interoperability and decentralization (Olsen et al., 2019)

Blockchain is an electronic distributed ledger technology (DLT), which can be described as a type of database that is shared across nodes in a network. Nodes are devices that collectively maintain the database records using DLT software. These nodes are linked together in order to share and validate information. Blockchain enables scarce objects, such as cash, commodities, stocks, to become programmable and digital, and the transfer of these scarce objects can be recorded with the blockchain data structure (Girasa, 2018).

3.2.1 Generic blockchain elements:

Key elements of a blockchain can be considered to be distributed ledger technology, immutable records, and smart contracts (IBM, 2020). According to Bashir (2017) other generic elements of a blockchain can also include:

Addresses: are unique identifiers used to indicate the sender and receiver in a transaction on the blockchain. In most cases, addresses are public keys or extracted from public keys. It is possible for the same user to reuse an address, and the user is normally not directly identifiable, but research has showed that it is possible to successfully de-anonymize an user. Therefore, in order to remain anonymous, it is regarded as good practice to create a new address for each transaction.

Transaction: is the basic unit of a blockchain that represent the exchange of a value between two parties. A transaction contains the address of the recipient, transaction data payload and amount of transaction value. Transaction between nodes on a blockchain network is visible for all network participants (nodes).

Block: A block contains transactional data, such as time confirmation and sequence of transactions, a unique hash (digital identifier), and the hash of the previous block. This prevents alteration of the blocks or sequence of the blocks in the chain.

Peer-to-peer network: means that all actors (nodes) in the network can communicate with each other and can function as both publishers and subscribers.

Nodes: In a blockchain network, the function of a node can vary depending on the role it assumes. These functions includes validation and proposal of transactions. By performing mining, nodes can facilitate consensus and secure the blockchain. Additionally, depending on the type of blockchain, nodes can perform a number of different other functions and roles.

Smart Contract: is code that run on the blockchain whose function is to automatically execute the business logic when the demands and conditions of an agreement are fulfilled. Transactions are made to certain functions, and once received, the function is executed. Smart contracts are not available on all blockchains, but is becoming increasingly desirable due to the power and flexibility it offers (Bashir, 2017).

3.2.2 How a blockchain functions:

By using a distributed structure, blockchain records and adds changes to the database in a series of "blocks" containing transactional information and timestamps, and are identified with a cryptographic hash. Each block is referencing the previous block and is structured in a chronological linear chain formation known as blockchain (Bahga & Madisetti, 2016). Every block confirms the time and sequence of transactions and has a unique one-way digital fingerprint that cannot be altered. With every additional block added, the verification of the previous block, and thus the entire blockchain, is reinforced. These characteristics ensures that the data stored on the distributed ledger cannot be tampered with, which provides the strength of immutability (IBM, 2020).

3.2.3 Types of blockchains:

As the blockchain technology has developed, several types of blockchain has emerged, with distinct attributed that sometimes also overlap. Different blockchains includes: Public blockchains, private blockchains, semi-private blockchains, sidechains, permissioned ledger, distributed ledger, shared ledger, fully private and proprietary blockchains, tokenized blockchains, and tokenless blockchains (Bashir, 2017). According to Blaha and Katafono (2020) there are three types of blockchain:

Public blockchains
This type of blockchain is also known as a "permissionless blockchain", and is publicly accessible. This entails that there are no restrictions regarding who can participate as user, miner or validator. It is fully distributed and all transactions are transparent, which allows anyone to examine the transactions. No single entity controls the blockchain, enabling it to be resistant to censorship or manipulation. In order to incentivize and award participants in the network, there is a token associated with public blockchains. One of the challenges with public blockchains is often in regards to the ones that use the consensus algorithm Proof of Work, as the energy cost of validating transactions is significant. Some of the most well-known public blockchain include Bitcoin and Ethereum (Blaha & Katafono, 2020). For

example, in Bitcoin, Proof-of-Work was by Nakamoto (2008) proposed to be used as a consensus mechanism. Here, it was argued that as long as the majority of CPU-power in the network is controlled by honest nodes, the honest chain will outgrow competing chains, and thus rejecting the competition (Nakamoto, 2008).

Private or permissioned blockchains

In this type of blockchain, there are restrictions regarding who can access the network and who is permissioned to participate in transactions and validation. Here, a single entity has significant control of the participants and the structure. It is more centralized than public blockchains, and the transactions are private to the participants of the network. This type of blockchain commonly regarded to be more valuable for organizations that do not want sensitive data to be publicly accessible. Tokens can be used, but it is not necessary (Blaha & Katafono, 2020). The main benefits of this type of blockchain is that it is secure from external attacks, sole control over who may access it, low cost, and it is efficient for internal use (Girasa, 2018)

Consortium blockchains

Consortium blockchains can be described as almost a hybrid between private and public blockchain, and rather than being governed by an individual entity, the network is governed by a group. Some of the nodes may control the consensus processes, and other nodes in the network can participate in transactions (Blaha & Katafono, 2020). It is described to be permissioned, and that administration and governance can be shared, and it is possible for the administrators to regulate the participation of the other users (Cook & Zealand, 2018).

3.2.4 Benefits and challenges of blockchain:

Benefits of blockchain are numerous, and Bashir (2017) list the top benefits that blockchain can provide in the following order as 1) Decentralization, 2) Transparency and trust, 3) Immutability, 4) High availability, 5) Highly secure, 6) Simplification of current paradigms, 7) Faster dealings, and 8) Cost savings.

Some of the most sensitive challenges are listed as 1) Scalability, 2) Adaptability, 3) Regulation, 4) Relatively immature technology, and 5) Privacy (Bashir, 2017).

It has been described that one of the advantages of blockchain is the high degree of interoperability which is beneficial when implementing blockchain as a traceability system that is required to work between several external actors, different systems such as IoT technologies and sensors (Jæger & Mishra, 2020). This is because the information stored in a blockchain is in the form of transactions, while a traditional electronic traceability system would store a variety of different data element values. This means that blockchain systems are relatively more homogenous, they all are online, all blockchains are immutable, they use cryptography for verifying identity, and all information is in the form of transactions. This ensures that operability between different blockchain systems is much easier to implement (Olsen et al., 2019).

3.2.5 Blockchain in Food Traceability

Blockchain is a decentralized, distributed ledger that offer a method for information to be recorded, shared and maintained by a community. A distributed ledger allows digital information and assets to be transacted in a real-time, immutable manner. Storing data from the supply chain in a publicly available blockchain could appease the concerns regarding food safety and sustainability. Key benefits of implementing blockchain in a seafood supply chain includes improved traceability, transparency, trust, automation, and collaboration. This could result in better fish welfare and biology, innovative finance and insurance products, and efficiency gains (DNV GL; Deloitte, 2019). One of the largest actors within food retail, Walmart, launched a project in China in cooperation with IBM. The pilot project involved applying blockchain technology to improve pork safety and supply chain management (Kamath, 2018).

It has been concluded and recommended to base an electronic traceability system on blockchain technologies, unless speed and confidentiality are of paramount importance. This is because of the data sharing capabilities the high degree of interoperability provides. Instead of counting on the widespread adoption of standards that support interoperability, it may be more sensible to hope for the implementation of blockchain traceability systems, because this will increase interoperability by itself (Olsen et al., 2019).

It has been suggested that in a blockchain-based food traceability system, it is possible to discover where the fraudulent or incorrect information has been entered, by using a method

known as "mass-balance reconciliation". In short terms, if a tuna of 20kg is harvested and provided with a unique identifier, and it produces four loins at 5kg. Each of the loins are then delivered to distributors that register the unique identifier to the blockchain system. The fish is then sold to and received by retailers. The retailers then confirms the receival of the fish, and further process these into ten 500g steaks. Each of these also carry the same unique identifier. At no point in time should the weight related to the unique identifier exceed 20kg. If it exceed this, it indicates that there has been an adulteration or substitution of the product (Cook & Zealand, 2018).

3.3 Norwegian Seafood Supply Chain

Norway has primarily two categories of sources for seafood; wild catching and farming. The value of farmed seafood amounts to 77% of the total seafood value exported, and looking at farmed salmon isolated, it accounts for 67,5% of the total seafood value exported. Therefore, the supply chain description will focus on farmed seafood, more specifically salmon (Norwegian Seafood Council, 2020b).

The supply chain of fish farming is complex and consist of many various suppliers. Examining the supply chain of farmed salmon, the suppliers can broadly be categorized into three main supplier groups: technical solutions suppliers, biotechnology suppliers, and distribution suppliers (EY, 2019). The primary elements of the fish farming supply chain can be listed as:

Feed production:
The cost of feed accounts for around 50% of the total production cost of salmonids. Having a correct composition of ingredients is essential in feed production (EY, 2019). Producers of food will most possibly also have their own sub-suppliers of raw materials and distributors.

Egg and spawn production:
The suppliers in this supply chain segment are specialized in spawning and egg production. The main product these companies provide are fertilized fry. Additionally, these companies

supply eggs, smolt and broodstock. It is not uncommon that these companies also cross over in smolt production and small scale sea farming (EY, 2019).

Smolt production:

Smolt is the terminology for when a young fish is ready to transfer from fresh water to the sea. The process of reaching this stage is called "smoltification" or smolt production (Norwegian Environment Agency, 2014). The salmon grows until it reaches 100-250 grams until it is transported to, and released into seawater to the salmon cages. This process takes between 6-12 months (EY, 2019). In recent years, the industry has started to invest in freshwater facilities that can grow the smolt until it reaches 1000 grams (Mowi, 2020).

Sea farming:

Sea farming is the final stage in the growing process, and the largest segment in the aquaculture industry. Sea farming starts when the fish enters the seawater and ends when it is harvested (around 4-5 kg). The duration of this process is between 14-24 months, varying on the size of the smolt when it arrives (EY, 2019).

Transportation and distribution:

This segment of the supply chain consist of well-boat companies that transport smolt from the on-shore facilities to farming cages where the smolt will continue to grow further. Additionally, there are companies that specializes in freight of feed. A majority of these well-boats can treat the salmon for various diseases, count and the population onboard. Trading companies may include both independent companies, as well as internally owned companies of the production company (EY, 2019). These companies are also responsible for distribution to customers.

Processing and packaging:

Processing is often distinguished by the level of processing, and sorted into two categories; primary processing (slaughtering and gutting) and secondary processing (such as fileting, filet trimming, portioning, and smoking). Both primary and secondary processing can be performed by independent suppliers and by an integrated part of a seafood production company. The majority of Norwegian salmon is exported for further processing (EY, 2019). Products that has been secondary processed are called value-added products (VAP) as they

represent an additional value to retailers, but most of all to the consumers (Mowi, 2020). Packaging companies are usually small-medium sized business that provide packaging and wrapping for fish and food (EY, 2019).

Customers:

In the European Union, Mowi report that around 70% of secondary processed salmon supply was sold to retailers, while the remaining 30% went to hotels, restaurants, and cafés (HORECA market). Filets were the had the largest market share with a 45% share (Mowi, 2020).

The models below illustrates typical aquaculture supply chains:

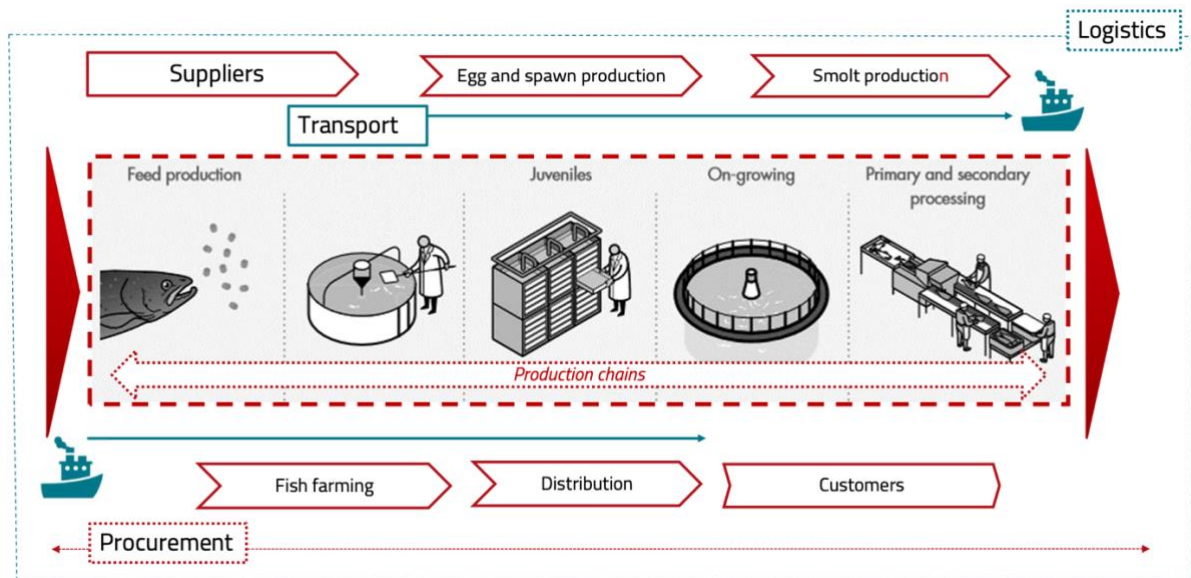*Figure 1: Aquaculture value chain (Inventura, 2020)*

Figure 2: Aquaculture supply chain (Inventura, 2020)

3.4 Chinese market

The Chinese market is one of largest consumer markets in the world, consisting of more than 1.4 billion consumers. With more than 850 million internet users, China is a global leader within e-commerce and mobile payments. E-commerce accounted for approximately 24% of total retail sales in 2019. In 2018, China accounted for 45% of global retail e-commerce transaction value, making it the world's largest e-commerce market (McKinsey & Company, 2020). In order to gain a meaningful understanding of the Chinese market, it is important to be aware of the cultural aspects that impacts business conduct. Traditionally, China is regarded to be a "collectivistic" society, typically emphasizing cooperation and interconnectedness, and that achievements are a result of a group effort. Groups can be categorized as either "in-group" or "out-group", in which the levels of trust is much greater for the "in-group". Furthermore, this indicates that China is a relation-oriented society. In China, these interpersonal relations are often referred to as "guanxi" and is regarded as fundamental to establish before doing business. This is because trust is established through "guanxi", the personal relationships between people (Zigang & Fan, 2004).

3.4.1 Chinese Consumer Trends and Characteristics

During the first months of 2020, the COVID-19 pandemic completely changed the dynamics of many societies as strict policies and social distancing became adopted by many nations worldwide (Chakraborty & Maity, 2020; Singh & Singh, 2020). Being firstly identified in Wuhan, China has been in the frontline of both economic and societal changes. As a result, several pre-existing consumer trends has been accelerated in the wake of the pandemic. McKinsey & Company has identified five trends shaping the Chinese economy that has been accelerated due to the COVID-19 pandemic: digitization, declining global exposure, rising competitive intensity, consumers come of age, and private and social sectors step up (McKinsey & Company, 2020).

Declining global exposure
The Chinese domestic consumer market has increasingly been growing, and local innovation has gained a stronger position than before. The domestic consumer market is now a stronger

economic driver than export, trade and investment, accounting for 60-70% of Chinas GDP, and as a result, Chinas exposure on the rest of the world has been declining. Maturing supply chains and the growing middle class is driving domestic consume, resulting in declining proportions exported. The world's exposure on China is also being questioned, as businesses increasingly is diversifying their production facilities to other low cost countries. The covid-19 pandemic is expected to accelerate this declining exposure even further (McKinsey & Company, 2020).

E-commerce

In China, digitization has been a significant emerging trend during the recent years. The development of digital solutions has led to a rapid evolution of the digital infrastructure. This has enabled China to become one of the world's leading digital nations, with e-commerce sales amounting to nearly half of the global e-commerce sales. When the virus struck and societal restrictions were enforced, an ongoing consumer shift from traditional retail to online channels, further accelerated. Especially segments new to online ordering increased their share of e-commerce spend. This sophisticated digital infrastructure and its physical fulfilment infrastructure has proven its agile capabilities when digital initiatives quickly accelerated (McKinsey & Company, 2020).

According to a 2020 consumer survey, online penetration of grocery sales increased by 15-20 percentage during the height of the crisis. In the same survey, Chinese consumers also reported that more than 55 percent will likely continue to buy more groceries online after the pandemic (McKinsey & Company, 2020).

Brands that already had established an online social commerce infrastructure were able to increase sales during the crisis by shifting resources toward online channels. Companies with established digital solutions were also able to launch marketing strategies that relied on digital technology to increase customer engagement through mobile applications such as Douyin (Chinese TikTok), WeChat, and Taobao. Initiatives typically relying on physical interaction include for example digital showrooms, online medical consultation, online property viewing etc (McKinsey & Company, 2020).

It is suggested that brands that typically has been consumed publicly, such as in bars or restaurants, need to rethink their approach to their portfolio marketing strategy in order to accommodate at-home consumption (McKinsey & Company, 2020).

Increasingly, Chinese consumers want an omnichannel experience. This entails that products are available through several channels, both online and offline. For Chinese consumers, social commerce is becoming an increasingly stronger commercial driver. Social commerce is when social media is the driving force behind a sale. In these types of e-commerce, the use of KOL's (Key Opinion Leaders) is often used to drive the sale. There are five archetypes of social commerce in China; 1) social first commerce, 2) e-commerce platform with social marketing, 3) social discounter, 4) community buy, 5) social DTC (direct to consumer) (McKinsey & Company, 2020).

Quality and Safety

With several high profile food scandals in China the recent years, trust toward the domestic food system has been weakened. This has resulted in an increased emphasis toward food quality and safety for the Chinese consumer. Low levels of trust and increasing demand from the middle class is creating more demand for safe and authentic food of high quality (Helen Kendall et al., 2019; Lam et al., 2013; Liu et al., 2019; Xie et al., 2020).

The trend of becoming more health and quality conscious has been accelerated by the covid-19 pandemic as consumer attitudes has changed in response to the risk of being infected by the virus. According to research carried out by McKinsey & Company (2020) family safety and personal health are among Chinese consumers' greatest concerns. Consumption patterns reflect these anxieties, with two-thirds of respondents claiming that they care more about product safety than they did before the pandemic. In addition, close to a third of the respondents reported to spending more on fresh food, in order to facilitate a healthy lifestyle. However, in China's grocery market the gap between claimed intent to purchase organic food and actual spending is quite considerable. Around 30% claim they prefer organic food, while only 1% actually purchase (McKinsey & Company, 2020).

The covid-19 pandemic has accentuated concerns regarding product safety and quality, and the importance of food products being fully traceable has been reinforced. It is believed that

consumers' appreciation of products that can confidently be traced through the supply chain to its origin will increase due to covid-19 (McKinsey & Company, 2020).

A qualitative research study by Helen Kendall et al. (2019) examining Chinese consumers attitudes, perception, and behavioral response toward food fraud identified three main perceptions of barriers to attaining authentic and safe food. These were described to be; 1) Complexity of the food chain, 2) Scale of the food chain, and 3) Regulatory deficiencies (Helen Kendall et al., 2019).

As a mean to mitigate risks related to food fraud and safety issues, Chinese consumers has developed risk relieving strategies. These strategies were identified to be:

1) Information searching: due to imperfect authenticity knowledge and distrust in the regulatory environment, consumers seek knowledge using kinship networks (word of mouth), online sources (product reviews, forums etc.) and social media channels (i.e. 'WeChat');

2) Authenticity cues: at point of purchase consumers reportedly rely on traditional attributes, such as brand, price and packaging, as key-differentiators when determining the authenticity and quality. Despite manufacturers efforts in including authenticity clues such as certifications and country of origin, traditional techniques for inferring quality were more common. Integrity cues provided by manufacturer specifically designed to prevent product tampering, such as tamper-proof seals, QR codes and barcodes, were recognized to support authenticity assessment;

3) Acquisition source: the source of purchase was reported to be relevant when determining the product authenticity. The good reputation of large international retailers, such as OLE or Carrefour, positively impacted the perception of risk and food authenticity. Smaller retailers were perceived as more prone to be involved in food fraud.

4) Domestically situated practices: consumers take measures at home in order to ensure food authenticity and safety. Some consumers reported that they try to grow some vegetables at home in order to reduce the intake of chemicals used in food production. Others reported to using methods to wash and cleanse food of residual contamination and chemicals. As for fish and crustaceans, some reported that it was preferable to buy alive products and keep it in fresh water to let clean water pass through prior to consumption (Helen Kendall et al., 2019).

Brand Loyalty

Brand loyalty is the concept of "habitually always buying a product with the same name, made by the same company" (Cambridge Dictionary, 2021).

The covid-19 pandemic and following societal restrictions has resulted in Chinese consumers becoming more willing to seek new stores and trying new brands. A third has reported to switching brands due to convenience and promo/display. A fifth of these are planning to stick to their new choices. When it comes to purchase decision making, research show that Chinese consumers are world-leading in researching brands and products before purchasing. 45% of Chinese consumers has reported to increasing this type of behavior during the covid-19 outbreak. Among consumers that have switched brand during the pandemic, 33% report it was because the usually purchased brands were not available (McKinsey & Company, 2020).

Because of a significant shift from physical stores to online alternatives, especially apparent during the pandemic, it is important to offer an omnichannel experience to facilitate the retainment of customers by meeting the demand in different channels. By increasing consumer engagement with the brand through word of mouth and social interactions, brand equity and loyalty is stimulated between the consumers, rather than between consumers and the brand (McKinsey & Company, 2020).

3.4.2 Fraud in the Chinese Food Industry

There are many issues food products can encounter in the global food supply chain. Four different categories has been identified in regards to food integrity; food fraud, food defence, food safety, and food quality. These four categories are overlapping, but can be distinguished by whether the action is deliberate or unintentional, and the underlying motivation (The Food Integrity Project, 2018).

If unintentional and harmful, it is regarded a food safety issue, but if it is not harmful it is simply a food quality issue. However, if the action is intentional, they are distinguished by the motivation for the action. If the action is intentional and motivated by inflicting harm, it

is described as a food defence issue. If the action is motivated by gain, often economic, it is regarded as a food fraud issue (The Food Integrity Project, 2018).

Food fraud is defined by The Food Integrity Project (2018) as an action *"intentionally causing a mismatch between food product claims and actual food product characteristics, either by deliberately making claims known to be false or by deliberately omitting to make claims that should have been made"*.

Chinese consumers have concerns about the integrity of the domestic food supply chain, and perceive domestically produced food to be of inferior quality compared to other countries (H. Kendall et al., 2018).

An analysis based on 1553 media reports of economically motivated food fraud and adulterations in China found that "Animal foods" was the largest category, accounting for 592 of the cases. "Dairy products" was the sub-category with largest number of incidents, with 123 cases. "Seafoods" came in at a close second, with 109 incidents reported, accounting for nearly 7% of the analysis (Zhang & Xue, 2016).

According to EUROPOL (European Union Agency for Law Enforcement Cooperation), fish is considered to be the third highest risk category for food fraud (Maestri, Imperiale, Parmigiani, & Marmiroli, 2018). EUROPOL consistently report seizures of large quantum of food and drinks related to food fraud. An examination of press release-articles reveal that seizures coordinated by EUROPOL include food and drinks related to fraudulent activities such as tampering with expiration dates, controlled pharmaceuticals substances added to drinks, storage of food in unsanitary conditions, counterfeit food products, mislabeled food products, illegal import and export of food products, and various other food products unfit for human consumption (EUROPOL, 2021).

Uncertain labeling and vague naming practices of species indication is another challenge in the Chinese seafood market (Xiong et al., 2016). In processed fish products, such as fillets or steaks, or further processed products, where visual recognition is not possible, the fish products can be counterfeited. An economic gain can be achieved by substituting fish species of higher value with lesser valued fish, or fish from illegal fishing, by claiming it actually is the higher valuated fish species. Furthermore, it is problematic that many species are termed under a shared name (umbrella term/specie genre), and even further problematic; translations

of species into other languages can fuel even more confusion. Declarations on label of geographical origin might be fraudulent to disguise potential substitution of species, or to disguise illegal, unreported, or unregulated seafood. Additives, processing, or treatments may be falsely declared on the label, such as in the case of selling previously frozen, then thawed, fish as fresh fish (Maestri et al., 2018).

In restaurants and stores, it is common to find 20-30% of the seafood samples collected to be mislabeled (Maestri et al., 2018).

3.4.3 Norwegian Seafood in the Chinese market

According to the paper "RCA Analysis on Norwegian Salmon Exports to China" (2010) by Jing Ma and Jing Xiao, where they analyze the comparative advantage of salmon products from Norway in the Chinese market compared with other main salmon exporting countries, China is the third largest importer of Norwegian salmon among Asian countries. The article claims that Norwegian salmon is getting more and more accepted by young Chinese, particularly the middle-class due to its particular taste. The authors argue that the high price is not of great importance, because the high price reflect the high quality. The consumption of Norwegian salmon is increasing in line with the growth of Chinese GDP. It's claimed that the demand for quality in China is high, and therefore any increase in income will equal to the same increase in consumption (Ma & Xiao, 2010).

In 2019, fish export from Norway amounted to 104 billion NOK, accounting for approximately 11,4% of the total export value of Norway (SSB, 2020). Excluding Poland, China was the largest growth market in 2019 for Norwegian seafood, making it the seventh largest market in total (Norwegian Seafood Council, 2020). Coinciding with the increasing consumer awareness and concern for healthy, and ethical food, the growing population and growing middle class will require more protein from sustainable sources. The UN estimates a total population of 9,77 billion in 2050, which implies a 35% increase in protein consumption. It is therefore expected that demand for Norwegian salmon will increase in the future (Mowi, 2020)

In the case of Norwegian seafood and the Chinese market there has been several problematic incidents during the last decade. In 2010, China imposed economic sanctions toward Norway as a retaliation for Norway awarding Liu Xiaobo, a Chinese dissident, with the Nobel peace prize. Despite not officially confirmed, there has been found strong evidence that Norwegian salmon was imposed to disproportional border measures, effectively restricting import of Norwegian salmon. It has been reported that these restrictions were bypassed using various methods such as rerouting, falsify country of origin and smuggling (Chen & Garcia, 2016). A Chinese-Norwegian woman connected to Norwegian seafood companies was imprisoned by Chinese authorities suspected for smuggling Norwegian salmon worth up to 180 million NOK (Fiskeribladet, 2018).

Recently, there has also been incidents that has caused harm to the reputation of Norwegian farmed salmon in the Chinese market. One example of this was when the COVID-19 virus was linked to fresh salmon at a wet-market in Beijing (Pang et al., 2020). This resulted in mainland China halting the import of European salmon, with many major supermarkets and restaurants removing salmon from their shelves and menus (South China Morning Post, 2020). It was reported that it was difficult to import salmon to the Chinese market, despite Chinese food experts on disease control said that there was not any evidence that salmon was the source of the new outbreak in Beijing (Pang et al., 2020; The Norwegian Government, 2020)

It was reported in 2021 by the Norwegian Seafood Council that Chinese consumers had a large proportion that report to often buy seafood online. 46% of the Chinese respondents in their study revealed that they 'often or very often' buy seafood online. This number was relatively large compared to the other countries respondents. This is close to double of the second highest country, which was Thailand (Norwegian Seafood Council, 2021).

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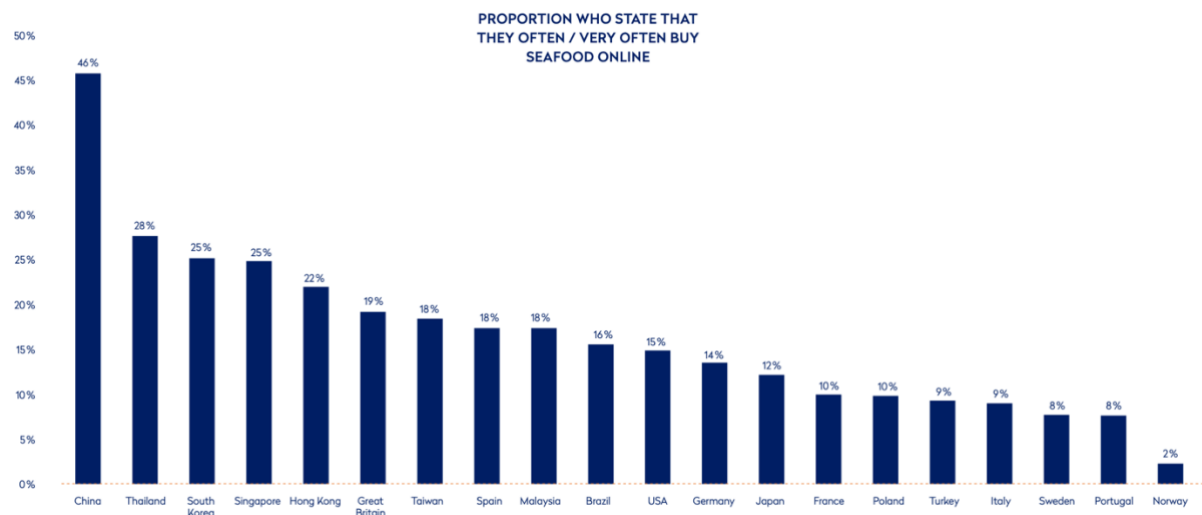
Figure 3 (Norwegian Seafood Council, 2021)

4.0 Methodology

4.1 Research strategy

The concept of research strategy is referring to the overall approach in conducting research for the project. A qualitative approach can be employed when collecting data comprised of written or spoken language (Bell, Bryman, & Harley, 2018). For this research project a qualitative approach has been selected due to the qualitative nature of the research questions.

The data for the analysis has been collected by obtaining insight from experts within the fields of export of Norwegian seafood to the Chinese market, and blockchain technologies. Because the data collected could be characterized as having qualitative qualities, the author decided that a qualitative strategy approach to conducting research would be most suitable.

The objective of the research study has been to establish the current situation in relation to supply chain and traceability challenges faced by Norwegian seafood in the Chinese market, and to what extent blockchain technologies can contribute to meet the challenges identified. In order to collect data and obtain insight toward the research area, the author has conducted in-depth interviews with industry experts.

According to Bell et al. (2018) the term 'theory' often refers to "a way of explaining observed patterns of associations between phenomena". However, it may also refer to the background literature to any specific enquiry. The author has chosen the latter approach to theory. A literature review has been developed in order to illuminate topics that are relevant for the research that has been conducted. The literature review has also contributed to having increased the authors knowledge and understanding of the topics. Additionally, the literature review has been performed in order to discover whether there are particular aspects of a topic that has been neglected.

4.2 Research design

Research design can be defined as "a strategic framework for action that serves as a bridge between research questions and the execution or implementation of the research" (Durrheim, 2006). There are five different types of research methods which includes experiment, survey, archival analysis, history, and case study. To assess which type of research method is most suitable, there are three conditions which consist of a) form of research question, b) control researcher has over actual behavioral events, and c) the degree of focus on contemporary events (Yin, 2018). The five different research methods and the framework for which to choose is illustrated in the table below.

Strategy	Forms of research quesiton	Requires control of behavior events?	Focuses on contemporary events?
Experiments	How. Why	Yes	Yes
Survey	Who. What. Where. How many. How much.	No	Yes
Archival analysis	Who. What. Where. How many. How much	No	Yes/ no
History	How. Why.	No	No
Case study	How. Why	No	Yes

Table 1 (Yin, 2018).

According to Yin (1981b), a case study represent a research strategy that attempts to examine real-world life occurrences when the boundaries between a phenomenon and the context are not apparent. Case study is an optimal methodology to examine a phenomenon in-depth while maintaining a holistic perspective. By using multiple sources of data, case studies are

designed to emphasize the different perspectives of all the participants involved (Tellis, 1997). Case studies can be applied in order to engage in a detailed examination of data within a specific area. Such specific areas are common to be a geographical selection or a limited number of subjects of study (Zainal, 2007). If the form of research question is what (if exploratory), how, or why, the researcher does not have control over behavioral events, and it focuses on contemporary events, a case study research design can be justified (Yin, 2018).

The research of this thesis has revolved around the supply chain of Norwegian seafood in the context of the Chinese market. Furthermore, the research has explored how blockchain-traceability can meet challenges that has been identified in the Chinese market. It has been essential to collect data from multiple sources in order to gain a detailed understanding of the individual perspectives, to comprehend the entirety of this complex topic. In this research it has not been possible to isolate the phenomena from the real-world context in which they occur, the researcher has no control over the behavioral events, and it focuses on events that are contemporary. Because of these characteristics, the author has decided that a case study approach would be the ideal research design.

When deciding the type of case study, there are several options. Yin (1981a) has identified and defined three main types of case studies; exploratory, descriptive, and explanatory.
A characteristic of an exploratory case study type is that "it is used to explore those situations in which the intervention being evaluated has no clear, single set of outcomes" (Yin, 1994). Exploratory research has been described as making early investigations into areas that are relatively unknown. The goal of the exploratory research is to collect new insight into phenomena by applying a flexible, open, and inductive approach (Stebbins, 2001). The challenges Norwegian seafood is faced with in the Chinese market, and how blockchain-traceability can meet these is a relatively specific and unknown area of research. There are no single set of outcomes, and the goals of the research is to collect new insight into this specific area. The author has decided that an exploratory case study approach was to be applied, which allows for a an open and flexible approach to research.

Furthermore, having decided upon which research method and the specific "type" of case study to conduct, the author had to decide whether to conduct a single case study, or a

multiple-case study. If the case is limited to a specific context, which may be interesting due to its uniqueness or extreme situation, a holistic single case study can be considered (Baxter & Jack, 2008). In this thesis, the case is "blockchain-traced Norwegian seafood in supply chains" and the context is "the Chinese market". The decision to focus on a single generic seafood supply chain structure from Norway to China, can be justified by having included enough complexity to represent the large majority of seafood supply chain elements. This case study will focus on a single context, and therefore it has been determined by the author to be of those characteristics similar to a single case study.

4.3 Sampling

As described by Bell et al. (2018) a *sample* is "the segment of the population that is selected for investigation. It is a subset of the population. The method of selection may be based on a probability or a non-probability approach". The non-probability approach indicates that the segment selection has not been randomly selected, but that some units in the population has a greater probability of being selected than others. A bias might occur as there may be a possibility that human judgment could affect the selection process (Bell et al., 2018).

Purposive sampling is a non-probability approach. Here, the sample is purposively not randomly selected. The goal in this approach is to strategically select participants that are relevant to the research questions asked (Bell et al., 2018). Purposive sampling is also known as *judgmental sampling* because the researcher will use its judgement to select cases that will best enable the research questions to be answered and meet the objectives (Saunders, Lewis, & Thornhill, 2012). This is because of their relevance to understand the phenomenon being investigated. Often, the researcher select a sample in order to ensure variety in the sample. This approach also entails that the results cannot be generalized to a population (Bell et al., 2018).

For this particular qualitative exploratory case study, it was required that the participants had a relevant understanding of the phenomenon and context in which the research questions sought to answer. More specifically, it was imperative that the participants had legitimate

and trustworthy knowledge of the seafood supply chain, the Chinese market, blockchain-technology and traceability, and/or a combination of all of the previous.

The aim of this research has been to explore how blockchain-based supply chain traceability can mitigate challenges in the context of the Chinese market. In addition, it has been essential to investigate the current status of blockchain-traced Norwegian seafood in this market, and how a typical supply chain structure from Norway to China is structured. It is worth mentioning that the aim of this research is not to engage in an in-depth examination of the technicalities of blockchain technology, but rather the opportunities blockchain enables.

On the basis of the research goal, the author regarded especially three topics as fundamental. These include a) blockchain traceability, b) Norwegian seafood supply chain, and c) the Chinese market.

Altogether, the researcher selected five participants. Because the type of sampling approach applied was purposive (non-probability), the participants were carefully selected due to their relevance to one or more of these topics. Several of the selected participants possessed knowledge and had experience with two or all of the three fundamental topics. Purposive sampling is often used when working with very small samples, and used to select cases that are especially informative. It is therefore often not statistically representative (Saunders et al., 2012)

The researcher identified potential participants by using online resources such as search engines. By using keywords and phrases such as "blockchain", "Norwegian seafood", "China", "traceability", "supply chain", and a combination of these, both in Norwegian and English, the researcher could identify strategic participants that held positions related to Norwegian seafood exports and/or enterprise blockchain. In addition, the researcher also identified relevant participants through recommendations from its network. Participants were contacted by e-mail. When approved, a meeting was scheduled for the interview. Due to large geographical distances and the restrictions of the covid-19 pandemic, the meetings were arranged and conducted virtually using Microsoft Teams.

Identifier	Expert knowledge areas (ranked by expertise)	Position	Date
X1	China, seafood	Director China	28.01.21
F1	Seafood, China	Commercial director	16.04.21
F2	Blockchain, seafood, China	CEO	13.04.21
F3	Seafood, China	Senior Sales Manager	04.05.21
B1	Blockchain, seafood	CEO	22.04.21

Table 2: interview respondents

4.4 Data collection method

Data collection is the action of obtaining information. The literature commonly distinguish between two types of data; primary data and secondary data. Saunders et al. (2012) describe five types of methods for data collection which include sampling, secondary data, observation, interviews, and questionnaires (Saunders et al., 2012).

4.4.1 Primary data

Primary data can be defined as *"data collected specifically for the research project being undertaken"* (Saunders et al., 2012). Primary data can be of both qualitative and quantitative character, and may be collected through methods such as observation, interviews, or questionnaires.

As previously mentioned, this research project has engaged in a qualitative approach to primary data collection. One such method of gathering qualitative data is the research interview. The research interview is a general term for several types interviews. The interviews can be sorted by their levels of formality and structure categorized as either: structured interviews, semi-structured interviews, unstructured or in-depth interviews (Saunders et al., 2012).

As previously established, the research strategy of this thesis is an exploratory case study. Saunders et al. (2012) recommend either using in-depth interviews or semi-structured interviews when conducting an exploratory study (Saunders et al., 2012).

As a central part of the data collection, the researcher has decided to conduct semi-structured interviews with respondents that has expert knowledge related to the research questions.

Semi-structured interviews are a type of interviews described as non-standardized and regarded as a qualitative interview type. The researcher has a list of some key-questions regarding some specific topics that are to be covered, with this list often being referred to as a *interview guide*. However, the researcher has great freedom in how to reply (Bell et al., 2018). This entails that questions may sometimes vary in form and sequence from interview to interview, depending on the relevant contexts and flow in conversation (Saunders et al., 2012). As a result of new information, questions that are not included in the interview guide may be included, but mostly, the questions will be the same from interview to interview (Bell et al., 2018). Semi-structured interviews has potential to provide background content and contextual material for the study. Furthermore, conducting interviews such as the semi-structured interview can be helpful when the research design adopts an inductive strategy (Saunders et al., 2012).

Saunders et al. (2012) describe several types of situations where it can be advantageous to apply semi-structured interviews as a method of data collection.

First, it is advantageous to use semi-structured interviews when it is necessary to understand the rationale behind behavior and attitudes. It also gives the opportunity to build on their response by "probing" answers when it is desirable that the respondent to further explain or build on their response. This can lead the conversations onto new areas which not had previously been considered (Saunders et al., 2012).

Second, it is beneficial to establish personal contact with the respondents. It is more likely for managers to participate in an interview, compared to completing a questionnaire. The respondent does not need to write answers down, and can receive personal assurance and feedback of what the data will be used for. A potential respondent that receives a questionnaire online may be reluctant to complete it for many reasons, such as providing someone they have never met with sensitive information, any questions that are unclear can be clarified, rather than declined (Saunders et al., 2012).

Third, a semi-structured interview will in a number of circumstances undoubtedly be most beneficial, such as when there are many question to be answered, questions are complex or open-ended, or if the order and logic of the questions can be required to be varied (Saunders et al., 2012).

For this research project the semi-structured interview guide was constructed and conducted in Norwegian, as this was the preferable language of the participants. All the interviews were conducted by telephone and online transmitted video and audio using the online video conferencing service Microsoft Teams. This was primarily due to large geographical distances and travel restrictions of the covid-19 pandemic. In order to ensure reliability and accurate transcription of the interviews, the researcher audio-recorded all the interviews. The respondents were notified and consented to this before the interviews started.

A short introduction to the project was performed at the start of each interview. The introduction briefly introduced the research topic and the objectives of the data collection in order to ensure that the respondent was prepared for the following questioning. Additionally, it was an opportunity for the respondents to ask any clarifying questions before proceeding.

The interview guide revolved around five main topics; background, seafood supply chain, the Chinese market, traceability, and blockchain. Altogether the interview guide comprised of 27 questions. These were intended as guidelines for the researcher, in order to ensure that all relevant key-areas were sufficiently covered throughout the interview process. Some of the questions were open ended and granted the respondent with flexibility and leeway in how to answer. Because of the flexible approach and open ended questions, it was very common for the respondent to tap into several of the other topics and questions while answering. If the respondent's answer sufficiently covered other questions, it was not necessary for the researcher to ask these at a later stage in the interview. Throughout the interviews, the researcher also included follow-up questions that were not listed in the interview guide as new information surfaced.

4.4.2 Secondary data

Secondary data can be defined as *"data that were originally collected for some other purpose, and then reused for a different research question"* (Hox & Boeije, 2005). In emergence with the internet, secondary data has become increasingly accessible and can be a good source of information for individuals that does not have the resources of larger organizations. Openly available online data from governmental- and non-governmental organizations can be useful to answer or partially answer potential research questions an individual seek to answer. Examples of secondary data can be internal organization records such as sales, letters, payroll details etc. Newspapers keep record of company share prices and takeover bids, government departments conduct surveys and have large databases of statistics, consumer research companies collect data that is shared with their customers, and social media sites host areas of web-pages for special interest groups, including those by organizations (Saunders et al., 2012).

The majority of the secondary data was collected in the literature research. The type of sources included research articles, business reports, official governmental reports, and websites that were related to the topics of the research questions, such as seafood supply chain, the Chinese market, food fraud, traceability, and blockchain. The majority of the secondary data was openly available online. However, some of the data collected from Norwegian Seafood Council was e-mailed upon request from the researcher.

In addition to a variety of academic sources, relevant data and information was collected from a number of different reports by non-profit organizations such as Norwegian Seafood Council, Food and Agriculture Organization of the United Nations, WWF (World Wide Fund for Nature), NOU (Official Norwegian Reports), Nofima, EU (European Union), WEF (World Economic Forum), Oceana, and Norwegian Environment Agency. A variety of business reports were also examined during the collection of secondary data. These included reports from PwC, Deloitte, GS1, Mowi, IBM, DNV-GL, McKinsey & Company, EY, and Accenture.

4.5 Data analysis method

There are two central general strategies of analyzing qualitative data; analytic induction and grounded theory. The intention of a general strategy is to function as a theoretical framework that guides the analysis of data. Grounded theory is by far the most widely popular approach to analyzing qualitative data. Some of the tools of grounded theory include theoretical sampling, coding, theoretical saturation, and constant comparison (Bell et al., 2018).

The data collected from the semi-structured interviews has been transcribed and functioned as the basis of the qualitative data analysis. A thematic analysis is one of the most common techniques for conducting an analysis of qualitative data. The search for themes is an activity that occur in most approaches to qualitative analysis, including grounded theory. The researcher has adopted the strategy of identifying and categorizing key-themes. After the interviews and transcriptions, the researcher has interpreted and sorted statements into different categories and summarized the findings. Furthermore, the secondary data was to a large extent already processed, and thus did not require any further analysis. However, while only primary raw-data data was reported and processed in the findings, the secondary data did serve an important purpose in the proceeding discussion.

4.6 Quality of research

In business research there are three prominent criteria for evaluation; reliability, replication, and validity.

The concept of **reliability** involves the concern of whether a result of research is repeatable. It is primarily a relevant issue in connection with quantitative research, and is concerned with whether the research measure is stable and consistent (Bell et al., 2018).

Replication is very closely related to the concept of reliability. However, replicability is concerned with whether another researcher can replicate the results at a later point. It is essential that a research study is capable of being replicated. Therefore, it is necessary for the research to clearly state the procedure of the research in great detail (Bell et al., 2018).

Validity is involved with the question of integrity of a research study conclusion, and is further distinguished into several different types. The main types include *measurement validity, internal validity, external validity, and ecological validity* (Bell et al., 2018).

Some writers also discuss the terms *reliability* and *validity* in the context of qualitative research, and sort them into external and internal. However, the concepts of reliability, replication, and validity are often associated with being relevant for quantitative analysis, and some writers argue that it is inappropriate for qualitative research. It has been suggested that qualitative research should be evaluated by other criteria. For example it has been proposed by Guba and Lincoln (1994) that the two main criteria *trustworthiness* and *authenticity* can be appropriate for assessing the quality of qualitative research.

The concept of trustworthiness comprise of four criteria which all has parallels to the previous mentioned concepts; *credibility* (parallels internal validity*), transferability* (parallels external validity), *dependability* (parallels reliability), and *confirmability* (parallels objectivity) (Bell et al., 2018).

Creditability of findings is concerned with ensuring that the research has been carried out in accordance with general rules and principles of good practice and with validation on the findings by the participants that was researched. In order to ensure creditability, the authors has applied a technique called triangulation, which entails using multiple sources or methods of data (Bell et al., 2018). By conducting semi-structured interviews with several informants within the same industries, collecting secondary data, conducting a literature review, and frequently attending relevant webinars, the author has collected data from a variety of sources, in accordance with the principles of triangulation. By using the interview guide as general guidelines for the interviews, ensured that all of the key-topics were sufficiently examined and thus comparable.

Transferability is concerned with whether the findings can apply to other contexts (Bell et al., 2018). Korstjens and Moser (2018) describes transferability as *"The degree to which the results of qualitative research can be transferred to other contexts or settings with other respondent"*. A strategy for ensuring this criterion is to provide a *thick description*. This

entail describing the context of the data collection, so that the data become meaningful to an outsider, and can assess whether the findings are applicable to their own setting. The researcher should provide descriptive information about the sample, such as for example information about sample size, interview context, sample strategy, demographic, and interview procedure (Korstjens & Moser, 2018).

Dependability is a parallel to reliability, and in order to accommodate the criterion of trustworthiness, complete records of the research process, in all of it phases, should be kept in an accessible manner (Bell et al., 2018). Dependability refers to the stability of results over the course of time. It involves the participants evaluation of the findings, interpretations and recommendations, so that conclusions are supported by the data from the participants (Korstjens & Moser, 2018). In order to accommodate this criterion, records of the data collection has been stored securely and anonymously throughout research process. By describing in detail the various research steps, a transparent approach has been maintained from start to end.

Confirmability involves that the researcher should not allow personal values and beliefs to affect the conduct of research or the results. While it is nearly impossibility to ensure complete objectivity, it should be apparent that the researcher has acted in good faith (Bell et al., 2018). Data has been kept and has been accessible throughout the study, and a detailed description of the data collection and analysis ensures transparency in the process.

Authenticity include several other sub-criteria such as *fairness, ontological authenticity, educative authenticity, catalytic authenticity, tactical authenticity, transparency and coherence,* and *impact and importance (Bell et al., 2018).* Korstjens and Moser (2018) describe the final criterion as *reflexivity* which entails the critical self-reflection of oneself as a researcher (e.g. biases or preferences) and the research relationship (e.g. the relation to the respondent and how it may influence the responses) (Korstjens & Moser, 2018).

5.0 Findings

This section will present the findings from the semi-structured interviews. Such data include statements and information that has been provided by the respondents that participated in the interviews. Relevant information has been transcribed from the interviews in order to facilitate the interpretation of the relevant findings. The interviews were conducted in Norwegian, and has been transcribed in Norwegian. For the purpose of presenting the findings, relevant statements has been translated into English.

In order to effectively organize the content of the interviews, a thematic structure has been applied. These categories consist of seafood supply chain, the Chinese market, traceability, blockchain technology and challenges. Within each of the categories, summarized text and associated quotes will be presented.

5.1 Seafood Supply Chain

In the literature research section of this thesis, the various stages and actors in a typical generic Norwegian seafood supply chain was described. However, the literature contained scarce information regarding the supply chain structure once the seafood had been harvested and processed. Only very brief descriptions of the transportation, import, and distribution processes were discovered and reviewed.

5.1.1 Structure

Among the first questions in the semi-structured interviews, the respondents were asked about the structure of their supply chain toward the Chinese market.

The structure of the various supply chains had many similarities, and the main product to the Chinese market was salmon, both fresh and frozen. Because of the very standardized process of farming salmon, the respondents focused more on the supply chain from the point of harvesting. Some of the seafood companies that were interviewed, operated fundamentally differently, perhaps because of the nature of their product, and has therefore somewhat different supply chain structure. While two of the companies focused on salmon as a "commodity", primarily selling whole, fresh fish or non-value added products as a

homogenous product in B2B, another company specialized on branding, value-added products that had been processed and packaged, creating a heterogenous product that was sold B2C and could demand a premium price.

For company F1, the first step that initiate the rest of the processes is the negotiation with customers regarding price, quality, and volume of the fish that is being produced. The fish is then harvested, packaged and continually loaded into trucks that will transport the fish to different airports. Airports vary depending on availability and distance from production area. For the larger airports, such as Gardermoen, the fish can be transported through direct routes to Shanghai. There are also other routes that entail sorting at airport terminals in intermediate countries. From these terminals the fish is re-distributed to various other markets, including China. It was reported that their main intermediate airport was in Doha in Qatar, which was used when transporting the fish from their local airport. The fish was then sent from Doha to China, where their customers received the product at the airport. Their customers are mainly distributors/whole-sellers/importers that sell to the HORECA market (Hotels, Restaurants and Cafes) and to producers that further process and package the fish. The respondent did not have knowledge of the structure of the supply chain from this point onward, as their traceability ended when the fish reached their customer in China.

Company F2 has purchased their fish directly from a variety of producers from different parts of Norway. The products are processed and packaged in consumer packaging, before the fish is transported by truck and/or ship, depending on the producers location in Norway, to Gardermoen for air transport to their hub in Shanghai, where their base in China is located. The products are then taken through the Chinese customs, and transported by truck to a main storage. From this location, the fish is either distributed to the consumer, or transported to one of their smaller rental storage facilities at other strategical locations in China. Last mile delivery is performed by a variety of methods, and is delivered at the customers residence. The distribution in China is provided by third-party actors.

Company F3 is a sales organization, fully owned by a salmon production company. However, the sales organization also sell salmon for other companies. This means that the fish come from different locations. From the production facilities in western Norway, fish is transported by truck to Gardermoen terminals. Here, the fish is unloaded at one of two

terminals, depending on the airline company that will transport the fish. The fish is then loaded onto trucks and transported to the airport area where it is loaded onto the airplanes. Most of the airplanes from Gardermoen does not have direct routes to China. But for example Qatar Airways has many daily flights from Gardermoen to Doha. The fish to China has always a transit, intermediate, country, either in Europe or the Middle East. Here, the fish is transferred to a new airplane that transports it to China. Whether the products are transported with cargo airplanes or passenger airplanes depends on the airlines. After the fish is received at the airport, the customer can collect and receive it. However, due to the covid-19 pandemic, this process has a longer duration than it normally would have. This is because each shipment needs to be tested for covid-19 and disinfected. Once the customer has received the shipment, the fish needs to be tested once more. This is because the customers does not receive any documentation of the testing from the customs. A third-party will test the products again. Some shared warehouses require negative covid test, and many customers require this as well. The customers are whole-sellers/importers/distributors, which in turn sell the fish to producers for further processing, restaurants, or to retailers/supermarkets.

5.1.2 Lead Time

Following up on the question regarding the supply chain and product mix, the companies that sold fresh salmon were asked how long time it would take from the fish is sent out from their processing facilities until it reaches the end-customer. For the company that sold frozen fish, this question was not as relevant, due to the long shelf-life of their products.

The time it takes from the fish is produced at the companies location in Norway was reported to be approximately four days, but it does vary. The other company reported that the covid-19 pandemic has had an impact on the time it takes due to disinfection and covid testing processes at the airport and at third-parties. Therefore, it would take an estimate of minimum six to seven days before the fish was available to the consumer. However, it can also take longer time if there are any delays in either one of these processes or under the transportation phase.

"It varies, depending on the airport we send it from. The fish is slaughtered and produced, then the trucks are continually loaded. When the trucks are loaded, they go straight to the airport, and this takes a day on average. Then another day is estimated for the airplane transportation, because it often goes down to… It varies, but usually it goes via a terminal somewhere. Usually there are large, full, "salmon-airplanes" that goes to a re-distribution terminal, then split, and then there is at least another day before it arrives in China. So, about two and a half day is the average. Then there is an additional day, because it usually takes about three and a half day, four days, until the salmon is out of the ocean until it reaches "a lady" in China." – F1

"Day 1, the fish is produced. Day 4, the fish arrives in China. Day 5, the fish is received by the customer. Therefore, the fish can be in the restaurant earliest at day 6. But it must be day 7 for the supermarkets, because they require customs clearance documentation and clinical health certification. In Guangzhou this takes 1-2 days, but in Shanghai it can take 1 week… From the fish arrives at the destination until it can be collected, it takes 1-2 days because of the extra testing" – F3

The company (F2) that sold frozen fish was asked about the lead time from when their customers placed an order for a salmon product, until it was received by that customer. The delivery time was usually very short, but did also vary somewhat, depending on where in China the customer was located, because they service the whole market. Delivery time was affected by which city the customers was located in. For the large cities such as Shanghai and Beijing, the delivery time was only a few hours. The respondent reported that it never takes more than one day to deliver the product to any customer.

"We have strategically placed warehouses that we rent, we do not do our own deliveries. We use actors with good knowledge of this in China… It is delivered at the door… [Delivery is] Within a day, if it is in the same city" – F2

5.1.3 Sales Channels:

Throughout the interviews, it was reported on the different types of sales channels in China. One of the most popular channels for sale was reported to be "wholesale". This type of customer was also described by other names such as importer and redistributor, and these expressions were often used interchangeably. The main characteristic of this type of customer is that they receive the product at the airport in China in large volumes. These products is then resold to a number of other customers, such as supermarkets, restaurants, or factories, who will then further process the fish to consumer ready products to for example supermarkets.

> *"Most of our customers are wholesalers, we call them importers. Some of these deliver to factories that further process the fish. No retailers buy from Norway directly." – F3*

> *"Our customers are mainly redistributors who service different types of customers. Their customers could be everything from a producer who take it into factory and does something to it, or… In China, until now, 90% has gone to the HORECA market, so that is the most common. It is perhaps one of the countries which has the largest share of salmon going to the HORECA segment, so the salmon goes to the restaurants whole, and is produced for the end consumer in the restaurant. And then there is only 10% that goes to retail, and when it goes to retail, it has perhaps been at a factory first, and comes as a finished product, most common in sashimi format… And then e-commerce has 20-30% of the retail segment, which is quite comparable to other food categories in China… So there is 20-30% of the 10% that goes to that [e-commerce] channel." – F1*

> *"When they [the respondents customers] deliver a shipment, a shipment has 161 boxes, then these are distributed to perhaps 20 customers…" - F3*

It was reported by a respondent that there is little control over where the fish finally end up, and they have little control over the further distribution after the fish is received by their customer.

However, they are not completely blind either, and one respondent did know some website in which their fish was sold. Another respondent was aware of which supermarket chains the fish typically appeared. The target for this respondent was to sell their branded salmon directly to a retailer, but it was not possible to deliver to these customers at a daily or weekly basis due to the restrictions of Norwegian salmon in China.

> *"Our goal is to make products from our own raw materials and sell it as our branded salmon to retail. This is our goal through cooperation with a Chinese factories". –*
> *F3*

There is increasing demand, especially during the covid-19 pandemic, for salmon in retail and online channels, and both factories and retail look more toward VAP (value-added products).

> *"I think the Chinese market is still increasing, especially the restaurant segment, but this year, after covid, we see an increasing demand from retail and online. So through the last year, visits and communication with customers, and even factories, we experience that both retail and factories look for VAP-products, salmon products, instead of just raw salmon… For example fried salmon with rice, salmon dumpling and products that use salmon as a raw material." – F3*

One of the respondent companies had a different business strategy. This company focused on branding their products and sell B2C, directly to the end-consumer. With an aim to eliminate as many intermediate parties as possible, the company sell the fish using an e-commerce model. Orders are placed on their website, and the products are sent directly from one of their own storages in China directly to the consumers residence.

> *"We brand Norwegian seafood and sell directly to consumers in China. We have been doing e-commerce there and want to cut as many intermediate actors as possible on the way. By doing this, we have good certainty for what we deliver and have greater control of what is delivered to the end-user… We want the Chinese consumer to feel that they receive the product directly from the producer in*

Norway… So therefore we have tried to set up a more seamless value chain where things moves faster…" – F2

5.2 Chinese market:

The Chinese market was investigates quite thoroughly in the literature research for this thesis. There was many reports that described the characteristics of the Chinese market and Chinese consumer trends. The Chinese market has also been described in the context of food supply chain and seafood, but it was not apparent if these descriptions was transferable to Norwegian seafood and its supply chain. Therefore, the semi-structured interviews was imperative in order to illuminate the Chinese market from the perceptions of relevant actors in the Norwegian seafood industry.

5.2.1 Characteristics

The findings indicate that the Chinese market is very complex. All the respondents had a general consensus regarding this matter. It was described as being unpredictable due to political forces and restrictions imposed by the government, especially during the covid pandemic. Especially the incident in June 2020, when it was reported that Norwegian salmon could be responsible for an outbreak of covid in Beijing. This story gained widespread media attention, and it also spread rapidly on social media. This had a significant impact on the import and sales of Norwegian salmon in the Chinese market. It was also reported by one respondent that there recently had been an issue regarding the import licenses of Norwegian salmon, but had not been informed of this by relevant authorities or why this is. They believe it may have political reasons stemming from the Nobel peace prize awarded by Norway in 2010.

"Customers were told by the Chinese customs, several of my customers, so it is confirmed, that import licenses is not given for more than 30 tons per license. When they customer are going to buy the fish, they have to apply for import license, and there it is stated a quota, from some tons to some thousand tons, completely freely. Now, this week, we were told there is a very limited quota on the import licenses. We were not officially informed of this or why. We believe it may have something to do with the Nobel peace prize, again." – F3

"Norwegian seafood, among other, experienced a big hit and weakening of consumer trust after Norwegian salmon was accused of covid infection and outbreak in Beijing. And that was something we really noticed in a period. The "propaganda" was in the media, it turned into a big fuss and it was difficult to handle" – F2

"Last year we were stopped. Restaurants and supermarkets did not dare to sell salmon, because the customers would not buy after many bad news regarding salmon" – F3

"When there comes a claim that it was found corona virus on Norwegian salmon, then it [the market] becomes unstable. Suddenly the authorities can come with demands that turns your everyday life upside down from week to week, so it is a market which is politically unpredictable. Things happens, and spreads quickly. A story can spread like wildfire on social media." – F1

It is also described as the largest market, demanding market, but also a very attractive market that has large potential for Norwegian seafood.

"It is a demanding market to enter, because China is the world's largest market and everyone with a name that wish to enter China invest large sums to attack the market." – F2

The majority of the respondents stated that they sell whole, fresh salmon. They mainly want large salmon around 6 kg, as this looks good in the counter. The most popular method of consuming salmon is by eating it as sashimi. One of the respondents said that whole fish was preferred as there is a market for many parts of the fish.

"In China they utilize the whole fish… If you go to a Chinese online store, you will find quite many who sell the head, backbone, and that type of products, so there is a market for that too, perhaps in order to build economy in their purchase." – F1

The Chinese market for salmon was claimed to comprise 90% of the HORECA market, which is said to be higher than many other markets. Only 10% of the market goes to retail.

The Chinese market was also described to not have any strong brands when it comes to salmon. The most important factor when it comes to product identity is the origin. The position of Norwegian salmon is much weaker than in for example South Korea, Japan, or Thailand.

> *"What is perhaps special about China as a market, compared with western markets, is that brand is… there is very little brands for salmon, almost nothing. Origin is what sells." – F2*

> *"There are no brands for Norwegian salmon today. If you look at other products such as nutritional supplements, cosmetics, or other types of foods, then the brands are really important, but for salmon… Salmon is a little bit too 'commodity', it is more about the product in itself. This har perhaps a little to do with Chinese consumer preferences." – F2*

One of the respondents stated that origin is most important in exclusive supermarkets, and there can be a preference at these stores. However, in the less exclusive supermarkets, origin is not of that much importance.

> *"I still don't believe they [the consumers] focus on origin. I work with some top supermarkets in Shanghai, they receive a lot of good and detailed feedback. They say they have a good share of customers who want to buy Norwegian salmon, and some customers want King Salmon from New Zealand… When you lower the grade [of supermarket], I don't believe they care much if its Norwegian or Chilean salmon." – F3*

The Chinese consumer is described as being quality conscious, and the willingness to pay is also quite high. But the middleman towards the end of the supply chain is very price conscious.

"I don't believe that the consumers is the one who is price sensitive, but the middleman is" – F1

5.2.2 Trust

The findings contain evidence that the respondents experience that the level of trust among consumers is low, at least in some regards. This include concerns regarding domestic food production and purchases.

"There was a great need and demand for foreign products, because they did not have great levels of trust toward domestic food production and documentation, there was a lot of counterfeiting and scandals, and this is what we have tackled, and that's where we saw a big problem." – F2

"As you say, there is a great focus toward food safety, and it has over many years perhaps been a greater focus on this among consumers in China than in other markets" – X1

There are also evidence that it is perceived by the respondent that there is a general lack of trust when purchasing, and as a mitigation strategy, Chinese consumers engage in large amounts of research before purchasing. In order to meet the consumers demand for research and information, it is very common to include highly detailed information about foods products such as in the case when buying salmon sashimi online. This is often much more detailed than in western markets.

"The Chinese consumer conduct an incredible amount of research, probably because they are nervous in regards to what they buy. Norwegian consumers have a much greater level of trust, but they [Chinese consumers] do not have great levels of trust, and therefore they do all the research they can, they check all possible channels." – F1

"When you go to a Chinese online store and look at the product page of a sashimi product at T-mall and you can look at the information, such as documentation on the

product. If you were to compare this with a product on Amazon, then there will be twenty times more information [on T-mall]. There are copies of the health certificates, copies of covid tests, videos, how the product is made, where it comes from, customer reviews, and an incredible amount of information compared with western websites." – F1

Another strategy Chinese consumers has developed in order to lower the perceived risk of purchasing salmon, is to only buy from a selection of supermarket chains they trust.

"They go to X supermarket to buy, because they do not trust other supermarkets" – F3

Frozen fish is according to one of the respondent at the bottom of the ladder regarding quality. The optimal is for Chinese consumers to buy live seafood. Then they can be sure of freshness and that the fish look healthy.

"Preferably, the fish at a restaurant should be alive, you should be able to choose your fish – I want "Henry" in that box over there, so that was a challenge for us when starting to sell frozen seafood." – F2

When talking to one of the respondents about a common food issue that entails making food with cooking oil that has been recycled, the respondent reported having personal experience with this issue. This was not only occurring at small food stalls, but also at larger restaurants with good reputations.

"This doesn't just happen at small restaurants, that I can promise you. We brought own chefs from Norway, and then things were sent back [to the kitchen]. We were served oils that were simply unfiltered, it did not look good. You could see that it had been used. So regarding that, I have my own experiences and examples of physically observing that this happens and actually at larger establishments with good reputation." – F2

As a strategy for minimizing the risk of doing business with unprofessional actors, people share information. In order to communicate with other actors in the salmon industry in China, the app WeChat is very important. Here, there are group chats where people can share bad experiences regarding various customers or suppliers, in order to warn other members to be careful when doing business with these.

> *"We have a group chat called Hai Xian Zhi Nan, which means Seafood Guide. Seafood Guide made a group chat that invited many importers and exporters, and a good share of wholesalers to the same group. That is a good platform where people can talk about bad things. For example, if a customer doesn't pay, then he will named in that group and notified 'this person has not paid us, you others need to be careful'. That is a very good function… If someone make wrong labels, because some importers, especially ones that sell little, when they see the market price drop, perhaps they do not manage to sell the fish in time, and then they will replace the label. They make a new one with a new package date. This is not allowed, but when they get caught, they will also be sent to the group chat" – F3*

The main function of these group chats are networking, but it has also become a natural platform for sharing bad experiences. Such bad experiences can include late payments, underweighting of fish, or mislabeling.

> *"It comes natural, the group was not meant to have that function. But people discovered that this is a good method. It has become the largest salmon group [on WeChat]. The starting point was that people could get to know each other. And if some packing plants underweights, it is also reported to the group chat." – F3*

5.2.3 Trends

There are several things that was regarded to be trends in the Chinese market. Some trends were more of the political nature, which entails that there is a shift politically toward a greater emphasis on domestic production. All the respondents brought attention toward the domestic production of food and salmon, and two respondents also claimed that the government attempt to motivate local factories to increase production. There are also

indications that this production will be more complex than before.

> *"Now we see a change through covid, that state and party has put more pressure on protectionism, which has increased the focus toward domestic production and own products." – F2*

> *"But factories in China still has little experience with making Value-added products from seafood. Chinese factories have been good at making products for the market abroad, but not so much for the local market. Therefore, after covid, the authorities tried to motivate Chinese factories to make products and serve the local market." – F3*

The Chinese market and the Chinese consumer has been reported to be very advanced in the use of digital mobile technologies. This was described in various ways by all the respondents related to the Chinese market. Specifically, the respondents mentioned QR codes as a very common way of marking products, and that Chinese market and consumer has widely adopted this technology. In addition, and as previously stated, e-commerce is very sophisticated in regards to aspects such as delivery, accessibility and selection. The high consumer and business adoption rate of digital technologies is facilitated by an advanced infrastructure.

> *"It is the supplier's task to input all the documents for an order into the system [e.g. Shanghai cold chain], so that they receive a QR code. In the supermarkets you can see this QR code on many products, especially on perishable products such as milk, cheese, yoghurt, frozen and fresh products, salmon and seafood especially." – F3*

> *"If you show a QR code to someone in China, they will pull up their phone straight away and scan, and in Norway they would not do that." – F2*

> *"China is in many ways the perfect market today. They are dynamic, modern within technological infrastructure, the smartphone prevalence is enormous, and they are very conscious about food safety, they do a lot of research. So I think the potential is there." – F1*

Also when doing business and communicating with customers or suppliers, it is common to communicate by using the common mobile application WeChat.

"We all use WeChat to talk about business" – F3

E-commerce has also accelerated and become more popular recently, especially because of the covid pandemic. This has driven several supermarkets and restaurants to offer online purchasing and home delivery, making the products available both offline and online.

"We see an increasing demand for retail and retail... E-commerce has become very popular after covid... They [X supermarket] has a very good model for connecting offline to online and online to offline... All products, most of them, can be ordered online... After covid there are several supermarkets doing e-commerce as well. The same with restaurants. Many restaurants only sold offline before, but now home-delivery is very popular, so they connect to apps such as Baidu Waimai, Meituan Waimai, and apps like this." – F3

"You have an incredible possibility for online shopping, so if you want something, it can be at your door within short time." – F1

E-commerce has also increasingly become more related to social media. KOL (Key Opinion Leader) marketing, also known as influencer marketing, has become very popular recently. The business model of this type of marketing in China is that influencers get paid based on how many purchases they manage to encourage.

"Very much of the marketing is connected through influencers, KOL's, sales through KOL, and the payment for the marketing happens through a cut of the sale... KOL marketing has completely taken off. Last year, if I trust the statistics, then 80% of all products sold under 100 RMB was sold through KOL marketing online." – F1

"Douyin has become very popular during covid. Earlier you just watched Douyin to look at funny things. But after a while people started to sell products on Douyin." – F3

The findings also highlight other trends, several connected to covid, which include home consumption, sports and fitness at home, fitness clothing, and healthy foods rich in proteins. Sashimi has been a food trend that has become a very popular method of consuming salmon. During the pandemic, many people have been afraid of eating raw fish, and therefore also other type of salmon products has become more popular, in which they used salmon as a raw-material for other dishes.

"Then there is this market trend of sashimi, which is the big use area… There could be other formats, but the most common is sashimi. If you look at T-mall, and what the first thing Chinese consumers will search for in relation to salmon, then it will be "sashimi…" – F1

"There are several people that are afraid of eating raw salmon. So people try to eat salmon in different ways. After covid, many people has started to eat at home, so people have the need to buy products and make the food at home. Not just sashimi, but other salmon products, such as frying salmon with rice, make salmon dumplings, products like this that use salmon as a raw-material. During covid, one industry has increased a lot, and that is sports. So people begin working out, and therefore sport clothing has become very popular online. Because of this, people have started to look for health foods. So they see the importance of proteins, and seafood is starting to become more popular." – F3

5.3 Traceability

Regarding traceability, the findings vary more than on other topics. It was reported by one respondent that the focus toward traceability to the end consumer is increasing. This is especially relevant for cold chain products, and has been further strengthened during the

covid pandemic. There has become stricter import requirements when it comes to traceability of cold chain.

> *"There has been an increasing focus toward traceability from origin country to the end user. This has been amplified during the period with covid-19, and there has been a special focus in China when it comes to cold chains. This is because there has been identified a connection between cold chain food and potential infection. There has been introduced additional import requirements of information of cold chain food from the producer to end user. So when it comes to tracing of seafood in China, this is absolutely very relevant." – X1*

For some respondents traceability was very important as it was a significant part of their business' value proposition. For one of the respondents, the full traceability aspect was an important part of their brand identity and aimed at reducing the number of actors involved in the supply chain. The motivation for focusing on traceability was to assure the end user that the fish is safe and authentic, and is coming directly from the producer in Norway.

> *"There was a market for well-documented food… It is important pay attention to your products from a to z – in all layers. So we built our systems so that we have control in all layers that involve everyone in the value chain." – F2*

> *"Most actors drop off their fish at the border, and it often goes through five or six other actors until it reaches the end user. And then you have no idea whether it is your fish, some other fish, or what fish is delivered" – F2*

For the other respondents full traceability was not a priority, and they only had control over the fish until it reached their customers in China. One of the respondents mentioned that the type of traceability information is primarily location tracking, but additional services such as temperature tracking can be ordered if needed. It was also found that it is not within their responsibilities to track the fish after it has been sold when asked about this.

> *"We do not have responsibility for that" – F3*

"We mainly have location tracking in order to assess where the product or the pallet is located. But then you can also order additional services such as temperature tracking and that type of things" – F1

"We have traceability through our supplier until it reaches our customer, but from there on out, we don't have any… So we have full traceability until the fish reaches our customer… When our fish has arrived, it is inspected and approved by our customer. Then it is fine. What they do later is hard for us to know anything about" – F1

"In one week, we can sell more than 100 tons, and most of it goes to wholesale, so it is very difficult to trace each shipment, not even just each fish, but also each shipment, we do not know where the fish goes after the fish has landed…" – F3

According to one of the respondents, the fish was theoretically traceable from Norway to supermarket in China. If they were to attempt to trace the fish, it was estimated to take one week.

"Theoretically, the fish is traceable from Norway to supermarket. Most supermarkets buy whole salmon, so they receive the fish as it was produced in Norway. Others only want loin or filets, and then the fish will be delivered to a factory in China to be further processed. Then the fish has been processed by a Chinese factory before it is delivered to the supermarket. Theoretically, the fish is still traceable, because the factory must give all the documents to the supermarket." – F3

As previously mentioned, one of the respondents offered full traceability for the end-customer. The customer could scan a QR code on the package, and is then taken to a website that show all of the stages in the supply chain for that unique unit up until the producer in Norway.

"You are taken directly to the landing page for the product you are scanning. Then you will get all the information about that exact package… Up until farm or catch"
– F2

Some respondents also talked about RFID technology, and that this could be used to facilitate the traceability and control of the fish in the supply chain. One respondent said that this type of technology is coming at package level eventually. This technology exist, but at current cost, it is too expensive to implement.

"It [RFID] is coming. It is at package level soon. Things are changing. The cost is relatively high, there is a lot of infrastructure that needs to be in place when using RFID." – F2

"There is technology that makes it possible. You can put an RFID chip in a fish, but it is too expensive currently, but the technology exist. We have looked into if we should do it, but currently it is too expensive, to put a chip in each fish." – B1

It was reported by one respondent that during the covid pandemic the requirements for traceability had become stricter. In the larger Chinese cities, the Chinese government has implemented local cold chain traceability platforms. These platforms provide some traceability for the products going into retail supermarkets, and documentation is uploaded to this platform by the retailers' suppliers, but the QR code itself is produced by the supermarket. A QR code is displayed on products that comes from cold chain, and especially perishable products such as dairy, meat or seafood. This QR code takes you to a website, and in the case of salmon, it will display information such as covid tests, health certificates from Norway, and customs clearance documentation.

"In Shanghai, Guangzhou, Beijing and Chengdu, in the large cities, they have a local cold chain. When you deliver, especially to retail chains, you have to be traceable. The cold chain is kind of a code that you scan in, and you can check all the papers. It is the supplier's task to post the documents for each order into the system, so they can get a code. In the supermarkets you can see this code on many products,

especially perishable products such as milk, cheese, yoghurt, frozen and fresh products, salmon and seafood especially… If you scan this [QR code] you will be displayed the covid tests and disinfection tests, custom clearance documents and health certificates from Norway. These are requirements by the authorities, and the code must be displayed in the supermarkets. The retail must have the code ready, they make it themselves, but in order to make it, they need all the papers for that batch" – F3

Despite stricter policies regarding traceability of products, it is still possible to tamper with the documentation, such that the stated original producer could be falsely declared. This can be especially challenging for whole salmon. This is because if a retailer receives a shipment with two boxes from two different producers, it is only necessary to print up a code for one of the producers, which then could be used for both the boxes. When asking one of the respondents whether it is possible for someone sold different fish using their documents, it was reported that this was still possible.

"It could happen. Strictly speaking, it could happen. For an example, let's take a supermarket. Even if they have a cold chain code, which might be ours, but if they buy two boxes, one belongs to us, and another belongs to another importer. Then there is no need to make two codes, it is enough with one. So in other words, when dealing with whole salmon, it is not easy…" – F3

When further questioning the respondent if it easy for their customer/importer to sell Chilean salmon as Norwegian salmon, it was stated that this was not very difficult for the importer to do, as it was simple to change the labels on the boxes.

"This is correct. Because every box has three or four pieces of fish and only one label, and the label is easy to get rid of. When the fish has been taken out of the box, it is kind of naked, and no one can know where it is from and what day it was produced. You can even put a label on the gills, but it doesn't help." – F3

When taking out the fish, it is easy to differentiate Chilean and Norwegian salmon if it is whole, but it can be very difficult if the fish has been further processed. But this is becoming

less common, as many importers and wholesalers are very familiar with the original labels on the boxes. But it is more possible to change the label when the fish is sold to retail, because the retailers are less experienced in identifying the labels.

> *"If you take the fish out, it is difficult to recognize if it is Norwegian or Faroese salmon. It is easy to recognize Norwegian salmon from Chilean, because the appearance is a little different, but if you filet them, it is more difficult to recognize. I cannot say no one, but now there are fewer people who make fake labels in the market, but it is still possible to make the wrong label to retail, because retail doesn't know the labels as well, they are not professional at recognizing fake labels." – F3*

Regarding whether someone had sold fish using their brand name, it was reported that there had been someone that had used their brand logo on the packaging of the fish, without consent or an agreement, and the respondent did not know whether this fish came from them or if it was from someone else. This happened in Indonesia, but the respondent could imagine that this type of incident also happens in China.

> *"We have seen this, not in China, but we have seen it in Indonesia among other places. We have seen products in the market with our logo in stores in Indonesia without having any agreement with that actor… We don't know [if it was our fish]. It is difficult, people take the logo from the internet, stick it on their products and say that they are 'pro distributor'… Without jumping to any conclusions, but I could imagine that this also happens in China" – F1*

When asking one of the respondents if it is possible for consumers to trace their products, for example when being served the fish in a restaurant, the respondent believed this would be quite difficult.

It is also believed that full traceability might not be desirable for all the supply actors, because this might restrict their flexibility. Marketing and logistics are a bit connected, as it is necessary to understand to which extent certain logistics is desirable. Even if there is a desire by both the producer and the consumer to have full traceability, there might be resistance towards the end of the downstream supply chain.

"Marketing and logistics are a bit connected, because when working with logistics toward the market, you need to think about if it is desirable… There could be an actor when you are getting close to the end [of the supply chain] who says 'I don't want that, because then I lose my flexibility. I want to sell Norwegian salmon, but I would like to buy Chilean salmon also, because one week it might be half price'. So it is not certain that there is a desire for traceability. The consumer may want it, and the producer might want it, but there could be resistance in some stages right before the consumer that you should be aware of." – F1

Lastly, the respondents were asked what they believe is was the drivers for implementation of traceability. There were primarily two different answers in relation to this. The first respondent believes the primary drivers to be transparency, openness, safety and sustainability. However, the drivers might be different among different countries. In the west and highly developed countries it is perhaps typically sustainability and health that drives traceability, while the current main driver in China is safety. As the quality domestic food production increase, and number of food scandals decreases, the drivers might shift toward environmental aspects.

"Transparency and openness. A trend is that the consumers, maybe not in China yet, but it will probably happen there too, but that the consumers are concerned with sustainability in USA, France, Germany, UK… Sustainability and health are strong drivers, especially for young people, and then traceability is important… The drivers are different from country to country. In China, food safety is the driver, in USA it might be sustainability. The trends we see in the west might come to China. Japan is more concerned with sustainability. Right now it is food safety [in China], but later it might be other things. For an example, the authorities might set requirements and standards for production of sashimi, and then 80% will be erased. Through increasing the quality of domestic production, and the authorities are probably concerned with this, and when number of food scandals go down, then it will not be the strongest driver. Then you begin to look up and think "the air is a bit bad here", and you will move on the next stage of the hierarchy of needs." – F1

The second respondent believed that the driver for implementation of traceability was government policy and regulations. This was underpinned by the example of how the Shanghai cold chain platform had made traceability of cold chain products much better, and that actors did not dare to sell the fish before the proper documents were provided.

«*I believe rules must be set by the Chinese authorities, they must demand that importers and supermarkets… Such as that Hu Leng Lian (Shanghai cold chain), it is much better than earlier. People don't dare to sell salmon before the documents are in order. But it needs to be on a better system, because they have to consider the practical challenges as well, such as with the Chinese health certificate, it is a challenge.*" – F3

5.4 Blockchain

The majority of respondents that exported fish to China did not have any experiences with blockchain technologies. However, there was two respondent who operated with blockchain in supply chain. One of the respondents that exported fish to China had developed their own blockchain solution. Another respondent also develop a blockchain based platform for supply chain within the seafood industry.

Both the respondents that used blockchain technology in the supply chain to enable traceability, used the public blockchain. This was said to be more cost effective when adding in information into the blockchain.

"*Since we are using the public blockchain, it is very cost effective to add more information in the blockchain as well*" – B1

"*Now we are using public blockchain. It is kind of like… I usually say that we are blockchain agnostics, we can connect to any blockchain we want to be independent*" – F2

There was also mentioned private blockchains, and other actors within blockchain platforms such as IBM Hyperledger and VeChain. It was reported that some try to do a private blockchain, because they believe it to be more secure. However, the respondent stated that a public blockchain is more secure than a private blockchain.

> *"That is what many misunderstand, this with the public blockchain and private blockchain. Very many attempt to do private blockchains, such as IBM with food trust and VeChain, because they believe it to be more secure, but they are not, it is so false. A public blockchain is much, much more secure as it is public. That is the whole idea." – B1*

In order to access blockchain information about the history of a product that has been registered in the blockchain, both the relevant respondents reported that they used QR codes at the packaging of their products. When you scan one of these QR codes, you will be taken to a page that is unique for each product, and here you will find information about the products and the different stages in the supply chain. These QR codes are unique to each single product, which also makes it difficult to counterfeit or reproduce.

> *"[We use] QR codes yes, among others, because this is the easiest… Then you will be taken to the landing page of the product. You will then get information about that exact package… When they scan the QR code, they will be taken to a landing page where the information is, and this is verified by DNV " – F2*

> *"You scan a QR code, then you get taken to what we call a 'digital product passport', which we just released. And what happens is that you come to this webpage that we create and this contains all the information that has been collected by all the actors in the value chain such as where it is from, where it has been produced, water temperature, how much co2, and everything the actors wish to share with the consumers." – B1*

One of the benefits of blockchain was reported to be related to being unable to tamper or change the information that is entered. This way, it is very hard to tamper with or manipulate the information that has been entered. Then it is possible to prove that the information

entered has not been tampered with along the way in the supply chain. QR codes are currently the most common method of marking products, and because these are unique, it is not possible for someone else to make another one. The QR code will then not have any history in the supply chain. If the QR code is copied and re-used, this will also be discovered as the QR codes communicates with the system every time it is scanned. Because of location tracking and time stamps each time the QR code is scanned, it will become apparent if the QR code has been scanned at the wrong time or place.

> *"The more people who participates in the value chain, who are registered in the blockchain, the harder to it is to cheat in the middle of this chain, because then suddenly you have products with no history or a fake history… If a product should have been delivered in Oslo, but then it is scanned and bought in Trondheim, then our system can see that 'No, this product doesn't exist in Trondheim, someone must have cheated with the QR code'… And when they are sold and scanned, they become inactive, so it cannot be used any other place either, so it is a smart QR code" – B1*

A common finding and theme among the respondents is related to blockchain is that it is very important to involve as many actors as possible in order to get the full effect of the benefits of blockchain, such as traceability abilities.

> *"Most the systems that exist today are only for the largest actors in the value chain, but with the help of blockchain technology and thanks to it being so cost effective, we can now involve all the actors in the value chain and get the whole value chain in on the same data layer, which enables us to have traceability, we can prove the quality and show sustainability… The more people that participates, the better it is for everyone, so it is like a network effect. It is the same as with Facebook in the beginning. Why should I join Facebook when none of my friends are there" – B1*

> *"The smallest user in our [blockchain] system only needs a smartphone" – B1*

> *"As a small actor, it is about how many you manage to involve in the value chain, there are large shipping companies, freight forwarders, and transporters that you need to get*

involved in order to get a full effect of things… It is absolutely crucial to get the other actors involved ." – F2

When asking the respondents for what type of incentives there are for the other supply chain actors to get involved and provide correct information into the system, it was reported that it was important to create value for all of the actors in the supply chain. This can for example, as reported by one of the respondents, be through smart-contracts by using nano-transactions in order to reward actors for sharing data.

"In the public blockchain, you can make nano-transaction, very small payments, such as a tenth or a hundredth of a cent, which makes it possible to start monetizing information. We can put a price on a certain temperature, a location, or weight, which indicate track and trace… The logistic companies today does not make any money on logging temperature or location. The have temperature sensors, but these are primarily manual, which you put down using pen and paper. With help from blockchain technology and nano-transaction, we can build a system which makes it possible to sell this information about temperature or location, all the time." – B1

"We are concerned with value creation in the whole value chain, because we believe that in order to make a good product, everyone must participate. It is important to take care of everyone in the value chain, because if the truck driver doesn't care about his job, then he has ruined everything, then it doesn't help having good administration." – F2

In regards to the process of information can be assured to be authentic, a respondent talked about how it is possible to use certificates, and by using blockchain and other processes, these certificates can be made digital.

"It is about giving the products a certificate, that easy, a verifiable digital certificate that the goods are treated as we claim, and this is where we use technology to speak for us instead of us as a brand saying 'This is how it is, just trust us'… In the form of blockchain and various other processes can we, actually for the first time in the

history, use the technology to speak for us and can actually verify this in a real way"
– F2

The other respondent had also similar statements regarding that blockchain technology can prove product quality, or at least trust that the information stored about the product has not been manipulated. By using something called a smart digital twin, a digital twin of the fish is created onto the blockchain, and the ownership of this twin will follow the physical fish in the blockchain as the ownership of the physical fish is transferred.

> *"We have something called Digital Smart Twins, which is when we take a physical object such as a fish, and then we make a digital twin of this. Then it is the one who created the digital twin who owns it and the fish, so if you sell the fish, will the digital twin follow, the ownership of this will be transferred in the blockchain, so you will always get ownership of the digital twin when you get ownership of the physical object, and then you will get documentation and information the whole way in the blockchain." – B1*

However, it was stated that blockchain can never verify whether the information in the blockchain is true or correct, but it is capable of assigning responsibility to the data. This is because the participants must use a digital signature when entering information to the blockchain. This creates incentives for entering correct and true data, as the source of any incorrect information will be apparent, and thus the quality of data will increase.

> *"The blockchain can never verify if the information is true, but what it can do, is that one need to sign for all the information that is entered. In that way you are responsible for the information that you enter and then the quality of information will be increased automatically." -B1*

One respondent that did not use blockchain technologies speculated around for what type of companies it could be beneficial for. The respondent believes that blockchain could be a part of the strategy toward building a premium brand around a product.

"A part of the strategy of getting there [building a strong brand], and then perhaps blockchain can be relevant, and that is that the premium product you have presented, it is not just salmon, it is our salmon, real arctic, among ice mountains and polar bears. That is something you can build a brand about. And then this could perhaps be actualized. Today, when you are over there, it is sort of a culture to get margins, and being half-honest about the way you present a product." – F1

5.5 Challenges

There was reported to be several types of challenges regarding supply chain, blockchain, traceability, and the Chinese market.

5.5.1 Supply chain challenges

The challenges that has been found in regards to supply chain are mostly related to maintaining a low and stable temperature throughout the supply chain in order to maintain the quality and freshness of the salmon. Especially during the air transportation phase, at airport terminals, there are serious concerns regarding whether the fish being stored in cold terminals and storages. These concerns are especially prominent when the fish has either arrived at the Chinese airport or is at an re-distribution terminal in an intermediate country. All relevant respondents reported this to be a challenge. It was also reported by a respondent that delays due to cancellation of flights, especially in combination with other delays, was a challenge as well.

"We are usually not very concerned for the fish at Gardermoen, because mostly, they have good control. But when the fish is in transit, either in Doha or Istanbul, or in countries that might not have good facilities, or they are very busy, then we cannot guarantee for the customer that the fish is safe. Every time there are delays, we ask the freight forwarder if they can guarantee that the fish is being kept cool, they all say yes, no one says no. But it is not easy to get confirmation. I have asked for pictures before, but that was not possible to get." – F3

"They have so-called cooled storages, but the doors can be open and there are 30-40 degrees outside, things remain standing at the airstrip, you can mention plenty [quality challenges]." – F2

"The things that can happen under transportation is that cases can break, and there has been complaints about too little ice when it arrives. Things could happen, perhaps the fish has been left standing in transit in Doha, and has been left on the landing strip for five hours without a cooling hood, but there hasn't been a lot of these incidents, it is not a common problem" – F1

Maintaining the cold chain was reported by one respondent to be especially challenging in China because of the covid test policies for imported seafood.

"There are new things that must be in place in China when things are being imported. This includes listings, disinfections, covid testing the products and packaging. When this is performed, the tests are ok, it is approved to be taken further. But this has resulted in things take much more time, and the danger for fish to thaw or there are variations in the temperature, has been a challenge lately." – F2

However, there are not only challenges outside of Norway, there are bottlenecks locally as well.

"We are good at blaming foreign countries, but there are challenges in Norway too related to maintaining the cold chain." – F2

Another challenge related to the supply chain include low negotiating power compared to the large transportation providers such as airline companies. It can for example be difficult to negotiate compensation for spoiled goods or set the terms for agreements. It is also not easy to get any confessions from anyone in the supply chain if something happened. It was reported that a large quantity of orders made would have made it too time consuming to negotiate compensation, unless there are very significant delays on a large quantum of fish.

"It is not easy to get a confirmation... The airplane company doesn't care, they say the fish always is in a cooling terminal, the fish is safe, and they always have good excuses for delays. It is not easy to negotiate complaints with the airplane companies. In one week I could have 100 orders, and I don't have time to use that much time on these things. In most cases we compensate our customers without much discussion. But if there are major delays, then we must... Then we are thrown to the insurance company straight away by the airline company" – F3

"Then we have to try to trace the product back to Norway, you will never get any confessions from anyone." – F2

"There are large shipping companies, freight forwarders, transporters, that you need to involve to get the full effect of things. And it is not always very easy to get information, even for the large actors [in the seafood industry] apparently, from the largest transporters." – F2

The findings in relation to supply chain, include opportunistic and unprofessional conduct by some, often smaller, importers in China. This include late payments, mislabeling and underweighting of fish.

"There are many small customers who doesn't pay in time... If someone make wrong labels, because some importers, especially ones that sell little, when they see the market price drop, perhaps they do not manage to sell the fish in time, and then they will replace the label. They make a new one with a new package date." – F3

In regards to the shift to e-commerce, one of the respondents highlighted one of the challenges with e-commerce. It was reported that it is not possible to see who is responsible and behind the products on a website. In a physical store it is possible to hold people accountable, converse with a sales person, and it is easier to get in contact with someone if there are anything that is unclear.

"The thing about e-commerce is that you cannot see who is behind, and the more important is it with documentation. In a physical store you can hold people

accountable then and there because you exchange a conversation and it is easier to contact someone for things, but with e-commerce there is a lot of phone, people you don't see, so it could be anyone." – F2

Lastly, it was reported several issues regarding *trust*. These issues include both Chinese consumers and supply chain actors. There was found evidence that Chinese consumers have low levels of trust, especially toward the domestic food supply chain due to many national food scandals. Some consumers would only trust certain supermarket chains.

"They go to X supermarket to buy, because they do not trust other supermarkets" – F3

"The Chinese consumer conduct an incredible amount of research, probably because they are nervous in regards to what they buy. Norwegian consumers have a much greater level of trust, but they [Chinese consumers] do not have great levels of trust, and therefore they do all the research they can, they check all possible channels." – F1

Among the supply chain actors, it was reported that some, especially smaller ones, would re-label the fish with new production dates, some packing plants would underweight the fish. Therefore, the different actors within the salmon industry in China will exchange this type of information on group chats, as a warning to anyone else considering doing business with these actors.

"Seafood Guide made a group chat that invited many importers and exporters, and a good share of wholesalers to the same group. That is a good platform where people can talk about bad things. For example, if a customer doesn't pay, then he will named in that group and notified 'this person has not paid us, you others need to be careful'. That is a very good function… If someone make wrong labels… They make a new one with a new package date. This is not allowed, but when they get caught, they will also be sent to the group chat" – F3

Lastly, in relation to the import requirements, as previously mentioned, it was found that cold chain products such as seafood must be covid tested and disinfected before leaving the airport. However, they do not receive any documentation of this. Therefore, despite knowing that the fish is safe, it is required to be tested at a third party. This is due to some storage facilities requiring this or the end-customer requires this documentation.

> *"So that means the customer is certain that the products are safe, but does not have papers for this. So then they need to get a third party to test it one more time for covid. Because some customer has own storages, but some does not have their own storages, and they need to send it to a shared storage facility, and then they need to deliver a covid test before they can deliver it to the storage. But the customers that do have their own storages, they also need to have the covid tests, because perhaps their end-customer requires it… One shipment is 161 boxes, and these are distributed to maybe 20 customers, and they have different requirements… Some customers are retail stores, and these are even stricter, so they need all the documentations in order. So this is a challenge. From the fish is sent to the customers storage until it is delivered can vary from 1-3 days"*

5.5.2 Traceability challenges

The challenges regarding traceability is to large extent linked to maintaining the cold chain. It has been reported that boxes of fish can be equipped with temperature and GPS sensors, but due to the very large volumes of fish being transported and that the fish is viewed more as a commodity, it is often too expensive to include temperature sensors with all the boxes.

> *"So what we have done is to use temperature logs in the boxes, but this is too costly if we put it into every box. So this could be a confirmation for us to track the temperature the whole way." – F3*

> *"There is technology that makes this possible, you should be able to put an RFID chip in each fish, men this is currently too expensive, but the technology exist." – B1*

The information that is put into systems is often recorded manually, but it is possible to connect IoT sensors or AI machine learning to reliably confirm the data. It does not help to have a digital system, it is still possible to manipulate it in various forms.

> *"Normal data tracking can be faked in many ways, the same for paper based documentation. It does not help that it is digital, many put electricity on the paper and believes this to be fine. What is exciting about blockchain, is that it is much harder to fake." – F2*

> *"And then you can connect various IoT sensors such as water temperature, oxygen level in the water, all important things, that today is often performed manually… The seafood industry today is very old fashioned and not digitalized, so that is something we help with when they come to our systems, then we help to integrate different systems, and help with put in new senders and IoT sensors." – B1*

There are also other challenges in relation to ensuring traceability across the supply chain. One challenge is to involve all the supply chain actors. However, this is not something that might desirable for all the supply chain members. The supply chain members close to the end customer might appreciate the flexibility of not implementing full traceability might offer. Also, the large actors within transportation such as freight forwarders and shipping companies can be reluctant to share or provide information.

> *You need to think about if it is desirable… There could be an actor when you are getting close to the end [of the supply chain] who says 'I don't want that, because then I lose my flexibility. I want to sell Norwegian salmon, but I would like to buy Chilean salmon also, because one week it might be half price'." - F1*

> *"… It is not always easy to get information, even as a large actors, I've heard, from the largest transporters. I don't believe people have the control they say they have" – F2*

"Every time there are delays, we ask the freight forwarder if they can guarantee that the fish is being kept cool, they all say yes, no one says no. But it is not easy to get confirmation. I have asked for pictures before, but that was not possible to get." –
F3

Another challenges that was found is that it is still possible to tamper with documentation, despite it becoming more difficult with introduction of systems such as Shanghai cold chain and other local cold chain traceability systems.

5.5.3 Political challenges

Many of the challenges related to the Chinese market involved political unpredictability and uncertainties. Often these challenges are also related to some other factors as well, but it is made more complex because of the political climate in China. These challenges can be very varied, and are often related to some other factors as well, but political aspects has a tendency to make the challenges more complex and demanding.

One of the challenges reported by the respondents was related to *market access*. It was claimed by several respondents that the political relation between Norway and Chins had been a challenge over many years. One of the respondents reported that they believe the incident when Norway awarded Liu Xiaobo with the Nobel Peace Prize still continue to be the source of several challenges regarding market access and relations.

"Customers were told by the Chinese customs, several of my customers, so it is confirmed, that import licenses is not given for more than 30 tons per license. When they customer are going to buy the fish, they have to apply for import license, and there it is stated a quota, from some tons to some thousand tons, completely freely. Now, this week, we were told there is a very limited quota on the import licenses. We were not officially informed of this or why. We believe it may have something to do with the Nobel peace prize, again. So this is a big problem, and can become a very big problem, if the same happens as back in 2009, when Liu Xiaobo received the Nobel prize… These are political problems" – F3

Another political challenge was related to the instability of the market, often believed to be related to political issues.

> *"The 'propaganda' was in the media, it turned into a big fuss and it was difficult to handle" – F2*

> *"Other market trends includes instability, so when there is a claim that Norwegian salmon was the cause of a covid outbreak, it becomes unstable. Suddenly the authorities can come with demands that turns your everyday life upside down from week to week, so it is a market which is politically unpredictable. Things happens, and spreads quickly. A story can spread like wildfire on social media." – F1*

In relation to the covid pandemic, the government and import authorities in China has implemented very strict import policies and procedures, which increases the amount of time and resources required to import products to China. This is a big challenge for fresh salmon, which has a shelf life of 16 days. Before the covid pandemic, supermarkets would only accept receiving the salmon before 50% of the shelf life time, which is eight days. Because of the strict covid policies, they have extended this to 12-14 days.

> *"But now during the covid pandemic, the fish must be checked. They have to inspect every shipment and perform a covid test… Before, the supermarkets would not receive fish after eight days, that is 50% of shelf life, but has extended this up to 12-14 days. That means that because of the new covid cold chain policy, the fish is not as fresh as before." – F3*

Many findings are reported to be described as either before, during, or after the corona situation. Another finding that was reported in relation to the covid pandemic, is that there is an increasing sense of protectionism and protectionist policies.

> *"Now we see a change through covid, that state and party has put more pressure on protectionism, which has increased the focus toward domestic production and own products." – F2*

"But still, factories in China has little experience with making VAP (value-added products) from seafood. Chinese factories has been good at making products for the foreign markets, but not so much for the local market. Therefore, authorities, after covid, been trying to motivate Chinese factories to make for and serve the local market." – F3

When asked about how fish can be verified to be of a certain quality, and especially sashimi grade (a standard that qualifies the fish for raw consumption), the respondent mentioned that a health certificate that declare the fish to be of sashimi grade follows the fish. However, the actors in China that process the fish, not necessarily follows this standard in their production, and that this is something Chinese authorities might focus more toward going forward.

"I don't believe that all factories in China that has sold sashimi, and that has been a processing actor in China, necessarily has been sashimi grade in the production. So it can probably happen that the Chinese authorities tighten in a bit for those who serve that [sashimi] market, that there are additional requirements for cleaning and that they can actually operate with raw fish that doesn't make the consumer sick." – F1

6.0 Discussion and analysis

In this section of the thesis, the author will discuss the findings from the semi-structured interviews in relation to the topics explored in the literature research. The results of the discussion will be categorized and summarized.

6.1 RQ1: What is the structure of the seafood supply chain from Norway to China?

Looking at the information available using online sources and literature, it is possible to identify and describe general value and production chain for this industry. There is especially an abundance of information regarding the production process of producing farmed salmon.

However, the supply chain from production facilities to the long distance markets is less documented in the literature. This could perhaps be due to variations in the supply chain strategy from one market to another, or between companies.

In order to assess the typical supply chain route from Norway to China, it was imperative to get insight from different actors within the Norwegian seafood industry that had knowledge of and experience from the Chinese market. The interview findings provided the author with this specific knowledge, and it was possible to describe the supply chain structure from the Norwegian producers to the Chinese consumer.

There is a variety of descriptions of the salmon production chain provided by the seafood companies at their websites and in business reports. Therefore, the primary research conducted by the author focused more in-depth on the supply chain processes that occurs when the fish is exported to China.

A typical salmon supply chain starts with broodstock that produce row. This row is then hatched to fry. The fry is fed with feed optimized for salmon production, made from a variety of raw materials. After 1,5 months, the fry goes through a smoltification phase, a phase when the fry goes from living in fresh water to living in salt water, and then the fish grows until it is 100-250 grams. This phase takes around 6-12 months. Then it is transported by well-boats, boats that are specifically designed to transport live fish, to the fish nets, also known as the farming facilities. Here it will grow until it reaches a weight around 4-5 kg and this process takes between 14-24 months, varying on the size of the smolt when it arrives. The fish is now ready to be harvested, and well-boats will transport the fish to the production facilities for slaughtering, processing, and packaging.

From here, the fish is usually transported with cooled trucks. If the fish is going to the European market, it is transported with trucks to the market. However, if the fish is going to a long-distance market, usually the fish is transported with trucks to airports for export. Frozen seafood can also be transported with ship, because it has longer shelf life.

The airports are usually larger airports, such as Gardermoen, but the specific airport vary based on capacity and geographical location of the producer. The fish is then delivered and received at a cooled airport terminal. From here, it can either be placed on airplanes on direct routes to China, but most commonly, the fish is transported on a route that includes an

intermediate country. For example, Qatar Airways has many daily flights to the airport in Doha. This was reported by the respondents to be a very common intermediate airport. However, the intermediate airports could also be in Europe. Depending on the airline, the fish is either transported with cargo or passenger airplane. From the terminal in Doha, the fish is re-distributed to other markets, such as China.

When the fish arrive China, is taken through the Chinese customs and stored at a cooled airport storage, waiting for the customer to collect it. However, due to covid-19, there has been implemented several strict procedures for import of cold chain products such as salmon. These procedures include that the packaging require disinfection and to test the products for covid-19 before the fish leaves the airport. From the fish arrives in China until it can be collected by the customer, it could take between 1-2 days because of the extra testing.

Despite having been tested and disinfected at the Chinese airport, the Chinese custom does not provide any documentation regarding these tests. Therefore, it is very often performed tests at third parties. This is because during the covid pandemic, many customers or shared storage facilities require documentation that the product test negative for covid. The fish is transported by truck to a cooled storage for sorting and further distribution.

Up until the this point, the structure of the three supply chains that has been examined has been relatively similar and following the same route. For two of the supply chains, the fish change ownership when the customer collects the fish at the airport in China. These customers are primarily wholesalers and importers that buy a large quantum. The wholesalers will distribute and sell the fish to the HORECA market, to retail stores such as supermarkets, or to a processing company that will further process the fish, before it is sold to retail stores.

The third supply chain control the value chain in China as well. Through establishing a sister company in China, they import the products themselves. The fish is transported to their main storage facility by truck. From here, the fish is distributed to other smaller strategically placed storage facilities they rent. This is to be able to quickly fulfil orders in whole China. Last mile delivery is performed by a third party, and is performed in various ways, and is delivered to the customer's residence.

The typical supply chain for Norwegian seafood has been mapped and is illustrated in the swim-lane diagram below. The timeline is organized to be displayed horizontally.

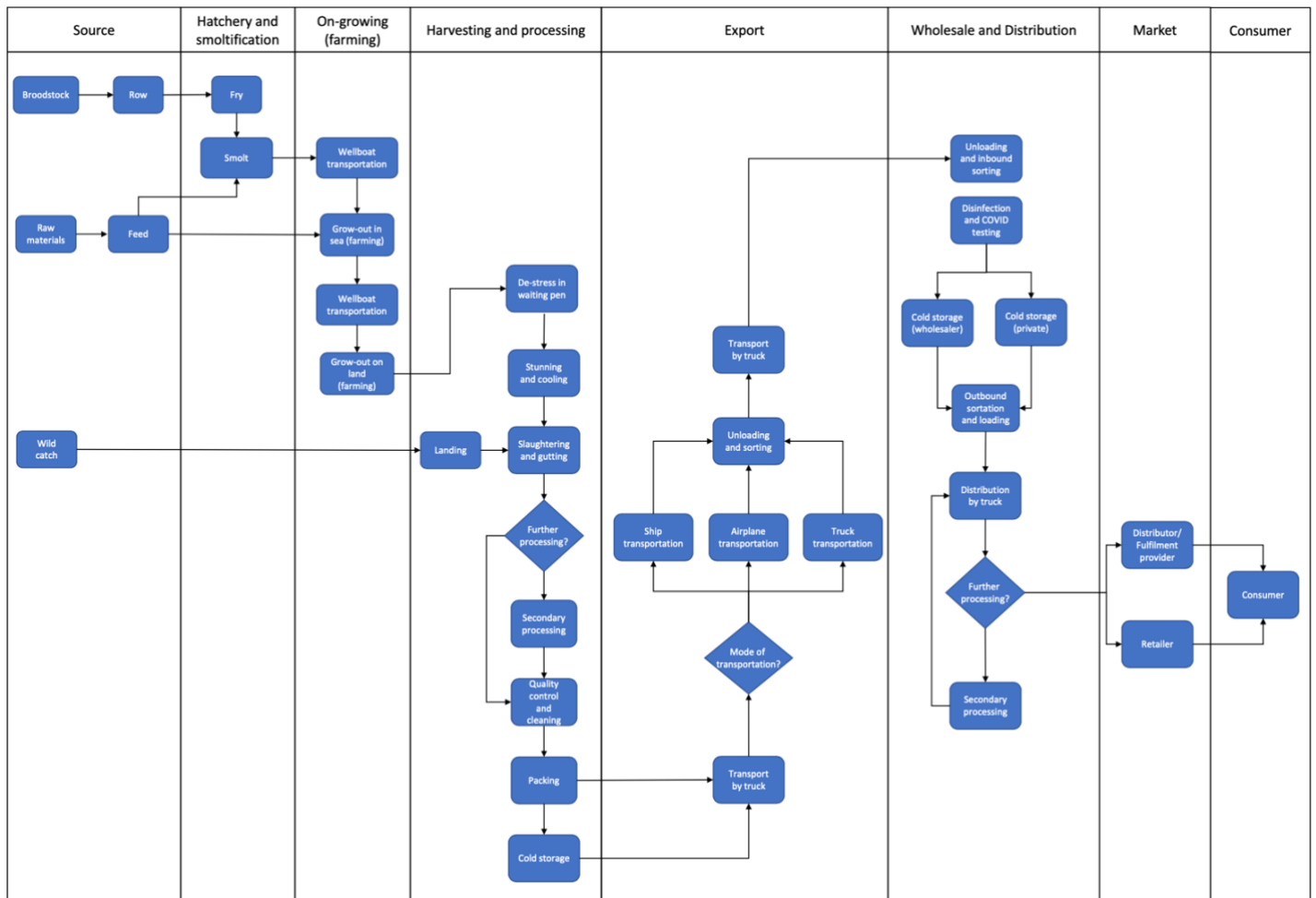*Figure 4: Supply chain of Norwegian Seafood to the Chinese market*

6.2 RQ2: What challenges is Norwegian seafood faced with in the Chinese market?

Through the primary research and an analysis of the information provided by the semi-structured interviews, it was identified 14 clear challenges in total. Table 3 below summarizes the challenges that could be identified in the "Findings" section.

Area	Challenge	Description
Supply chain	(1) Low power	Obtaining information from the large actors within the transport industry such as airlines and ships, is a challenging task. If there are delays or there has been any issues during the transportation phase, it can be difficult to negotiate compensation or get confessions regarding whose responsible. Due to large volumes that is being transported, it is time and resource consuming to negotiate compensation.
	(2) Cold chain control	Maintaining control over the cold chain can be difficult during the transportation phase. Especially when the fish is in transit in an intermediate country or is waiting in transit in China. This is because it is difficult to get definitive confirmation that the fish is stored correctly, and therefore correct handling cannot be guaranteed.
	(3) Shift in sales channels	The shift from traditional offline retail to online retail is accelerating due to covid. Due to the nature of e-commerce there is a lack of transparency in regards to who you are dealing with. It is also more cumbersome to contact someone in regards to any issues.
	(4) Delays	The fish is transported by air the majority of the distance, and often with several airplanes due to intermediate landings. Because fresh fish is perishable, delays will shorten the time the fish can be sold in the stores. Delays also make it more difficult to confirm that the fish is stored correctly

		and the amount of ice in the boxes might not be sufficient to maintain the low temperature.
	(5) Opportunism	Some actors, often the ones that sell little fish, will make new labels with new package dates in order to sell the fish. Package facilitates may underweight the fish. There are also many smaller customers that do not pay in time.
	(6) Trust	Chinese consumers have low levels of trust toward the domestic food supply chain, and engage large amounts of research before purchasing, likely because they are nervous in regards to what they buy. Stories in the media can also create distrust on an incorrect basis.
Traceability	(7) Participation	It may not be desirable for all supply chain actors to implement full traceability, especially actors close to the end customer. It can also be difficult to involve the largest actors within transportation to share information.
	(8) High cost	In order to track various processes, it is can be applied different technologies, but it was reported by several respondents that it is currently too expensive to track all units.
	(9) Manual input	The seafood industry was reported to be old-fashioned and not very digitalized, and the input of data is often performed manually.
	(10) Tampering	It was reported that despite improving the traceability aspects, there was still possibilities of mislabeling.
Political	(11) Policies	There has been introduced new policies due to the covid-19 pandemic, especially for cold chain import, which includes seafood. This creates logistical challenges in the supply chain. These

		policies include covid-testing, disinfection, and new requirements regarding health certificates from Norway. This has increased the time it takes to import seafood, which is critical for a perishable products such as fresh seafood. Additionally, it was believed the government policies would become the driver of full traceability.
	(12) Market access	Norwegian companies has since 2010 struggled with market access to China due to political issues related to the Nobel peace prize awarded to Liu Xiaobo in 2010. The relations have been to a large extent been normalized, but it is believed that this issue still continue to be a source of challenges related to market access.
	(13) Unpredictability	The Chinese market can be very difficult to handle due to authorities suddenly changing policies. It was also believed that stories spread in the media may have political motives that causes the trust toward Norwegian seafood to decline.
	(14) Protectionism	It was reported numerous times in the findings that protectionism is increasing and the Chinese government is attempting to motivate domestic companies to produce for the domestic market. It was also expressed that this production will focus more toward VAP and stricter policies related to the quality of such production.

The challenges identified through the primary research, that relates specifically to the Chinese market, seem to be quite consistent with the what has been described as general challenges in the literature research section previously.

As described in the literature review, China has been plagued with several high profile food incidents during the recent decades (H. Kendall et al., 2018). Trust toward the domestic food system has declined and several consumption trends has emerged. One of the largest trends is "health", and this is especially prominent in regards to food (McKinsey & Company, 2020). This trend was also confirmed by the primary research. This has also resulted in an increasing trend of emphasizing product attributes such as quality, safety and freshness when purchasing food. Concerns regarding these factors has been accelerated even further by the covid-19 pandemic in response to concerns about personal and family members health (McKinsey & Company, 2020).

6.2.1 Supply chain challenges

Challenges related to food trust was also emphasized by several respondents. In order to mitigate the low levels of trust, Chinese consumers would engage in large amounts of research before purchasing. It was reported among the respondents that this perhaps was especially prominent due to the shift from offline to online retail currently taking place. It was highlighted that due to the nature of e-commerce, it is not possible to know exactly who is responsible and behind the products that is being sold, and it is more difficult to hold people accountable. Therefore, it was reported that Chinese e-commerce websites would provide large amounts of information of the products, such as copies of Norwegian health certificates, covid tests, disinfection confirmations, videos from the stated origin, recipes, how it is made etc.

The challenges associated with the Shanghai cold chain traceability system involves the additional time it takes in order to perform covid testing and disinfection. These procedures are import requirements, and documentation, such as the Chinese health certificate, must be uploaded to the system. As reported in the findings, these processes must be performed two times, once at the airport while in the custody of the customs, and because there is not provided any documentation that these tests has been performed, the importers or wholesalers must test the fish one more time at a third party. This was reported by several respondents to be a great challenge. Fresh salmon has a shelf-life of 16 days, and because of these strict import policies, the fish is required to wait at the Chinese airport while waiting for the tests. This could take 1-2 days. After this it must also be tested by a third party. This reduces the freshness of the salmon and it must be sold in a shorter amount of time.

These extra procedures leaves less room for time margins, and if there are any delays, such as cancellation of flights, there is a risk that the fish will have short shelf life when it finally reaches the retail store or restaurant. It was also reported that when there are delays, such as if there is a flight cancellation from Doha to China, it is more difficult to guarantee that the fish is stored correctly in a cooled storage. If there are any incidents occurring in the transportation phase, it was reported that it is difficult to negotiate compensation or get any confessions regarding whose responsible.

6.2.2 Traceability challenges

While the literature focused on mislabeling in terms of substituting fish species (Xiong et al., 2016) for financial gain, findings from the interviews did not find any support for this to be a great challenge. However, it was found that mislabeling challenges for Norwegian salmon included actors replacing labels in order to assign the fish a new production date. This was performed in order to sell the fish as fresher than it actually is. It was reported that it is fully possible to switch out the content of boxes with other fish, or make new labels for the boxes. Importers and wholesalers are very professional at recognizing fake labels, but at the retail stores, they are not as professional at recognizing labels, so therefore it was possible to use fake labels when selling to retail stores. It was however also reported that fake labels was becoming less common in the market.

The desire for information has also become more apparent during the covid-19 pandemic. As a result of the pandemic, according to one of the respondents, the government has launched a type of cold chain traceability system locally in large Chinese cities. For the Chinese suppliers, it is required that they upload information such as origin, supplier, copies of health certificates, covid tests, disinfection test and more. This information is accessible for consumers by scanning a QR-code that has been made by the retail store. It was also reported by the respondent that despite the stricter policies, it is still possible to tamper with the documentation at the retail store. An example was that for a supermarket that buys two boxes of fish from two different suppliers, it is only necessary to print one QR-code and it can be used for fish from both of the boxes.

The findings regarding the cold chain traceability systems that has been implemented the large Chinese cities were unexpected, as this had not previously been reported in the

literature researched. The implementation of this food traceability system is quite recent, and has perhaps therefore not been widely documented.

While it was reported that the Hu Leng Lian (the Chinese pinyin name for the cold chain traceability system in Shanghai) was an improvement in regards to traceability, it was stated that the system needs to be better. This is because there are practical challenges related to using this system, such as double-testing and the time it takes to import the products.

It was also reported that it may not be desirable for all supply chain actors to implement full traceability, as this will provide less flexibility for these actors. This may perhaps be especially applicable for actors close to the end customer. This flexibility can be interpreted to be, as reported by respondent F3, that some actors may replace the labels in order to print a new production date on a new label. Another flexibility aspect can perhaps be, as reported by respondent F1, that they may purchase Chilean salmon for half price one week, but still wish to sell this fish as Norwegian salmon. Regarding the large transporters, such as freight forwarders, they are often hesitant to share information, and because the negotiation power towards these is assessed to be relatively low, it can be difficult to involve these actors.

Another challenge of implementing full traceability from producer to end customer, is that it currently is too costly, as most of the salmon sold is sold as a commodity, and there are low margins. If data is entered manually, it is receptive to errors or manipulation, therefore it is required to equip the boxes with IoT, RFID, or other types of sensors to get objective data. It was reported that this has been attempted, that the technology exists, but currently it is too expensive to implement.

6.2.3 Political challenges

There was a wide consensus among the respondents that political challenges remains as one of the major challenges. Despite being categorized as a political challenge, these greatly affect logistical aspects of the supply chain and becomes logistical challenges as well. Here, the challenges revolved around different policies, market access, unpredictability, and increasing protectionism. The perspective toward domestic production and the domestic market was reported in the literature research by McKinsey & Company (2020), and was supported by the findings from the interviews.

The other political aspects were less documented in the literature, such as the Norwegian market access to the Chinese market and the changing policies. As mentioned by one of the respondents, they believed that the sudden changes, such as the sudden reduction of the import quotas, to have some sort of political motives. It was believed that this could be related to the incident in 2010 when Liu Xiaobo received the Nobel peace prize, but this is never officially confirmed by the authorities. The economic sanctions imposed on Norway since 2010, such as restricting import of Norwegian salmon, has however been confirmed by literature after finding strong evidences supporting the existence of these (Chen & Garcia, 2016).

Changing policies, such as the very strict cold chain import policies was also reported to be a very big challenge. This is because the new import procedures requires more time, and this is a critical aspect, as fresh salmon is perishable and only has a shelf life of 16 days. The extra time required to perform the double covid testing and disinfection makes the salmon much more vulnerable to additional delays that may occur in the supply chain.

6.2.4 a) Which instruments can be implemented to meet the challenges identified in RQ2?

It has been proposed by several sources in the literature and by respondents in the semi-structured interviews that blockchain-technologies can improve many of the challenges related to supply chain efficiency and traceability. In addition, to facilitate the blockchain system, it has been proposed that IoT, sensors, such as RFID sensors, has the potential to function as a third party to increase the trust associated with the data that is being entered into the blockchain system. An advantage here is that blockchain would support interoperability between the different systems and technologies (Jæger & Mishra, 2020).

6.3 RQ3: How can blockchain technologies contribute to meet the challenges identified?

When examining the challenges that has been identified in RQ2, there are several issues that could be improved by implementing blockchain technologies. While not being the sole solution, based on the findings and the literature research, it is reasonable to believe that blockchain can contribute to be a part of the solutions that could solve these challenges.

Many of the challenges identified were to high degree overlapping or related to each other. Three of the most relevant challenges will be highlighted and examined in regards to how blockchain technologies can meet these.

In relation to political challenges, the author did not find any support for blockchain to meet the majority of these. However, when looking at the challenge *"policies"* it was reported in the findings that there has been implemented new import policies related to the covid-pandemic that require a higher degree of traceability. Therefore authorities has launched a cold chain traceability system, and it was also believed that government policies and regulations would continue to be a driver of the requirements toward full traceability.

As mentioned, the challenges identified are often overlapping, related and interconnected. This policy has created great logistical and supply chain challenges. Despite the Chinese government enforcing the implementation of some traceability, there were still some issues related to this. As reported, there was a need for testing the cold chain products two times, first while going through the customs at the airport, and then a second time at a third party. This is because documentation by the custom authorities was not provided after first test and disinfection. In addition, covid tests, disinfection documentation, health certificates and import documents need to be uploaded to the cold chain traceability system, especially for retail markets.

A unified system for traceability would have the potential to improve efficiency as documentation would not be required to be loaded repeatedly. As described in the literature, traditional electronic traceability systems often lack interoperability due to different database structures and a variety of standards for sharing information. This is a challenge for involving all the actors in a supply chain, as the systems would not be able to share information between them.

In order to create a unified supply chain traceability system, it could be possible to implement a blockchain based traceability system in the supply chain in order to ensure interoperability between systems, and this could potentially lead to the unification of systems. If all the documentation related to a shipment of fish could follow the fish throughout the supply chain, it would have been sufficient to upload the relevant documentation only one time. In the findings, it was stated that blockchain makes it possible

to get the whole value chain on the same data layer. This information can easily be transferred and become accessible for each actor until it reaches the end-customer. As reported by one respondent, the fish cannot be sold until all the relevant documentation is uploaded to the cold chain traceability system, and it is common that this becomes a bottleneck because of the additional time this requires in relation to complying with the cold chain import policies.

If all the traceability systems are able to share data and interoperability has been achieved, there is another challenge that was reported in the findings. This is the challenge *"participation",* which is the challenge of involving all the actors in the supply chain. The findings indicated that it is beneficial to involve as many of the supply chain actors as possible in order to get the full benefit of blockchain-based traceability. This is because the more actors that participate, the better effect it has for everyone. It was described as the same type of network effect Facebook has; why should someone join Facebook if none of their friends are there. Many of the systems today are only for the largest actors in the supply chain, but to achieve full traceability, it can be necessary to involve the smaller actors as well.

The challenge with *"participation"* is that not everyone in the supply chain might desire to participate and facilitate full traceability of the products. This could be for example because actors close to the end-customer would lose their flexibility, as described in more detail in the section describing the challenges. Or perhaps if the truck drivers do not care about doing their job well, then they can ruin everything, despite having good administration and conduct in the rest of the supply chain. It was also reported that it is a difficult task to involve the larger transporters. It is difficult task to efficiently involve many actors, there are no incentives as they currently do not make any profit from sharing data.

It was reported that in the public blockchain, it is possible to make nano-transactions, very small payments, such as a tenth or a hundredth of a cent. This was mentioned in the literature as tokens that are designed to incentivize actors to share data. This means that it is possible to put a price on a specific temperature, a weight, a location, which practically translates to track and trace. In a blockchain system, the nano-transactions can for example be automated by using smart contracts, IoT and sensors. Therefore, there are monetary incentives for the various actors to participate in the blockchain traceability system. Using the same

mechanisms, it is also possible to automatically "punish", get compensation, from the actors that might be responsible if there has been delays, quality issues or any forms of fraud.

A blockchain based system cannot itself verify the information that is entered is correct, but it was reported that it is apparent which actor is responsible for which information, which will increase the quality of information entered. It has been reported that Internet of Things technologies and sensors can be responsible for entering data automatically, which potentially can reduce errors and would function as an objective third party.

The final challenge that will be discussed is related to the aspect of *"tampering"* which is highly overlapping and related to *"opportunism"*. It was reported that despite the implementation of the cold chain traceability system in China, it is still possible to tamper with the documentation. It was also reported that it is a known issue to occur in China. The most common type of tampering was to replace labels and put on new labels with new production dates. As described in the findings, the respondents that sold large volumes to importers did not have any traceability after the fish was received by the importers and that it is not their responsibility in regards to what happens from there.

A public blockchain is immutable and transparent, which means that it is not possible to change or remove any information that has been entered, and that this information is visible and accessible. This makes it possible to "see" what previous actors have recorded, and that makes it possible to discover where false data has entered the system and who is responsible, because all information entered need to be signed with a unique digital signature that identifies the user.

 If a blockchain traceability system is implemented, the importer would have to account for where the fish with certain production numbers come from and where it goes, as it cannot move in or out of existence. The retailer that receives the fish can verify whether the fish with a certain production date has a complete history in the blockchain, or if it has just suddenly appeared out of nowhere without complete records.

It has been proposed in the literature that a method known as "mass-balance reconciliation" can be performed in order to detect fraudulent activity. This works by using a unique identifier, such as a QR code, to ensure that the fish associated with a certain QR code never exceeds the input amount recorded at the start of the supply chain. As it was described in the

findings, if receiving two boxes of fish from two different producers, it was only necessary to print one QR code that could be used for both. By using the same QR code for both boxes of fish, the amount associated with that QR code would exceed what was recorded on the blockchain.

For example, a 6kg salmon is marked with a QR code when it is being harvested. This QR code is uploaded to the blockchain and represent the fish digitally. As the fish moves downstream in the supply chain, being traded and processed, the unique QR will follow the fish. At no point should the total weight associated with that unique QR code exceed 6kg.

When the fish is received by an importer or retailer, it would be nearly impossible to either re-use QR codes, as this would exceed the 6kg associated with that QR code, and it is impossible for them to make new QR codes, as these QR codes would have no history or records in the blockchain, which would be visible for their potential customers (such as a retailer) to view and access in the blockchain.

7.0 Conclusion

Following the outbreak of the covid-19 pandemic, policies and requirements regarding food safety, traceability and import are changing drastically. The exact origin is believed to be a seafood market in Wuhan, China, and has been highly associated with cold chain import products. Due to these recent events, this thesis addresses several highly relevant issues in regards to food supply chain, traceability, Norwegian seafood and the Chinese market.

The research objective of this thesis has been to identify supply chain and traceability challenges faced by Norwegian seafood in the Chinese market. In addition, it has been the authors aim to investigate how blockchain technologies can meet the challenges identified.

In order to address the research problem, there was performed five semi-structured in-depth interviews with industry experts within seafood export, China, and/or blockchain. In addition, there has been collected secondary data throughout the literature research. The

primary data that was collected was transcribed and functioned as the basis of the qualitative data analysis.

The findings were structured by five different categories; supply chain, the Chinese market, traceability, blockchain, and challenges. The various findings were first described, then supported and proven by providing relevant quotes from the respondents as evidence.

The discussion section was organized by the various research questions. Here, the primary research findings were related- and compared to the theoretical research in order to elaborate on the findings in relation to the research questions. The research questions were answered by using a combination of primary research findings and secondary data.

The research found 14 challenges that Norwegian seafood was faced with in the Chinese market, categorized by three different areas; supply chain, traceability and political. It was also assessed that blockchain in combination with IoT and sensor technologies could improve many of the challenges identified.

In relation to the main research problem, three of the challenges were further examined in regards to how blockchain technologies could contribute in meeting these challenges.

The first challenge involved *"policies"* as there recently has been introduced new import policies and a traceability system in relation to cold chain products, such as seafood. This has created great logistical and supply chain challenges such as increased import time, more documentation and covid test requirements. It was found that a blockchain-based traceability system would have the potential to improve efficiency by ensuring interoperability between all supply chain traceability systems, so that documentation would only be required to be uploaded once for each shipment of fish.

When interoperability has been actualized, there is another challenge with *"participation"* as full traceability might not be desirable for all supply chain actors. With a blockchain system, it is possible to monetize information sharing through nano-transactions and smart-contracts. This would create incentives for supply chain actors to comply with traceability.

IoT and sensors could function as an objective third party that verifies and increases the quality of information uploaded to the blockchain system.

The last challenge to be examined in relation to blockchain is *"tampering"*. This involved mislabeling, replacing the old labels with new ones with a more recent production date. Here, it was found that a public blockchain traceability system could be implemented, as this increases the transparency and trust for all supply chain actors. This is because every actor must account for when and where the fish comes from and where it goes. "Mass-balance reconciliation" in combination with blockchain systems and a QR code, has been proposed as a method to ensure that the total weight associated with a certain QR code never exceeds the original input value. This would also make it impossible to re-use QR codes as an identifier for authentic fish on the blockchain. It would also be impossible for a downstream supply chain actor to make an authentic new QR code.

In conclusion, blockchain technologies has due to its unique characteristics, such as interoperability, immutability, and its nano-transaction incentives, the potential to meet many challenges related to supply chain and traceability of Norwegian seafood in the Chinese market. Consumers are demanding more and more information regarding what they consume; if it is safe, if it is healthy, if it is sustainable and if it is ethically produced. Blockchain is perhaps not the sole answer, but it is believed that blockchain technologies will have a key-role in providing trustworthy information, traceability and transparency in the global supply chain in the years to come.

8.0 Limitations

The primary research conducted in this thesis was based on interviews with experts within Norwegian seafood, the Chinese market and/or blockchain technologies. Two of the respondents sold the fish to Chinese importers or wholesalers, while the third respondent remained in ownership of the fish until it reached the Chinese end-consumer. One limitation of this research is the lack of nuance and perspectives. Each of the respondents may be less

critical toward their own conduct or practices, or perhaps they do not desire to share negative information as they may believe it is not be in their best interest.

Furthermore, it would have strengthened the research if there had been conducted interviews with other supply chain actors, such as representatives of transportation companies, Chinese wholesalers/importers and Chinese retailers. This would perhaps have provided additional insight in relation to what is considered to be a challenge, or to what extent blockchain could meet the challenges identified.

Due to time constraints there was conducted five interviews, but it would have been beneficial to conduct more interviews, especially related to blockchain. However, scheduling, conducting, transcribing, and analyzing the interviews was more time consuming than first anticipated, especially as the time duration of the interviews had a tendency to continue for longer than estimated.

9.0 Suggestions for further research

As previously stated in the limitations, it would have been advantageous to include more supply chain actors in the primary research. Therefore, it is suggested that future research investigate the perspective of actors such as Chinese wholesalers/importers, and to what extent it is desirable for these actors to implement blockchain traceability.

In addition, it has been stated and claimed in this thesis that blockchain has the potential to incentivize supply chain actors to participate through nano-transactions. It is therefore suggested to further research if these incentives are enough to encourage blockchain traceability participation, potentially, how strong should the incentives be, what is the value of such data. Would it be sufficient enough to outweigh the perceived benefits of not participating. Future research could also attempt to quantify the costs and benefits of implementing blockchain-based traceability in a seafood supply chain from Norway to China, including the cost of incentivizing supply chain actors by using nano-transactions.

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11.0 Appendix

11.1 Interview guide

Introduction	
I am a final year master student in Logistics with specialization within supply chain management. At the moment, I am writing my master's thesis about how blockchain-traced seafood can mitigate fraud and cheating in the food supply chain through non-manipulative documentation, and how this can provide better control for consumers, suppliers and authorities. Therefore, I wish to map the structure of the supply chain from Norwegian fjords to Chinese tables, which challenges is experienced in the Chinese market, if there are any challenges in the supply chain – potentially where, which demands customers and consumers have, and how to solve potential challenges.	
Area	**Question**
Background	Tell me about yourself: what do you work with and what position do you have?
Supply chain	Can you tell me about your supply chain and the products you sell?
	How long time does the fish use from Norway until it is ready for the Chinese consumer?
	Which IT-systems do you use in your supply chain?
Challenges	What market trends do you experience with export of seafood to China?
	Can you tell me a bit about the challenges you have experienced in the Chinese market?
	How is the trust and attitude toward Norwegian seafood in China?
	Do you know about any incidents where other, competitors, has been involved in issuing wrong documentation or any other quality problems with fish sold in China?
	How can the consumer assure that the fish has the stated quality and origin?
	How do you ensure that other actors in the supply chain handle and sell your fish in accordance to agreements or established standards?

	How do you ensure that other actors in the supply chain sell other fish under your brand name?
	Do you get information and feedback directly from the consumers?
	Are there any challenges related to e-commerce sale of Norwegian seafood in China?
Traceability	Do you have systems for product tracing?
	How can the end customer trace the product up-stream?
	How is product information made available for the end customer?
	Which aspects drives the development and implementation of full traceability?
Blockchain	Can you briefly explain the type of blockchain that you use?
	Do you experience that blockchain-traceability is something the consumers desire?
	Which incentives do supply chain members have to implement blockchain-based traceability solutions?
	What type of companies has the greatest basis for implement a blockchain-based traceability solution?
	What do you experience is the biggest challenges for a blockchain-based traceability solution for seafood?
	What types of technologies, equipment or instruments can facilitate a blockchain-based traceability system for best utilization?
	Compared to traditional digital traceability solutions, what advantages has a blockchain-based traceability solution?
	Would a blockchain-based traceability solution have greater benefits with e-commerce than in physical stores?
	Are there any phases in the supply chain that is more critical to use blockchain or automated documentation systems than other?