LUISS

Department of Business and Management
Master in Management

Course of Creative Industries and Business Model Innovation

Blockchain in the Seafood Industry: An Assessment of Adoption in The Norwegian Seafood Supply Chain

Prof. Nasta, Luigi
SUPERVISOR

Prof. Zattoni, Alessandro
CO-SUPERVISOR

755941
CANDIDATE

Academic Year 2022/2023

Table of Contents

List of Figure:

List of Tables:

Acronyms:

SCM – Supply Chain Management

IoT – Internet of Things

It – Information Technology

PEOU – Perceived Ease of Use

PU – Perceived Usefulness

P1 – Producer 1.

T1 – Transporter 1.

R1 – Retailer 1.

DOI – Diffusion of Innovation Theory

1.0 Introduction

"What happens when the generation Z starts buying fish?" were the topic at the Seafood Council cod fish conference (Kværnstuen, 2021). In the era of digitalization, the seafood supply chain has grown into a complex and global network that involves numerous stakeholders, from fishing and aquaculture operations to processors, distributors, and retailers.

Seafood is the largest traded food commodity in the world and provides sustenance to billions of people worldwide (WWF, 2023). Norway is the second-largest seafood exporter in the world and in 2022, the Norwegian Seafood Council reported that the country's seafood industry achieved record-breaking export figures, with a total of 2.9 million tons of seafood valued at 151.4 billion Norwegian kroner (Norwegian Seafood Council, 2023). These numbers have reflected an historic impressive growth in value, and the equivalent of 40 million meals per day throughout a year. An article from the Norwegian Seafood Council stated that the "Norwegian seafood is a robust trade good which are currently selling to 149 markets (Norwegian Seafood Council, 2023). The Norwegian government has recognized itself as a leading ocean nation with a prominent and highly competitive player in the global seafood industry. The rich coastline has not alone contributed to its success, but also being able to develop effective processes by taking usage of advanced technologies (Aune, 2021), (Norwegian Seafood Council, 2023).

Norway has gained a reputation as a country that faces up to its responsibility, continuously making improvements to increase the sustainability of seafood practices (Aune, 2021). Today, the trend is clearly highlighting sustainable practices in terms of traceability, transparency and accountability in order to reduce fraud and to promote sustainable business. In fact, IBM Institute for Business Value has released their latest report (Haller, Lee, & Cheung, 2020) where a global poll stated that more than three-quarters of respondents want products that are environmentally responsible.

These trends have roots in the unfair seafood trade linked to fish fraud and mislabelling fish. Furthermore, substitution of fish seems to be present mainly at the end point of the supply chain, more specifically in retailers, restaurants, canteens and food services, as a consequence of less stringent controls and of processing which makes the fish less recognisable (Christiansen, Fournier, Hellemans, & Volckaert, 2018).

Modern technology can create more effective and developed supply chains, as well as reducing the trust issues linked to a more complex global network. Blockchain technology is a controversial topic amongst scientists nowadays (Chen & Chang, 2020) as its features can be considered a key technology to stay on top of this trend (IntraFish, 2019).

Blockchain is most known as the underlying technology for Bitcoin (Swan, 2015), and was first introduced in 2008 (Nakamoto, 2008). In recent years, the technology has found various applications, including within the field of supply chain management (SCM) (Chen & Chang, 2020). Much research has been conducted on how the technology can increase traceability, transparency, and security around product origins. The use of blockchain technology in food tracing has also received considerable attention in the literature, where commodities such as fruits, meats, and seafood have been traced using the distributed database technology (Tian, 2016) (Yiannas, 2018). The pertinence of blockchain technology in the seafood industry is associated with the challenges it faces. Its trustworthiness is attributed to its decentralized structure, whereby it functions as a pool of information that adds block of information or transactions to the chain as more data is added to the network. Once added to the blockchain, the information becomes immutable and transparent to all parties.

Over the past four years, various Norwegian fish producers have implemented blockchain technology in their operations. For instance, Cermaq collaborated with IBM Food Trust and Labeyrie in 2019 (Kvile, 2019), while Norway in a Box has also adopted blockchain technology (Aadland, Fiskeribladet, 2019). Additionally, Lerøy entered into an agreement with Carrefour (Svendsen, 2020) and Atea is currently collaborating with IBM and Norwegian Seafood Trust in the Atea Globe Track project to track Norwegian farmed fish (Atea, 2020). Based on this initiative, a good example is Kvarøy Arctic, a Norwegian salmon-farming company, has successfully leveraged blockchain to enhance traceability, transparency and accountability in its supply chain (IBM, 2020). In a recent interview with The Ocean Economist (Ocean Economist, 2020), Kvarøy highlighted blockchain technology as one of the key factors that has helped the company become one of the most sustainable farms in the world of Atlantic Salmon. In June 2020, Kvarøy Arctic joined the IBM Food Trust (Aadland, 2019) to improve the traceability of its salmon. The blockchain network enables Kvarøy Arctic to provide specific data about its fish, such as their production location, diet, harvesting time, and processing and transportation information (temperature inside the carrier), thus enhancing accountability in its supply chain.

Moreover, the global seafood industry is also known for having several challenges, including illegal, unreported, and unregulated (IUU) fishing, diseases, salmon lice, escapes, and greenhouse gas emissions from transportation. This has led to a lack of consumer trust (Volini, Shah, Koch, & Moradian, 2019). In a report conducted in the United States, it was found that 20% of the fish sold is incorrectly labelled (Gibbens, 2019).

Current literature suggest that we are witnessing a digitalization and a significant transformation in consumer behaviour, characterized by a growing preference for transparency within the food industry. Concurrently, the adoption of blockchain technology in supply chains holds the potential for desirable consumer satisfaction and reducing fish fraud.

Political interventions are increasingly promoting the transition to a more sustainable supply chain. For instance, started from 01.07.2022, Norwegian supply chains are now required by the regulations from "The Transparency Act" (Norwegian Government, 2021) that retailers need to provide compliance information at the request of the public.

For Norway to maintain its leadership position in the global seafood industry, it is imperative that the seafood supply chain demonstrates agility in responding to market changes. Adopting blockchain technology by the entire range of stakeholders throughout the seafood supply chain is crucial to ensure its sustainability. Such adoption would enable the creation of a consistent, end-to-end product that carries the same bookmark throughout the entire supply chain, thereby providing the market with accurate information about its sustainability. For instance, enhancing blockchain technology by a single producer/processor which is the earliest stage of the supply chain, is insufficient, as the product must traverse multiple stages before reaching the end-consumer. This means that the entire supply chain needs to adopt the same technology in order for every stage to be tracked until it reaches the plate.

Sabari, (2018) identified four main categories of adoption barriers for new technology, which include intra-organizational, inter-organizational, system-related, and external barriers. Intra-organizational barriers include the lack of knowledge about blockchain technology, which is crucial for decision-makers in the industry. Inter-organizational barriers include the reluctance to share information among supply chain partners, while system-related barriers include the cost of integrating blockchain technology, which is related to the immaturity of the technology in terms of scalability. External barriers are from stakeholders, such as industries, institutions, NGOs, and governments. The lack of regulations and standards regarding traceability systems and information sharing through the supply chain is identified as an external barrier.

The purpose of this master thesis is to shed light on the advantages by adopting blockchain technology and the benefits it can provide in the supply chains for Norwegian fish. The thesis also places emphasis on the system-related barriers as the technology needs to be adopted by the entire supply chain in order to achieve maximum benefits. The current literature has mainly focused on blockchain at a producer stage. But the seafood supply chain involves multiple stakeholder, including fishermen, producers, processors, transporters, retailers, and consumers. Each stakeholder plays a critical role in ensuring that the seafood is harvested, processed, transported, and sold in a safe and ethical manner.

1.1 Research Question

Failure of all stakeholders in the supply chain to embrace a single traceability system, may lead to increased possibilities of fraud or unethical practices during the product journey. This is primarily caused by data gaps resulting from inconsistent utilization of the network among stakeholders, highlighting the need for uniformity in technology adoption throughout the supply chain to mitigate such risks. Therefore, it is crucial for all stakeholders to utilize the same network and adopt blockchain technology to ensure transparency and accountability in the supply chain.

Limited research exists on the adoption of blockchain technology within the different stakeholders in the seafood industry. Consequently, one main research questions were formulated to address the issue:

RQ1: What are the perceptions, experiences, and challenges of stakeholders in the Norwegian seafood supply chain regarding the adoption of blockchain technology?

Considering the main RQ's focus on technology and its relevance to the seafood supply chain, an additional sub-question emerged. This sub-question aims to explore the level of technology acceptance among stakeholders within the seafood supply chain. By leveraging existing theories, it becomes possible to gain insight into the current attitudes and perceptions of these stakeholders towards technology adoption:

SRQ: What is the current level of technology acceptance among Norwegian seafood producer, transporters, and retailers in relation to the adoption of blockchain technology.

The problem at hand is being elucidated through the application of a qualitative research methodology, wherein the characteristics and potential of the technology are comprehensively examined. The value of the technology is perceived as a consequence of its capacity to effectively trace seafood along the supply chain. To investigate the perceptions of the industry towards tracing and blockchain, nine sets of interviews are conducted. Furthermore, a targeted literature and theory review is employed to elucidate the technology applicability and creation of a conceptual framework. The collective insights derived from the interviews and the literature review are anticipated to facilitate and informed and well substantiated resolution of the research question.

The master's thesis commences with a presentation of the existing theory relevant to the research domain of the study. The literature provides a comprehension of supply chains, the Norwegian fishing and aquaculture industry, tracing, and blockchain technology, and serves as the base for selecting a theoretical foundation which will aid the analysis, discussion and conclusion of the thesis. Chapter 3 presents the methodological choices and procedures of the study, along with an evaluation of the research's quality. The interview findings are presented in Chapter 4. The findings are then discussed in relation to the theory in Chapter 5. Chapter 6 presents the conclusion of the research question, as well as the theoretical and practical implication and addresses opportunities for further research.

2.0 Literature & Theoretic Review

This chapter presents the literature and theory applied in this study. Firstly, 2.1 provides an overview of supply chains and SCM. Subsequently, Chapter 2.2 delves into food supply chains followed by chapter 2.3 which discusses the Norwegian seafood industry. The chapter 2.4 is about traceability and transparency whereas 2.5 dives into blockchain and its features. Lastly, the chapter 2.6 assesses the suitable theoretic approach followed by the presentation of the conceptual framework in chapter 2.7.

2.1 Supply Chain and Supply Chain Management

Azzi et al. provide a definition of supply chains as a system of organizations, individuals, activities, information, and resources that aim to transport a product from suppliers to customers (Azzi, Chamoun, & Sokhn, The power of a blockchain-based supply chain, 2019). Olteanu (2003) highlights that a supply chain consists of various stakeholders, including upstream actors (suppliers of raw materials and other supplies) and downstream actors (transport, distribution, and sales actors to consumers) (Olteanu, 2003) (Rangan, Shapiro,

& Rowland, 1995), as shown in figure 1. In addition to product flow, information flow is a crucial part of a supply chain (Lofti, 2013) and is equally essential upstream and downstream (Khan, 2016). The involvement of numerous stakeholders often renders supply chains complex, and globalization means that goods cross several borders on their way to customers (Jahre, Persson, & Gripsrus, 2006).

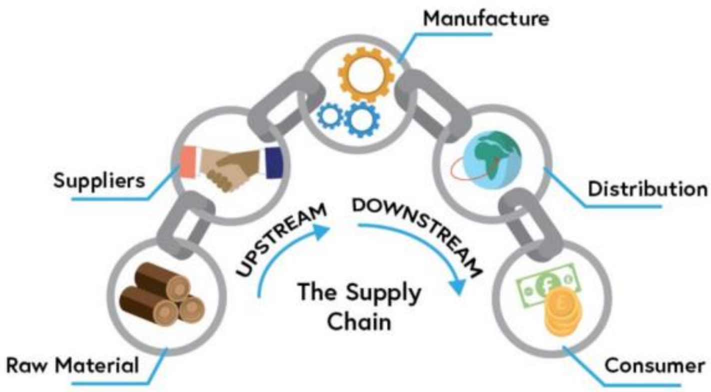

Figure 1: Illustration of the upstream and downstream in a supply chain (Larson, 2007)

It is challenging to provide a clear definition of the term Supply Chain Management (SCM) (Moosavi, Naeni, & Fathollahi-Fard, 2021). An attempt is to define it as the design and coordination of a network through which organizations and individuals get, use, deliver, and dispose of material goods; acquire and distribute services; and make their offerings available to markets, customers, and clients (LeMay, Helms, Kimball, & McMahon, 2017). This definition emphasizes a collaborative approach among supply chain stakeholders to move products through the chain and make them available to customers. SCM involves coordination and collaboration among stakeholders such as fishermen, producers, processors, retailers, third-party providers, and consumers (Zijm, Klumpp, Heragu, & Regattieri, 2019). Managing supply chains involves simultaneously directing and planning activities within a supply chain. Furthermore, the focus is on inter-organizational connections between activities and processes (Grønland, 2017).

2.1.1 Corporation and Integration

Supply chain collaboration is often seen as a generic term for B2B relationships (Huang, Han, & Macbeth, 2020). Like other relationship (e.g., strategic alliances, joint ventures, networks), collaboration is based on creating benefits that cannot be achieved alone. Supply chain collaboration refers to the interaction between two or more stakeholders in a supply chain with the aim of building a competitive advantage (Simatupang & Sridharan, 2002). Information sharing is seen as a central dimension of collaboration in supply chains, involving the capture and sharing of decision-related information to plan and control the supply chain (Huang, Han, & Macbeth, 2020).

Integration is a form of collaboration that enables stakeholders to function as a cohesive unit (Prajogo & Olhager, 2012). In the context of supply chains, integration refers to a strategic partnership between stakeholders in the supply chain that governs both intra- and inter-organisational processes. By integrating their operations, stakeholders can establish a seamless connection where the boundary of activities between the parties become blurred. This type of integration can enhance the operational and business performance of the supply chain, foster mutual trust, facilitate information sharing, and extend the duration of collaboration.

2.1.2 Information Integration

As a result of continuous advancements in information technology, the sharing of information has become increasingly important (Lofti, 2013). Information integration must be present to maximize the benefits of integration, referring to information sharing in the supply chain through the use of information technology (IT) (Prajogo & Olhager, 2012). Real-time data sharing is seen as one of the primary objectives of such integration. When it comes to information integration in supply chains, Prajogo and Olhager (2012) identify two aspects: technical and social. The technical aspects involve interoperability and linkage through IT. IT increases the amount and complexity of information communicated between stakeholders. At the same time, the technology enables the delivery of real-time information about the supply chain, including inventory levels, delivery status, and production planning. The available information increases coordination between stakeholders through operational collaboration. Furthermore, the social aspects highlight information sharing and trust between stakeholders (Prajogo & Olhager, 2012). Information integration requires companies to share strategic information about the supply chain and not just transactional data related to materials or products (Fawcett, Osterhaus, Magnan, Brau, & McCarter, 2007). Sales history can assist suppliers in predicting demand, and real-time information about inventory levels can help suppliers plan for replenishment and delivery. Such a level of information sharing requires frequent communication between stakeholders in the chain.

2.1.3 Sustainable Supply Chains

In recent years, sustainable supply chains have emerged as a critical area of focus within the field of SCM (Kshetri, 2018). Sustainable supply chains refer to the effective management of flows across the supply chain while ensuring that social and environmental conditions are not negatively impacted. The UN define sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations , 2020). Sustainable development is framed within three dimensions - climate and environment, economy, and social conditions - that serve as a guiding framework for global efforts. The environmental dimension entails preserving nature and climate as an renewables resource for human use. The economic dimension aims to ensure economic security for individuals and communities. A greener growth strategy can facilitate the development of more sustainable approaches to addressing inequality across the world. The social dimensions strive to guarantee that individuals have a fair and decent basis for leading a dignified life. In the context of food and related production processes, this factor is about the impact on consumer health and mitigating concerns about specific food items (Wognum, Bremmers, Trienekens, & van der Vorst , 2011).

2.2 Food Supply Chains

Food supply chains involve collaboration among various partners including raw material suppliers, manufacturers, distributors, retailers, and consumers (Tan & Yan, 2018). Compared to other supply chains, food supply chains are more vulnerable and require increased attention (Aung & Chang, 2014). Complex production processes for food also entail a higher risk of product failure and require extra attention to raw material quality and production processes. Production and storage are examples of steps in the chain that require proper handling of food products (Aung & Chang, 2014). At the same time, the quality of food is constantly changing, making it challenging to ensure food safety and quality. The quality of food is also influenced by external factors such as temperature, humidity, and transport. Food waste is a significant element in food supply chains and leads to significant resource loss and negative environmental impact (Beretta, Stoessel , Baier, & Hellweg, 2013). Food waste occurs in several places in the supply chain (Chauhan, Dhir, Akram, & Salo, 2021), and is defined by FAO as a reduction in the amount or quality of edible food intended for human consumption (FAO, 2022). Literature suggests that food waste in food supply chains is a multidimensional problem that requires attention from various stakeholders and stakeholders in the chain (Chauhan, Dhir, Akram, & Salo, 2021).

All the steps in the food supply chain influence the final form and quality of food products, creating a need for close collaboration between the stakeholders (Van der Vorst, 2000). E.g., if one of the parties in the supply chain leaves the milk at room temperature for an extended period, problems will arise for stakeholders further down the chain. Effective information handling within the chain can also contribute to increased productivity, increased control, and reduced delivery times (Jahre, Persson, & Gripsrus, 2006). This leads to more satisfied customers, as well as better coordination of capital and resources. To maximize competitive advantages, all stakeholders in the chain should collaborate to satisfy the end consumer (Towill, 1997).

Today's food supply chains are largely centralized and depend on central control mechanisms (Duan, Zhang, Gong, Brown, & Li, 2020). Such centralization creates an imbalance in information sharing, threatens the transparency of the supply chain, and leads to trust issues (Tian, An agri-food supply chain traceability system for China based on RFID & blockchain technology, 2016). Centralized data storage systems in supply chains increase the possibility of corruption, fraud, and unwanted data changes, threatening the integrity and availability of data (Abeyratne & Monfared, 2016). Azzi et al. (2019) also highlights that traceability and data handling are a challenge in food supply chains due to centralized systems (Azzi, Kilany, & Sokhn, 2019). Much of the information in supply chains is typically stored in multiple locations and is only available to certain units in the chain (Abeyratne & Monfared, 2016). In such cases, customers or other stakeholders have only partial access to the information.

2.3 Norwegian Seafood Industry

Norway is recognized as one of the world's foremost fishing nations, with the seafood industry ranking among the largest export industries after oil and gas (NFD; OED;, 2017). This industry encompasses both fishing and aquaculture. Fishing is one of the oldest industries in Norway, involving the capture of saltwater fish, shellfish, and molluscs (Johnsen, 2022). Since the 1970s, Norwegian aquaculture has experienced significant growth in both production and value creation (The Norwegian Government, 2019). Aquaculture, as defined by the FAO, refers to the farming of aquatic organisms such as fish, molluscs, crustaceans, and aquatic plants (FAO, 2020).

2.3.1 Supply Chains in The Seafood Industry

Various resources are required in both fishing and aquaculture, resulting in different supply chains (FAO, 1988). For instance, boats, fishing gear, and port facilities are essential in fishing, whereas roe, feed, cages, and IT systems are critical elements in aquaculture, with feed being particularly important (Ólafsdóttir, et al., 2013). Despite the differences between these two industries, they can be viewed as a single seafood industry, as the products sold to end customers are primarily in the same market (FAO, 1988).

Figure 2 provides an overall illustration of the supply chains of fishing and aquaculture. The supply chain of wild-caught fish may vary, as the fish can be processed and sold fresh, salted, frozen, canned, smoked, etc. (Cruz & Cruz, 2020). Between each process in the chain, the fish is simultaneously transported and stored several times. For instance, Austevoll Seafood ASA divides its supply chain into three principal areas: fishing, processing, and distribution (Austevoll Seafood ASA, 2021). On fishing vessels, the fish is pulled from the sea and slaughtered before being put on ice. When the fish arrives on land, a first-hand sale is conducted where the value and quality of the fish are evaluated by a sales team (Norges Råfisklag, 2021). The fish is then transported to processing and subsequently distributed to the market.

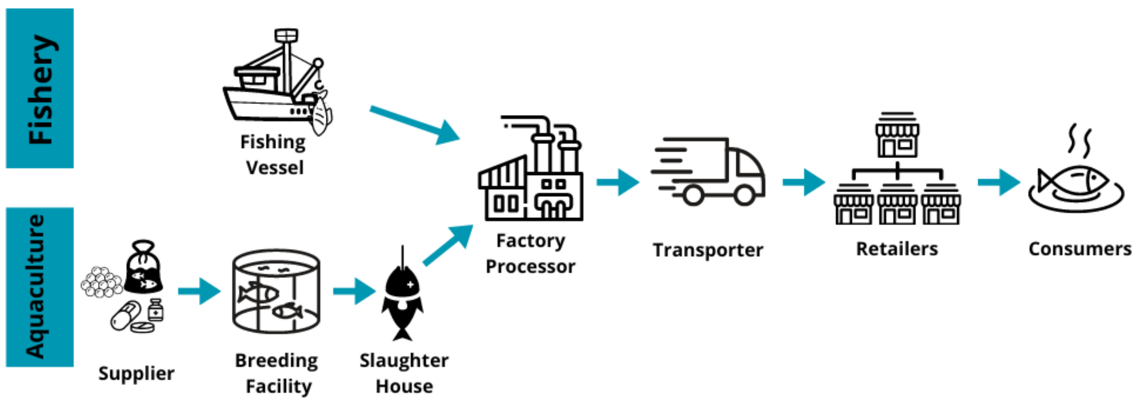

Figure 2: General illustration of the Seafood Supply Chain

When describing the production of farmed fish, salmon is taken as a crucial export commodity for Norway (The Norwegian Government, 2019). The production of salmon starts with fertilizing roe, a process that takes place on land. When the eggs hatch, the fish is transferred to larger freshwater tanks, where it is called fry. Towards the end of its stay in freshwater, the fish adapts from living in freshwater to saltwater and becomes smolt (FAO, 2023). The fish is then transferred to larger saltwater facilities out at sea (Cermaq, 2020). Most of the smolt is internally produced by salmon farmers (Mowi, 2022). This production is usually for their use, but it can also be sold to third parties. After the production process itself, the fish is slaughtered, gutted, washed, and put on ice. The fish is then packaged and prepared for distribution or further processing. During transport, it is crucial to ensure that the fish is not exposed to temperature fluctuations or other conditions that could compromise its quality (Laksefakta, 2021). The fish is transported either to export or outlets such as hotels, restaurants, catering and retailers, where consumers purchase it.

The weight of salmon is a critical factor in determining the price that producers can fetch. The optimal weight for some salmon is typically between 4 and 5 kilograms, although fish are usually introduced into the market weighing between 3.5 and 7 kilograms. The variable profitability in salmon farming suggests that information that improves decision-making holds considerable value. A producer must decide whether to slaughter and export the fish now, at the current price, or to wait and export at an unknown future price (Asche, Guttormsen, Nøstbakken, Roll, & Øglend, 2014).

In Norway, large fish producers own both fish farming facilities and slaughter and processing facilities, and many producers engage in both land-based and sea-based activities (Ólafsdóttir , Mehta, Richardsen, & Cook, 2019). This vertical integration spans several stages of the supply chain. Smaller companies do not have the same facilities and often have to borrow or purchase services from other companies. Several different stakeholders must be considered in supply chains, such as equipment, raw material, and feed suppliers. To ensure the quality of the fish, for example in fish farming facilities, it is crucial to maintain a good relationship with feed suppliers (Mowi, 2022). Furthermore, a good relationship with processing companies, distributors, and retailers is advantageous to optimize products for both fisheries and aquaculture (Glavee-Geo & Engelseth, 2018). This collaboration involves a good flow of information that can contribute to increased productivity and better control over the activities in the supply chain, ultimately leading to improved delivery quality to the end-user.

2.3.2 Regulation of The Seafood Industry

The fishery and aquaculture in Norway are strictly regulated which has contributed to a high global trust towards the Norwegian seafood industry (Opdahl & Saric, 2021). Regulations for obtaining license to engage in aquaculture activities have been in place since 1973 (The Norwegian Government, 2019). These regulations specify the permitted species and areas, which serve as guidelines for aquaculture production and growth. The aquaculture industry is required to adhere to framework conditions that address various aspects, such as fish escapes, disease outbreaks, lice, and environmental impacts caused by the facilities. In the fishing industry, annual quotas are set to regulate the amount each fleet is allowed to catch (Directorate of Fisheries, 2022). These quotas also play a crucial role in distributing resources among different fleet groups. Furthermore, there are laws such as the Marine Resources Act and the Participant Act, which aim to manage marine resources (NFD; OED;, 2017).

In addition to regulations, there are standards that the seafood industry must adhere to. In Norway, there is an increased focus on standards to make the Norwegian seafood industry more sustainable and competitive (Standard Norway, 2021). In 2012, two new ISO standards were adopted for tracing seafood, which applied to both wild-caught and farmed fish. These standards explain the information that must be recorded at each stage in the supply chain. Other standards focus on the responsibility of aquaculture operators to monitor discharges from their facilities to ensure that environmental impacts are sustainable and acceptable (Standard Norway, 2021).

2.4 Traceability and Transparency

One way to define traceability is: "The ability to access any or all information related to that which is under consideration, throughout its entire life cycle, by means of recorded identifications" (Olsen & Borit, How to define traceability, 2013). The definition refers to the ability to obtain information regarding the lifespan of a particular object. Moe distinguishes between internal traceability and chain traceability. Internal traceability concerns the ability to collect information within a step or company in a supply chain (Moe, 1998). Good traceability depends on each company in the chain having good systems and practices when it comes to registering and documenting internal information (Olsen, Borit, & Syed, 2019). Chain traceability is tracing through the entire supply chain between all steps and stakeholders (Moe, 1998). Good chain traceability depends on good internal traceability, as well as the information being readable and understandable in the next step. The relationship between internal traceability and chain traceability is illustrated in Figure 3.

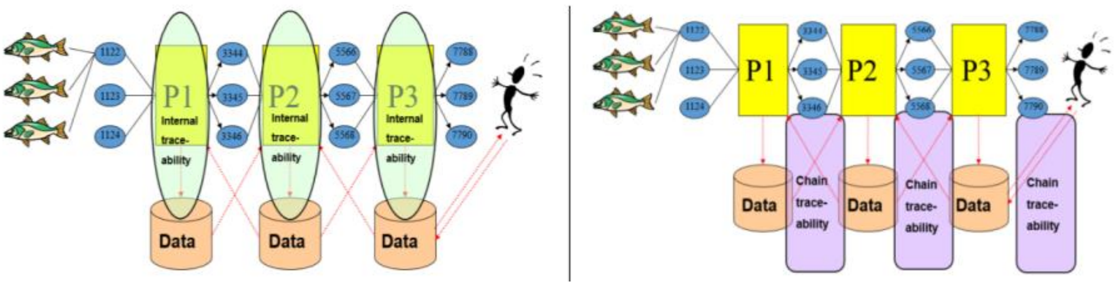

Figure 3: Internal Traceability & Supply Chain Traceability (Olsen, Borit, & Syed, 2019)

Openness in the context of supply chains refers to the extent of access to reliable product-related information without any loss, noise, delay, or disruption (Sunny, Undralla, & Pillai, 2020). Further, we can distinguish between two types of openness: horizontal and vertical (Kalfagianni, 2006). The former pertains to legislation and requirements in the various stages of the supply chain, allowing for the mapping of information on sustainability attributes of products and processes, including those related to human and animal health and safety, animal welfare, and the environment. This type of openness enables the estimation and visibility of the supply chain's sustainability for all stakeholders and society as a whole. On the other hand, vertical openness pertains to the ability to trace the history of a product from start to finish. It ensures the accurate and rapid identification of products in the chain, creating traceability.

Olsen et al. (2019) distinguish between openness and traceability, emphasizing that tracing provides the basis for openness, as noted by Sunny et al. (2020). To ensure the reliability of unverified claims recorded in a tracing system, Olsen et al. (2019) suggest various methods to evaluate claims related to biochemical food properties, given their relevance to food safety. One of the analytical methods they highlight is DNA-based analyses, which can indicate the type of species, geographic origin, freshness, use of additives, organic production, and durability. By providing a comprehensive overview of products with associated raw materials and processes, traceability can contribute to openness in the supply chain.

2.4.1 Traceability System

To ensure effective product tracking, it is necessary for information to be formatted in a way that allows the product to be traced throughout the entire supply chain (FAO, 2020). This can be achieved through the use of tracking systems, which can be paper-based or database-based (Olsen, Borit, & Syed, 2019). The tracking system should provide access to all product characteristics, ingredients used in every stage of the supply chain, and allow for backward and forward traceability (Moe, 1998). The goal of a tracking system is to make product-related information available in multiple locations without loss of data (Olsen, Borit, & Syed, Applications, limitations, costs, and benefits related to the use of blockchain technology in the food industry, 2019). Transformation of products is a significant event that should be documented within a tracking system. During a transformation process, one type of product is received, and a changed type is produced (Grønland, 2017). Activities involving the transformation of products add value to the product's characteristics or form by combining, dividing, or mixing them (Olsen, 2018).

Bhatt et al. (2016) have identified two essential concepts in tracking: "critical tracking events" (CTE) and "key data elements" (KDE). CTE are events that require data recording to maintain traceability, such as when a product undergoes transformation or is moved to a different location within the supply chain. KDEs refer to information that must be recorded at every critical tracking event to ensure effective product tracking.

Efforts toward effective digital supply chain traceability are not new. There are systems with data pools for tracking with the same benefits as what blockchain can offer. Popular systems used in the various supply chains, such as Enterprise Resource Planning (ERP) (Amini & Abukari, 2020), optimizes database administration framework whereas a decentralised blockchain technology employs a real-time scalable database that supports verification of purposes, stages and application. Theoretically, blockchain and ERP have a sizeable portion in common. ERP runs on a system of a single modification of data. Whereas blockchain also controls a single table of data which is shared by millions of buyers on the web (Febrianto & Soediantono, 2022).

2.5 Blockchain

Blockchain is a distributed database which files and share digital transactions (Azzi, Kilany, & Sokhn, 2019). Information being stored on blockchain are normally distributed over a network of computers. (Olsen, Borit,

& Syed, 2019). Instead of information being stored on a centralised system and needs to be forwarded back and forth between stakeholders, the blockchain network enables offers public access to the information. Stakeholders involved get real time updates of information as new information are added (Deloitte, 2021). Blockchain can easily be explained as a file which consists of different blocks of information. Blockchain can simply be seen as a log consisting of multiple blocks of information. A block is generated and encrypted based on the previous and the next block in the chain (Puthal & Malik, 2018).

A block's number ensures its uniqueness and prevents it from being linked to multiple chains. Any alteration would produce an invalid chain, making it nearly impossible to modify existing blocks. Transactions recorded on the blockchain are immutable and cannot be altered once registered (Puthal & Malik, 2018). As each block includes information about the subsequent block in the chain, the history and ownership are automatically verified and cannot be changed. Additionally, the blockchain network requires a majority of actors in a transaction or network to agree on the correct chain. Before registering a transaction, all parties involved must verify the accuracy of the block's information and its reference to the previous block. Blockchain technology enables secure and reliable access to data (Puthal & Malik, 2018). Its distributed nature results in a high degree of shared understanding within the network. Figure 4 illustrates how transactions are created, validated, and added to the blockchain.

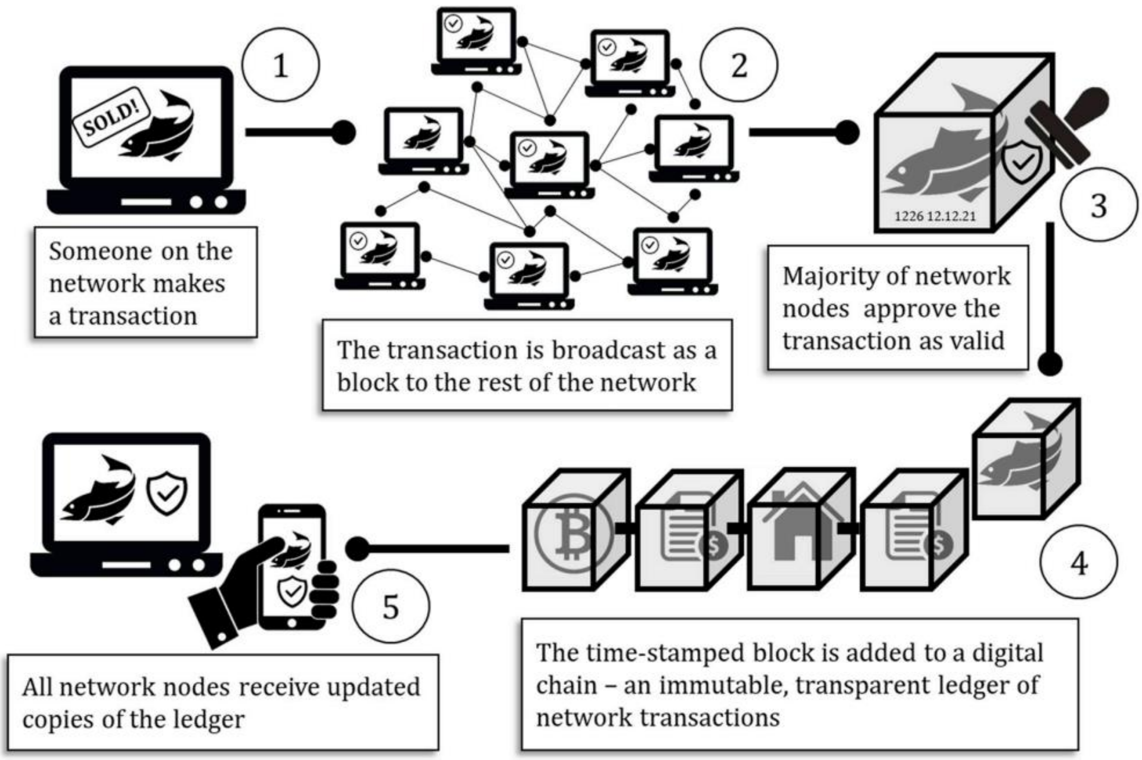

Figure 4: Illustration of the blockchain technology (IBM, 2023)

Smart contracts play a crucial role in blockchain technology as integrated agreements between network participants (IBM, 2023). They operate as data protocols that digitally verify or enforce the terms of a contract, allowing for reliable transactions without the need for intermediaries. By preventing malicious transactions and facilitating data-driven interactions, smart contracts enhance the security and efficiency of the blockchain network (IBM, 2023).

2.5.1 Blockchain in The Food Supply Chain

Blockchain technology has caught the attention of researchers for its potential use in supply chains in recent years (Chen & Chang, 2020). This technology has the ability to improve the transparency and traceability of supply chains by utilizing immutable data records, distributed storage, and controlled user access (Abeyratne & Monfared, 2016) (Azzi, Kilany, & Sokhn, 2019). The various steps and events in a supply chain can be recorded as transactions and stored as blocks in a blockchain (Kouhizadeh, Zhu, & Sarkis, 2019). All stakeholders in the supply chain can view and verify these transactions, providing a single source of truth. Thus, even though no individual stakeholder owns the information in the chain, the supply chain can still be considered trustworthy (Azzi, Kilany, & Sokhn, 2019). The use of blockchain creates a decentralized system for gathering, storing, and managing crucial information for each product during its life cycle (Abeyratne & Monfared, 2016). This system has the potential to create a secure and shared record of transactions and specific product information for each individual product (Azzi, Kilany, & Sokhn, 2019). It can establish a reliable network of stakeholders where transparency is a priority and product traceability are ensured.

The use of blockchain in food supply chains aims to establish a reliable and transparent environment for food production while integrating key actors and stakeholders (Kamilaris & Fonts, 2019). Stranieri et al. (2021) point out that the implementation of blockchain in food supply chains is still in its early stages, and that the technology is largely used by larger companies to increase sales and create a better reputation. However, blockchain also has the potential to impact the overall performance of food supply chains (Queiroz, Telles, & Bonilla, 2020).

Tan (2018) highlights that in 2016, Walmart and IBM initiated a project to showcase the potential of blockchain technology in tracing food from its source to retail outlets. The primary focus of the project was on reliability and traceability, with the objective of tracking mangoes from farms in Mexico to two stores in the USA. The outcome of the project was a comprehensive history of all the stages involved in mango production, processing, and distribution. This encompassed monitoring the mango harvest in Mexico and the entire voyage to the retail outlet in the USA. Each stakeholder contributed new data to the blockchain for every stage in the supply chain. Ultimately, the blockchain connected the data to illustrate to customers the entire journey of their mango, from the farm to the store (Yiannas, 2018).

Tian (2016) introduced the use of RFID and blockchain technology to reduce food waste and improve food safety in Chinese agriculture. The technology utilization created more credible tracking and information sharing throughout the supply chain. This was done by collecting, transmitting, and sharing information about production, processing, storage, distribution, and sales. The blockchain technology helped to strengthen trust, ensure good food safety, and provide reliable information. At the same time, all stakeholders in the supply chain had the opportunity to see the information that was recorded. Tian (2017) points out that blockchain and Internet of Things (IoT) can provide real-time information to all stakeholders in the supply chain, as well as improve efficiency and transparency in the food supply chain. This, in turn, will increase food safety and consumer confidence in the food industry.

The food tracking tool IBM Food Trust, built on blockchain technology, connects participants across the food supply chain through an authorized, permanent, and shared system for data (IBM, 2023). This creates a collaborative network where all relevant data, documents, certificates, and the like can be efficiently shared with stakeholders such as suppliers, producers, exporters, distributors, retailers, and authorities. IBM notes that Food Trust addresses seven aspects of food supply chains: supply chain efficiency, brand trust, food safety, sustainability, food freshness, food fraud, and food waste (IBM, 2023).

2.6 Theoretical Framework

The Diffusion of Innovation Theory and Institutional Theory together illustrates a relevant theoretical framework that can be used to better understand the individual adoption choices, raise important considerations in terms of the adopting of new technologies or practices in the Norwegian supply chains. Another issue underlining the relevance is the pro-innovation bias, characterized as the assumption that all innovations are good and thus should be adopted by all members of a community (Haider & Kreps, 2010) (Jeyaraj, Rottman, & Lacity, 2006) (Rogers, 1995) is a significant concern.

The diffusion of innovation theory focuses on the process of how new technologies, or practices spread through a social system, while institutional theory looks at how institutionalized norms, rules, and structures influence the behaviour of organizations. As the literature review has clearly shown, these two theories can be particularly useful in analysing qualitative data and can provide valuable insights into the factors that affect the adoption and implementation of innovations within the different stakeholders in the seafood supply chain.

2.6.1 Diffusion of Innovation Theory

This study on adoption of blockchain take base from using the theory of the diffusion of innovation (DOI) which investigates the factors that influence the acceptance of a new idea, product, or practice. This theory was introduced by Everett Rogers (1995), who suggested that a small number of individuals are receptive to new concepts and willing to implement them in practical settings. As early adopters influence others to adopt the innovation, a critical mass of adopters is formed, leading to widespread diffusion throughout the population until it reaches a saturation point. Rogers categorized adopters into five unique groups: *Innovators, early adopters, early majority, late majority* and *laggards*.

According to the theory, technology adoption is influenced by factors such as *complexity, compatibility, relative advantage, observability, and trialability*. Hence, in measuring the variation of factors influencing adoption of blockchain technology for enhanced effectivity in the supply chain, these factors must be considered to gain acceptance across the entire chain. When it comes to the adoption of blockchain technology within the seafood industry, the theory suggests that early adopters, who are willing to take risks and try new things, will be first to embrace the innovation. As more companies become aware of the potential benefits and are persuaded by early adopters, their innovation will gradually be adopted biologic group of individuals.

Relative advantages of implementing blockchain technology lie in its potential to enhance current processes related to product, information, and financial flow, resulting in improved organizational performance. By digitalizing operations, blockchain can accelerate the flow of products, while the use of blockchain-based digital documents can eliminate the need for time-consuming paperwork, reducing waiting times and minimizing delays at ports and customs (Yang, 2019). Moreover, blockchain technology has the capability to streamline information flow by virtue of its traceability, transparency, immutability, and accessibility. The use of blockchain allows for the dissemination of information to all stakeholders involved in the seafood supply chain, enabling them to track the real-time status of goods, make more informed predictions, and exercise greater control over their supply chains (Yadav & Singh, 2020). Furthermore, blockchain has the potential to enhance financial flow in the seafood industry, which involves numerous financial transactions. Tokenized contracts can expedite and secure payments by automatically executing their processes in a timely and impartial manner once the contract's terms are fulfilled. When used in conjunction with Bitcoin, blockchain technology can revolutionize trade and simplify financial flow by utilizing disintermediated electronic cash payment systems.

Compatibility refers to the degree of blockchain’s compatibility with the vision, strategy, and existing software and technologies of the seafood company. When blockchain can fulfil the strategic goals of seafood companies, such as operating costs reduction or digitalized seafood journey, and comply with their strategies such as sustainable operations, seafood companies would be more willing to implement the blockchain technology. Additionally, the degree of blockchain’s compatibility with the existing infrastructures of seafood companies is a critical consideration (Nour, et al., 2019). A high level of integration capability speeds up the implementation of blockchain.

Complexity pertains to the level of difficulty in comprehending and utilizing blockchain technology. Innovations that are uncomplicated to understand, learn, and operate are more readily embraced than intricate ones. Moreover, the existence of consistent standards can alleviate the complexity of using blockchain technology. The absence of standards may give rise to interoperability issues. The seafood industry involves numerous upstream and downstream partners with varying objectives, which may lead to conflicts in practices (Yang, 2019). Different technological standards make it challenging to collaborate and integrate effectively, hindering the global adoption of blockchain technology (Morat, Andersson, & Schelen, 2019). Therefore, the development of standards is critical to ensure ease of operation.

Trialability and observability are concepts that relate to the capability of testing a technology's suitability and evaluating its performance (Rogers, 1995). Trialability concerns the extent to which an innovation can be evaluated and experimented with. A successful trial is a crucial stage before mass implementation because it allows seafood companies to gauge the real potential of blockchain, avoid being misled by false or overestimated performance claims, and become more familiar with blockchain operations (Zheng, Xie, Dai, Chen , & Wang, 2018). Observability concerns the degree to which the outcomes of an innovation are apparent to others. When the benefits of blockchain are visible to seafood stakeholders, they are more committed to implementing blockchain technology.

2.6.2 Institutional Theory

DiMaggio & Powell (1983) defines the *Regulatory environment* by the use of the institutional theory on how institutional environments prompt organizations to respond strategically to achieve competitive advantages. The institutional environment can be categorized into macro, meso, and microenvironments. Based on the institutional theory, external environmental factors affecting the implementation of blockchain in seafood companies, such as the external market and regulatory environment, and stakeholder factors, such as the relationship inside the supply chain, its stakeholders, including suppliers, shareholders, and customers, are proposed.

Supportive Environmental Forces

Market competition consideration refers to the competitive pressure from the maritime seafood market and the ability of blockchain to enhance firms' competitiveness. Maritime seafood faces increased market competition due to increased market consolidation and alliances. Stress from market competition and competitors will force seafood companies to develop resources to enhance core competence through digitalization. Therefore, the desire to withstand fierce global competition is a driver of blockchain implementation.

Economic and political consideration refers to seafood companies' aspiration to increase adaptability and resilience against economic or political uncertainty by implementing blockchain. Seafood companies operate under an uncertain and volatile environment featured by changing oil prices, fluctuating freight rate and foreign exchange, supply chain disruptions, unexpected epidemics, supply and demand uncertainty, and other political and economic tensions. Blockchain has the potential to improve security by digital cash payment and shorten response time by data sharing, thereby increasing seafood companies' control over uncertainty.

Regulation and incentives are related to the regulations and incentives that support the implementation of blockchain technology. Regulations are a significant external force that guides or mandates businesses to comply with specific standards (Bavassano, Ferrari, & Tei, 2020). In recent years, more emphasis has been given to environmentally friendly seafood, and companies are urged to improve their sustainability through innovative transformations. Additionally, blockchain technology is still in its initial stages, and the regulations governing it are not yet fully established. The lack of proper regulations could lead to illegal behaviour and conflicts in real-world applications. Therefore, establishing supportive regulations can address concerns over regulatory uncertainty and provide incentives and confidence for seafood companies to adopt blockchain technology.

Supportive external stakeholders are related to business partners' support refers to maritime business partners' support to develop blockchain. The implementation of blockchain in pioneering seafood companies would affect the behaviour of others (Gausdal, Czachorowski, & Solesvik , 2018). The desire to collaborate with partners along the maritime supply chain would push digitalized transformation as well (Angelis & Da Silva, 2019). Furthermore, industry involvement and cooperation are positively associated with blockchain implementation. Collaboration and joint development allow seafood companies to share costs and risks in blockchain implementation.

2.7 Conceptual Framework

The study's aim is to explore the phenomenon of blockchain adoption within the stakeholders of the seafood supply chain. To guide the investigation, it was reasonable to employ two prominent theories: The diffusion of innovation and the institutional theory. The conceptual framework which is presented below provides a theoretical foundation for understanding the factors influencing the adoption of technology, or more specific, blockchain technology.

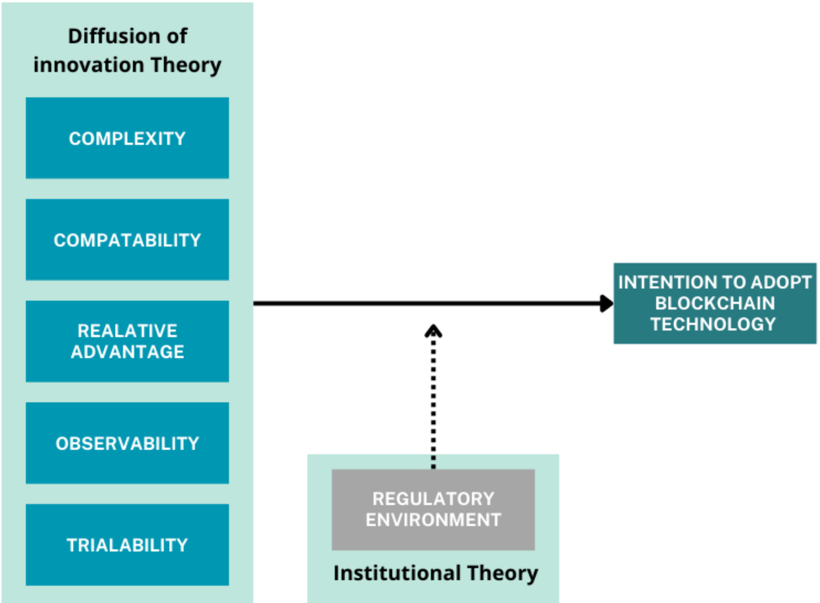

Figure 5: Conceptual Framework

The theory of diffusion of innovation, pioneered by Everett Rogers (1995), offers insight into the process through which new technologies are adopted and diffused within a social system. This theory recognizes the existence of different groups of adopters, ranging from innovators to laggards, each playing a role in the acceptance and adoption of innovation. By applying this theory, we can examine how the various stakeholders in the seafood supply chain, such as producers, transporters, and retailers, perceive and adopt blockchain technology.

In addition to the DOI, it is also reasonable to incorporate the Institutional theory to provide a deeper understanding of the contextual factors that influence technology adoption. The Institutional Theory by DiMaggio & Powell (1983), highlights the role of institutional norms, regulations, and social structures in shaping organizational behaviour and practices. By considering the institutional pressures faced by seafood stakeholders, such as government regulations and industry standards, it is possible to analyse how these factors affect the adoption of new technology.

By integrating these theories within the conceptual framework, it is possible to explore the complexities, challenges, and opportunities associated with the adoption of new technology in the seafood supply chain. This study will examine the variations in perceptions, attitudes and behaviours of different stakeholders towards the technology adoption, taking into account the role of DOI and IT. Lastly, this conceptual framework will guide the data collection, analysis, and interpretation, providing a comprehensive lens through which to understand the adoption of new technology.

3.0 Methodology

This chapter outlines the methodology used in the study, including the reasoning behind the chosen methods and they were executed. Chapter 3.1 presents the selected research design, describing the methodological approach and procedure. Chapter 3.2 covers the data collection process, while chapter 3.3 Explains the analysis methods used. The chapter concludes with an evaluation of the quality of the methodology in chapter 3.4.

3.1 Research Design

This master thesis is based on an exploratory research design, with the aim of exploring how blockchain adoption can vary in type of stakeholders in the Norwegian seafood supply chain. Such a design was considered appropriate, as there is little information available on the phenomenon being studied. An exploratory approach allows for flexibility before the research question is narrowed down. This approach is supported by Brymann (2016) and Johannessen (2011) whereas the emphasis lays in making a structured plan on how the research should be performed. Underscores the fact that a research design is everything which can connect to the actual research.

3.1.1 Research Approach

An important part of the methodological assessment is to consider the relationship between data collection and analysis, as well as how the study relates to theory and empirical evidence (Flick, 2018). In a linear-sequential approach, researchers first collect all the data, then analyse the information. An iterative approach, which is the opposite of the linear approach, refers to a repeated interaction between data collection and analysis. During such a research process, researchers move back and forth between data collection and analysis. Data analysis guides and provides input on which data should be collected and how it should be obtained, which in turn influences the choice of new data collection methods. In this study, the interaction between data collection and analysis had a linear-sequential approach. In other words, the research was based on constant structure from data collection to analysis. It serves the thesis as a methodological framework where data collection and analysis occur in a sequential and structured manner. It began with the formulation of a research question, followed by the sources of data. The approach provided good structure in adapting data collection and analysis to the needs and development of the study. This is considered an important advantage of such a process (Mills, Durepos, & Wiebe, 2010).

Regarding the relationship between theory and data, the literature mainly distinguishes between two theoretical approaches: deductive and inductive (Bryman, 2016). Inductive approach involves starting an investigation without any theoretical position, where the researcher tries to find general patterns that can be turned into theory. In this method, one moves from empirical evidence to theory. In a deductive approach, one moves from theory to empirical evidence, i.e., from the general to the more specific (Johannessen, Christoffersen, & Tufte, 2011, s. 55).

On the basis of and linear-sequential approach, this master's thesis has followed a deductive approach (Nisbet & Yale, 2018), which are a known theoretical approach among qualitative researchers. The research topic on the adoption of blockchain in the Norwegian supply chain already has a foundation of existing theories that can help explain perceptions and feelings and perceptions towards the technology. By employing a deductive approach, the thesis can utilize these theories as a framework to guide my research and examine how well they apply to the specific context of the Norwegian supply chain. The approach allows a structured and systematic investigation of the research problem. By formulating research questions or/and hypotheses based on the identified theories, it is possible to design a research methodology that collects relevant qualitative data to either support or challenge these theories. This approach provides a clear direction for data collection, analysis, and interpretation, contributing to the rigor and validity of the research.

3.1.2 Chosen Research Method

This thesis perspective and approach taken in a study shape the selection of research methods, and the methodological procedure is based on ontological (reality approach) and epistemological (knowledge approach) principals (Slevitch, 2011) (Grotty, 2003). In order to capture the different perceptions and thoughts related to adoption of blockchain in the supply chains of Norwegian fish, a qualitative approach was deemed appropriate. Moreover, the methodology is supported by interpretive epistemology and relativistic ontology, where opinions and phenomena are tied to respondents' subjective perceptions and are conveyed through the researcher's own interpretations (Tuli, 2010) (Bryman, 2016, s. 375). With this perspective, adoption of blockchain in the Norwegian seafood supply chain is viewed as a phenomenon with various functions and values, and the intentions to adopt simultaneously vary depending on the stakeholders that the technology encounters. The study investigates how people subjectively perceive the phenomenon based on their experiences and understanding (Sander, 2022). The research method aims to explain if there are various attitudes towards adopting the technology, which underscores a qualitative method as a suitable approach.

Another argument for the use of qualitative method is that blockchain has not been widely applied in the seafood industry, making it difficult to quantify (quantitative) the integration of using the technology.

3.1.3 Research Process

The study began with a topic of interest, which lead to concepts, existing research and theory. By the use of the information, it was possible to explore data related to adoption of new technology, more specifically, adoption of blockchain in Norwegian seafood industry. This information was used during the interviews to collect information and identify attitudes towards adopting new technology for tracing Norwegian fish, by using the DOI. Additionally, questions were raised how the regulatory environment could affect the relationship either positively or negatively the intention to adopt blockchain amongst players in the seafood supply chain. The analysis was conducted shortly after the interviews to concretize and structure the findings, evaluating blockchains perceived usefulness (PU) and perceived ease of use (PEU). Interesting discoveries were identified related to the variation of adoption and the utilization of blockchain technology. Based on these findings and a need to narrow the research topic, the factors determining adopting blockchain was chosen for closer examination. It was assumed that blockchain had several advantages and could streamline the journey of fish from sea to plate, which is related to how the fish moves between stakeholders in the supply chain, making SCM an important theoretical element.

The findings from the interviews, in combination with the research area, formed the basis for the theoretical exploration. The process looked more closely at the factors determining the potential use of blockchain in supply chains, both generally and with a focus on food traceability. The literature review gave a greater focus on the opportunities of blockchain technology in supply chains for Norwegian fish. The collected information was then analysed and structured in the analysis round. The literature review has covered the use of blockchain in supply chains for seafood by revealing the technology's benefits for the existing research area.

This research process explains how the research area of the task has continually developed and taken an abductive approach. The shift between theory exploration and data collection reflects this, where interesting findings have been used to concretize and reduce the scope of the task. The structure from data collection to analysis also reflects a deductive analysis process, where the analysis has provided input for new research areas. The empirical information gathered, in combination with theory, is used to discuss the task's research question. Then, a conclusion is developed based on the discussion.

3.2 Research Question and Hypothesis

The main RQ are: "*What are the perceptions, experiences, and challenges of stakeholders in the Norwegian seafood supply chain regarding the adoption of blockchain technology?"*. With an additional sub-question which is: "*What are the current level of technology acceptance among seafood producer, transporters, and retailers in relation to the adoption of blockchain technology"*. In order to stay true to the RQ's, a suitable hypothesis for this study would be:

HQ1: The ease of use of blockchain technology in the seafood supply chain will be influenced by the stakeholders' perceptions of governmental interference.

This hypothesis suggests that stakeholders' perceptions of the institutional characteristics will play a significant role in their decision to adopt blockchain technology. Moreover, the institutional pressures, such as regulatory requirements and industry standards, will moderate this relationship. Either facilitating or hindering the adoption process.

3.3 Data Collection

The data used in this thesis is gathered from primary and secondary data. The primary data consists of interview, theory and the literature review. Further, the secondary data have given valuable information which have helped shaped the scope of the research.

3.3.1 Interviews

As part of the qualitative method, a series of in-depth interviews were conducted. The use of interviews was considered highly beneficial for obtaining comprehensive and detailed information. One round of interviews was conducted, as explained in the research process overview. The round of interviews focused on how leaders in the Norwegian seafood industry perceive the value of traceability systems by using blockchain technology. The interviews looked closer at the possibilities of blockchain technology in the supply chains for Norwegian fish. The interviews provided a broad insight into how the industry works, and thoughts and opinions on the implementation of tracking and blockchain were mapped out.

3.3.2 Chosen Sample

The participants were chosen depending on what information was necessary to collect. A purposefully (Patton, 2002) selection was used in order to distinguish candidate with appropriate knowledge about the Norwegian seafood industry and product traceability. The sample consisted of individuals on a managerial level and collaborates actively with the Norwegian seafood supply chain for at least five years. Within the whole supply chain, the stakeholders studied in the supply chain included exclusively stakeholders within the fishery industry, and not the aquaculture industry. This is due to the aquaculture industry being more technological developed than the fishing industry which gain a more narrowed insight in one specific part of the whole seafood industry. Within the supply chain of the fishery industry, the stakeholder studied exclusively included processors, transporters and retailers, which is not yet utilizing blockchain in their daily operations. These stakeholders are responsible for handling and distributing the seafood products, and thus have direct stake in ensuring that the products are of high quality, safe, and traceable. On the other hand, fishermen may not have the same level of influence over the adoption of blockchain technology in the supply chain, as they do not hold a managerial level and may not be directly involved in the handling and distribution of the products. Similarly, consumers may not be the best target group for this study, as they are unlikely to be involved in the adoption of the technology, but rather only the end-users of the traced and verified seafood products. Therefore, particularly studying the processors, transporters, and retailers may provide a more focused and relevant understanding of the factors influencing the adoption of blockchain technologies in the Norwegian seafood supply chain.

Potential participants were identified through online searches, professional networks, and referrals from the industry itself. Moreover, referrals were achieved by starting with the producers, who occupy the first stage of the supply chain, and asking them in the end of the interview to provide information on their transporters. From there, the transporters were interviewed and asked about the buyers they supplied the seafood to, which helped to identify seafood retailers and other relevant stakeholders. By targeting these key players within the supply chain, the research was able to gain a comprehensive understanding of the perspectives and experiences involved in the seafood industry in Norway. In addition, participants were selected to ensure diversity in terms of gender and age. The purpose of this selection was to ensure that the study captured a range of perspectives and experiences related to blockchain adoption. Table 1 below shows the participants and the time lapse of the interview.

Participants	**Company**	Nature	**Duration**
Leader 1 (CEO)	John Greger AS	Producer	45 min
Leader 2 (CEO	Røst Fiskeindustri AS	Producer	50 min
Leader 3 (Quality M.)	Røst Sjømat AS	Producer	40 min
Leader 4 (CEO)	Rasumussen Transport AS	Transporter	40 min
Leader 5 (CEO	DFDS Logistics AS	Transporter	40 min
Leader 6 (CEO)	Sletteng Transport AS	Transporter	50 min
Leader 7 (CEO)	Bofisk AS	Retailer	60 min
Leader 8 (Quality M.)	Meny AS	Retailer	55 min
Leader 9 (Quality M.)	Son Fiskebrygge AS	Retailer	50 min

Table 1: Interview Participants

3.3.3 Type of Interviews

Due to the benefits of flexibility, a semi-structured interview was chosen for this data collection. A semi structured interview takes its base in an interview guide, but questions and the structure can vary during the interviews. The reason behind this type of interview is to be open to unexpected discussion while at the same time, following a guide (Galletta & Cross, 2013). In addition, a semi structured interview gave the possibility to make follow-up questions when a deeper insight was appropriate. The interviews were performed individually to gain a bigger understanding and reflection without any external influence.

To ensure the clarity and comprehensiveness of the interview guide, a pilot test was conducted with a small group of individuals who were similar to the study participants in terms of demographics and experiences. The pilot test was conducted in a similar setting and followed the same procedures as the actual interviews. Participants were asked to provide feedback on the clarity of the questions, the order and flow of the questions, and any additional topics that could be included. Based on the feedback received, minor changes were made to the interview guide to improve its clarity and completeness before the actual interviews were conducted. The pilot test was crucial in refining the interview guide and ensuring that the actual interviews would yield high-quality data.

3.3.4 Interview Guide

A distinct interview questionnaire was created for interviews (Attachment 1), where the questions were adapted to align with the meeting's objectives. The interview questionnaires were designed to promote fluidity and an open dialogue, as well as to ensure that all essential inquiries were addressed. The respondents received the interview questionnaire in advance, affording them the opportunity to prepare and formulate more reflective responses. By doing so, the researchers prevented brief and impromptu answers. A systematic categorization of the various questions aimed to provide the participants with a swift overview of the interview's content, while also facilitating the researchers' subsequent analysis of the interviews. The interview questionnaire was initially sent to the designated supervisor at LUISS University for assessment. Prior to conducting the interviews, the researchers evaluated the questions on one another to assess their relevance and coherence. This approach allowed for modifications and enhancements to the wording of the questions.

3.3.5 Execution and Evaluation of The Interview Process

The interview session was conducted in the lapse of a three-week period. The interviews were executed in-person and Microsoft Teams as distance were making it difficult to meet. The software's features made it possible to record the interviews which were later used to the transcription of the interview. Voice recording the interviews was also done during the in-person interviews. All of the participants consented to the interviews and being recorded. The digital approach was a clear disadvantage as it made it harder to perceive non-verbal message from the participant. Body language has a considerable influence on the complete understanding when in in-dept interviews. However, the participants answers were clear enough to give a picture of their thoughts and experiences.

There was some uncertainty surrounding a few of the questions, which needed additional clarification. As a result, modifications were made to the interview guide and question phrasing to avoid meeting the same uncertainties in future interviews. Throughout the course of the interviews, new insights were continually gained about the behaviour of the interviewees. Some individuals displayed high levels of enthusiasm and willingly engaged in extensive conversations, sharing both pertinent information and engaging in casual conversation. In contrast, others were more succinct and preferred to limit the duration of the interviews to the necessary minimum.

When the interview session started, more open-ended questions were posed with the intention of allowing the respondents to speak freely. The researcher used the interview guide to maintain a focus on the topics while fostering an open dialogue, allowing participants to freely express their thoughts and feelings on the subject matter. In hindsight, the researcher acknowledge that additional follow-up questions should have been asked to elicit more specific answers. Furthermore, it is important to note that the respondents' answers may have been influenced by receiving the interview guide in advance. The interview guide included a list of potential benefits of traceability, intended to assist the informants in considering possible thoughts on the topic. This may have influenced the responses to the extent that the categories may have been "suggested" to the informants.

3.4 Analyse of interviews

Shortly after the completion of the interviews, a transcription of each interview was done. Bryman (2016, s. 581) considers this to be essential and contributes to a greater understanding of the collected data. The analysis process began by reviewing the transcriptions and creating a more concise summery of the interviews. The summary was structured based on the interview guide and focused on information deemed relevant to the study's research question. Developing the summary was done to provide an immediate overview of the interview content, reduce the amount of text, and make it more manageable before further analyses (Johannessen, Christoffersen, & Tufte, 2011, s. 185). Bryman (2016, s. 581) emphasizes that such a review highlights important aspects of the interview.

After the transcription, coding was used to identify central categories that emerged during the interviews (Bryman, 2016, p. 581; Johannessen et al., 2011, pp. 207-215). While reviewing the summaries, keywords using the theoretic approach related to the adoption of new technology were identifies and noted. These factors were organized in a table and linked to the companies who contributed with the information, see Table 2. This comparison provided a clearer picture of which factors were considered more or less critical.

CODING FACTORS	P1	P2	P3	T1	T2	T3	R1	R2	R3
LEVEL OF AWARENESS	High	High	Moderate	High	Moderate	Moderate	Low	Moderate	Low
PERCEIVED BENEFITS	Traceability & Trust	Traceability & Trust	Traceability	Efficiency	Sustainability	Transparency	Traceability	Transparency	Trust
PERCEIVED BARRIERS	Investment	Investment	Expertise	Readiness	Expertise	Expertise	Readiness	Readiness	Readiness
PERCEIVED COMPLEXITIES	Neutral	Neutral	Neutral	High	Neutral	Neutral	High	High	High
COMPATABILITY	High	High	High	High	High	High	Neutral	Low	Low
OBSERVABILITY	High	High	High	High	High	High	Low	Neutral	High
TRIALABILITY	High	High	High	High	High	High	High	High	High
ORGANIZATIONAL READINESS	Resources	Resources	Resources	Assessment	Assessment	Assessment	Resources	Resources	Resources
PERCEPTION OF INNOVATION	Positive	Positive	Positive	Positive	Neutral	Neutral	Negative	Negative	Neutral
ROLE OF INSTITUTIONS	Standards	Standards	Standards	Regulations & Standards	Standards	Regulations & Standards	Influence	Influence	Influence
ATTITUDES TOWARDS CHANGE	Open	Open	Open	Open	Open	Open	Neutral	Neutral	Neutral
PEU	Neutral	High	Neutral	Neutral	Neutral	High	Low	Low	Low
PU	High	High	High	High	High	Neutral	Neutral	Neutral	Neutral

Table 2: Coding of Interviews

Eventually, a review was made of the initial groups, which (Bryman, 2016, s. 581) argues as an important step in the coding process. In this stage, similar terms were merged overall categories. In order to create comparability with existing theory and literature, Everett Rogers (1995) five drivers for technology adoption used as a starting point for the categorization. The drivers were modified and adapted to the findings. The categories were used to show what the respondents thought were the factors for tracking Norwegian fish by adopting blockchain. In the summary, it was possible to compare these categories and see how the intention to adopt and why differ between the stakeholders in the Norwegian seafood supply chain.

3.5 Assessment of The Study's Quality

Assessing the quality of the study is an important part of the research and uncertainty about quality can be achieved through precise control and planning (Flick, 2018). In addition, reflection on choices will ensure high quality and credibility. This points out that it is as open as possible if choices that have been decided to increase the quality of the study. The method chapter presents and explains all choice made in convention with the task and make visible in this way the problem has been answered. In the study, it has been chosen to control the quality using Credibility, Transferability, Dependability, Confirmability and Reflexivity, which are all relevant criteria within qualitative studies (Guba, Lincoln, & Denzin, 1994, ss. 105-117).

3.5.1 Credibility

Credibility refers to the findings and the methodology of the study, and whether they represent the intended reality. The findings from the interview cannot be considered as truth but rather as intersubjectivity (Guba, Lincoln, & Denzin, 1994). The assessment of the interview's answers, therefore, depends on their shared opinions on several of the questions. This is crucial for ensuring coherence in the study's purpose. Moreover, the theory, research question, data collection analysis, and results needs to be aligned.

Due to the respondents' occupations and extensive industry experience, provides them with a more credible standpoint. Comparing theoretical findings with respondents' answers can enhance the credibility that the answers are accurate (Guba, Lincoln, & Denzin, 1994). Thorough searches were conducted in existing research projects on the topic to assess the reliability of the answers. Since a qualitative approach relies on the researcher understanding of the gathered information, the findings can be perceived differently by other researchers (Tjora, 2021). However, the similarities in the answers increased the transferability and credibility of the findings. The approach for assessing the data also followed an analytical approach. The goal was to identify key perceptions of the idea of traceability along with adoption of blockchain, reducing the need for interpreting the gathered data. Therefore, it is reasonable to believe that similar information could have been presented by another researcher.

Lastly, interview effects such as body language, demeanour, attire, and behaviour are difficult to avoid, but it has been essential for the researchers to be aware of these factors (Guba, Lincoln, & Denzin, 1994). This is performed to hinder excessive objectivity and to show interest in the respondents. Despite the fact that the research findings are influenced by the researchers' perceptions and understanding, there is still ground to believe that the study's credibility is sufficient.

3.5.2 Transferability

Having a study that is transferable means that data can be conveyed to comparable phenomena (Guba, Lincoln, & Denzin, 1994). In a qualitative context, it involves transmitting knowledge rather than generalizing, which is more typical in quantitative investigations. This is because definitive conclusions cannot be drawn. The contribution of this study lies in reinforcing existing theory, as well as enabling others to utilize this task in their own research projects. Factors that affect adoption within the different in the seafood supply chain can be transmitted to provide insights into the potential of the technology in supply chains for other food items. Consequently, the findings will be transferable and offer valuable understanding if the application of blockchain is to be assessed in analogous supply chains.

3.5.3 Dependability

For this study, dependability would refer to the extent to which the research could be replicated in similar conditions. Moreover, there is sufficient information provided such that another researcher could follow the same procedural steps, albeit possibly reaching different solutions (Guba, Lincoln, & Denzin, 1994). The theoretical approach which also represents the conceptual framework is well known theories which can be applied in other studies with similar conditions.

3.5.4 Confirmability & Reflexivity

When it comes to confirmability, it is important that it is a clear link or relationship between the data and the findings. For this study, it has been essential to show how the respondents made their answers and how the researcher made findings through detailed descriptions and the use of quotes (Guba, Lincoln, & Denzin, 1994). In addition, reflexibility means that in needs to be a continual process of engaging with and articulating the place of the researcher and the contest of the research. This has been proved trough explanations of how reflexivity was embedded and supported in the research process.

4.0 Result

In this chapter, the findings from the interviews are presented and categorized into subsections: The initial subsection, 4.1, identified the awareness of Blockchain whereas understanding their level of knowledge in this area provides valuable context for interpreting their subsequent responses, allowing a clearer understanding of the factor that may influence their awareness. The subsection 4.2 identified three drivers for adopting blockchain. These drivers are derived from the findings and also recognized in the theory. The subsection is based on inquiries concerning the significance of tracing system linked to adoption of blockchain for stakeholders in the seafood supply chain. The third subsection, 4.3, delves a deeper into the respondents' thoughts and perspectives on the governmental interference in terms of regulations and corporation between public and private affairs. Subsection 4.4 outlines findings regarding an unexpected sustainability issue. The chapter concludes with a summary that links the adoption drivers of blockchain technology to the benefits of tracing Norwegian fish. Figure 6. visually illustrates the chapter's structure.

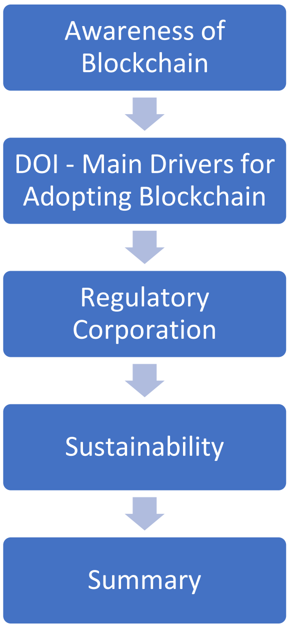

Figure 6. Structure of results

4.1 Awareness of Blockchain

The results reveal that all nine participants possessed some degree of knowledge about blockchain technology, although the level of understanding varied among them. Notably, the retailers demonstrated a lower awareness towards blockchain. Among the retailers, a particular association between blockchain and criminality, likely influenced by the common perception of bitcoins association with blockchain technology. Retailer 1 was convinced that they needed insurance that use of blockchain will not destroy their reputation before any adoption. However, retailer 1 was the one who clearly stood out with little knowledge about blockchain and how it could benefit traceability.

The findings indicate that al producers had information about the technology, highlighting a fellow producer, Kvarøy Arctic's utilization of blockchain, which served as a catalyst for their interest in learning more about blockchain. Consequently, the producer emerged as the participants with the most extensive knowledge about blockchain among the group. On the other hand, the transporters demonstrated a moderate level of familiarity with blockchain, with their focus primarily centred around traceability rather than the technical aspects of blockchain. Notably, the transporters exhibited the highest level of knowledge regarding traceability, while their understanding of blockchain remained neutral.

4.2 DOI - Main Drivers for Adopting Blockchain.

Adoption of blockchain throughout the supply chain has several benefits, misconceptions, doubts and characteristics. In these subchapters, the main factors which were discovered by the help of the interviews and theory, are categorized as three overreaching drivers: Complexity & Compliance, Trust & Security and Observability & Marketing.

4.2.1 Complexity & Compliance

When exploring the complexities associated with adopting blockchain or any new technology, the research findings revealed that the responses could be categorized based on the nature of the companies.

Producers:

When asking producer about the complexities of adopting blockchain, their PEU of blockchain was affected by three aspects: Integration challenges, data standardization and cost considerations. The producers emphasised that adapting new systems and processes to incorporate blockchain technology may require significant changes in infrastructure, data management, and supply chain operations. Data standardization regarded ensuring the consistent data formats, quality, and interoperability across different production facilities and systems can be a complex task. They ended it by stressing the cost considerations of implementing blockchain technology since it involves upfront investment costs, training program, and ongoing maintenance expenses.

"In the end, it is always a matter of cost" – Producer 1.

However, producers 1 and 2 were not emphasizing the complexities as a barrier compared to the PU it could provide their daily operations and trade. One of their main issues with the entire supply chain is product complaints. Producer 3 emphasized that blockchains ability to offer detailed information about the handling of fish from the moment it is caught until it reaches the plate, has the potential to distribute complaints evenly across the entire chain, alleviating the burden on producers who would otherwise bear the full cost.

Transporters:

When asking transporters regarding the PEU of with blockchain, three complexities were considered: Traceability complexities, data synchronization and regulatory compliance. The traceability issues roots from tracking and recording the movement of seafood products throughout the supply chain, particularly when dealing with multiple transportation modes, diverse routes, and varying storage conditions. Data synchronization was about coordinating and synchronizing data across different transporters, warehouse, and shipping partners as they may require the establishment of secure communication protocols and data sharing mechanisms. Regulatory compliance becomes a complexity to the adoption of blockchain when adhering to relevant regulations and standards related to food safety, customs, and international trade.

"It would seem easier and less complex to adopt blockchain if the whole supply chain is connected" – Transporter 3.

Retailers:

When asking retailers about their PEU of potentially using blockchain, three complexities were emphasised: Supply chain visibility, interoperability challenges and consumer education. When dealing with multiple suppliers, the visibility was stressed as gaining real-time visibility into the origin, quality, and handling of seafood products across the supply chain. Interoperability was emphasised as ensuring compatibility and seamless data exchange between different blockchain systems used by producers, transporters and retailers, which can be a complex task, requiring standardize protocols and integration efforts. Lastly, consumer education by educating consumers about the benefits and trustworthiness of blockchain-based traceability systems is necessary to promote adoption and drive demand for seafood products.

"Empowering consumers with knowledge about seafood - Understanding freshness, shelf life, and making informed choices. Education is key to combating ignorance and promoting sustainable seafood practices." – Retailer 3.

Retailer 1 saw blockchain as very complex as they possessed little knowledge about the technology. Due to their low knowledge, the retailer emphasised scepticism towards adopting it. They followed it up by making statement such as:

"We are already following the standards handed down to us and have great relationships with our suppliers. We have our own traceability system which is based on trust." – Retailer1.

4.2.2 Trust & Security

Transporter 1 with high knowledge about the technology emphasises that a blockchain contains information regarding transactions, rather than conclusive values as found in a traditional database. This implies that it retains information detailing the process through which the final value was attained. Retailer 1 gave an example of this considering a bank account. In this case, a traditional database would exhibit a balance, representing a definitive value. Conversely, a blockchain would not solely store the balance but also all the transaction that transpired to yield the ultimate value observable in online banking. The series or sequence if transaction furnishes a credible narrative elucidating shy the end value is as it appears, with all the transaction leading to the final value being accessible on the blockchain. Consequently, there is an enhanced level of trust in the values as all the transaction that contributed to that figure are transparent. By recoding claims using a tracking system and sorting the information on a blockchain, a more robust foundation for verification is established.

An interesting finding was that exclusive emphasis on B2B trust within the seafood supply chain by producers. When there is a complaint, the economic burden consistently falls on their shoulders. Due to the importance of maintaining positive relationships with buyers, particularly when dealing with white fish which has a smaller market share than salmon, bearing the cost becomes inevitable.

“Due to dishonesty, we would like to have a complete picture over the transactions, especially dealing with foreign clients” – Producer 2.

Within the seafood supply chain, transaction shed light on events involving the fish’s journey through processing, transportation, and storage. Retailer 2 and Producer 3 both underscore the facilitation of marketing the remarkable story of Norwegian fish trough continuous, accurate documentation and accessible information. Customers can be assured of the reliability of the information received.

“The immutability of the information entered into the blockchain creates a sense security. No one can taper with it” Producer 3.

The primary driver of adoption of blockchain on the background of trust & security, according to transporter 2, lies in the verifiability of the data. This contributes to safeguarding their company supply chain. For customers and consumers, this instils credibility and assurance in relations to the purchased product. Furthermore, there are occurrences in the industry that may now necessarily impact all aquaculture and fishery companies but still exert a negative influence on the industry’s reputation. The respondent from transporter 1 believes that if blockchain can assist in verifying the actual culprits, it can demonstrate that the wrongdoing does not extend to the entire industry but is limited to those who have engaged in illicit or improper activities. By ensuring access to trustworthy information, accountability can be fostered within the supply chain stakeholders. For the producers, which already are doing a lot in terms of labelling and internal tracking batches of fish, blockchain technology proves beneficial as it ensures the curacy of the provided information. They can have sensors linked to the blockchain, thereby demonstrating to customers their control over the supply chain.

“If our client desires, we can prove a paper printout detailing the temperature inside the container during the transportation of fish. However, the true value lies in leveraging sensors connected to blockchain, enabling direct access to log reports for everyone involved”. – Transporter 2

4.2.3 Observability & Marketing

The interviews revealed that one of the benefits of traceability is observability. Through trace ability and information derived from trace ability systems, it becomes possible to showcase products with the advantageous characteristics, Producer 1 highlights. Most respondents acknowledge that traceability can enhance the industry's reputation and contribute to compelling storytelling. Reputation building a narrative are associated with how the fish is promoted. By informing consumers about the content of their meals, one enhances the reputation of fish, Retailer 2 explains. The information received by consumers must be trustworthy end demonstrative off the company's command over the supply chain. Transporter 3 considers reputation building to be one of the most significant advantages of traceability. The transporter emphasised that to cultivate reputation, it is essential to make Norwegian fish appealing to consumers in foreign markets.

"Improving our reputation increases the appeal of our products and raw materials" – Producer 2.

Order complaints and carbon emissions Are two factors that undermine the reputation of the seafood industry, states Producer 3. Comprehensive knowledge and documentation throughout the supply chain can bolster the position of Norwegian fish. Fish fraud tarnish the reputation, and the participant from Producer 2 suggest that traceability can shed light on the responsible company besides the fish fraud. The informant from Transporter 1 remarks that much of the negative reputation associated with the industry is unwarranted, as the information often tends to be generalised to the entire sector rather than targeting the specific company involved. The Retailer 1 also presents prospects for enhancing the reputation of frozen fish, which currently suffers from a negative perception. By tracing the entire supply chain of frozen fish, consumers can gain a reliable indication of the fish's quality. Frozen fish is less dependent on air transport as its shelf life surpasses that of fresh fish. Expanding the consumption of frozen fish can consequently reduce the reliance on air transportation and thereby mitigate the industry's carbon emissions. Transporter 2 underscores the importance of reducing carbon emissions as a pivotal condition for reputation enhancement, despite the emissions being significantly lower than those associated with chicken, pork, and beef production. In terms of carbon footprint, transportation predominantly amplifies the overall CO_2 footprint.

"Our Norwegian seafood has a captivating narrative when it comes to emissions." – Transporter 2.

Three of the interviewees emphasize the significance of conveying the story behind the fish for the industry. Retailer 3 believes that the supply chain should excel in conveying the narrative to make consumers more aware of choosing products that have been properly handled and have undergone sustainable supply chain. Norway's minimal use of antibiotics provides marketing opportunities for the country's seafood industry, according to the producer 2. When marketing the story of Norwegian fish, the information must simultaneously be factually grounded and verifiable. Producer 1, who works quality management, suggest that marketing efforts should be built upon the pillars of sustainability, experienced individuals, and nature. When leveraging traceability appropriately, the value of each individual fish can be augmented.

4.3 Regulatory Influence and Standards

The producer 2 and retailer 3 emphasised in the interview that traceability is important to ensure that food complies with regulation and norms. There exist a variety of laws aimed at ensuring that companies meet the demands for documenting the supply chain of seafood, highlighted retailer 2. Due to an increased focus on secure food tracing, additional requirements have also been formulated in recent times. To achieve compliance with these laws, it is necessary to adhere the general principles, prerequisites, and procedures, thereby placing a focus on decision making concerning the safety of food and feed. As stated by both the producer and the retailer, ISO standards exists that explain the information that must be recorded at each stage in the supply chain through which the fish products pass. Moreover, in order to, to make this mainstream and effective, it has to be a standards for all stakeholder to uphold, highlighted transporter 2.

Producer 2 is looking forwards to the development of new standards and guidelines for the use of tracking, enabling a broader range of companies to adopt tracing technologies. In this way, it will become a more cost-effective to deploy systems across the whole seafood supply chain and consolidate and synchronize outdates systems into a unified framework. The producer believed that blockchain is the appropriate technology to test.

"Often, technology is developed, and the fish must adapt to it, but we need to reverse this. It is the technology that must be adapted to the fish" – Producer 2

Both producers and retailers were unanimously emphasising the fact that the new regulations and standards implemented by the government authorities, lack the necessary expertise and the know-how of fishing and seafood handling. Both parties continued saying that often when it comes to implementing new technology in order to comply with regulatory requirements, we need to adopt to the technology, and never the other way around. Producer 1 believed that in many cases, they are being put in contact with young professional from authorities with fresh educations, lacking experience in the industry and then receive instruction on how to manage our workday.

"People born on an asphalt; do not know how we do things in the sea" – Retailer 1

4.4 Sustainability

Regarding sustainability, traceability was emphasised as the tool to make sure where the fish was produced and the level of sustainability. Most of the respondents believed that this is an important aspect for today and the future. Producer 1, Producer 3 and Retailer 1 believed that traceability can create openness in terms of how well the companies are striving to meet the sustainability goals of the UN. For retailer 3, the sustainability was emphasised on a positive note as the technology have the potential to track inventory levels, labelling and customer engagement.

"The less you hide, more openness and security your make towards the consumer, seller, transportation and producer." – Transporter 1.

Whereas almost all participants emphasised a positive drive towards the environment, a nuanced perspective on the sustainability benefits emerged. Retailers expressed a degree of scepticism and emphasized the importance of empowering consumers to independently verify the fish they wanted to buy. Retailer 2 imagined either a digital live-sending label or QR-code to check obvious details about the fish. The retailers expressed concern that implementing such a system could potentially lead to higher food waste compared to current situation. Retailer 1 raised this question in order to prove their point:

"Imagine you have 20 cod filets in front of you, and you can now scan a QR-code to check the freshness of the fish, which filet would you choose?" – Retailer 1.

Retailer 3 stressed as the retailers get new fish-delivery every day and want to display it as it gets empty in their stock. The ones left in the counter will be perceived as "old" fish by the consumers, even though it is eatable. And the less desirable fish, always ends up in the bin, highlighted retailer 1.

"Are we creating new environmental problems to solve the existing ones?" – Retailer 2.

4.5 Summary of Findings

Keeping the RQ in mind, it is possible to shed light on "*What are the perceptions, experiences, and challenges of stakeholders in the Norwegian seafood supply chain regarding the adoption of blockchain technology?"*. The results examined the perspectives of three producers, transporters, and retailers within the seafood supply chain. The data collected through interviews was analysed using coding techniques on the background of the conceptual framework, hypothesis, and research question. The findings indicate that PU and PEU of blockchain adoption varied among the stakeholders. Producers demonstrated a high level of PU and moderate PEU, as they recognized potential benefits of blockchain in enhancing traceability and regulations but needed to change current routines. Transporters, also found a high level of PU and a moderate level of PEU, citing concerns about the integration of new technology into their existing processes. Retailers exhibited a lower level of PU and PEU, having high understanding of the benefits but expressing scepticism about the reputation of blockchain and the sustainability benefits and potential increase in food waste.

The assessment of the stakeholder's perspective revealed that the role of institutions played a crucial role in shaping their attitudes toward blockchain adoption. The participants emphasised high influence and interference by the Norwegian government and global standards. Government regulations and monitoring bodies were perceived to lack the necessary expertise and understanding of the seafood industry, which led to scepticism, frustration and hesitation among stakeholders. Therefore, we can keep the HQ1: The ease of use of blockchain technology in the seafood supply chain will be influenced by the stakeholders' perceptions of governmental interference.

Overall, the results highlight the importance of considering stakeholders PU and PEU, the role of institutions, and their impact on the adoption of blockchain technology in the seafood supply chain. These findings contribute to the understanding of the challenges and opportunities associated with implementing blockchain in the industry and provide insights for policymakers and industry stakeholders seeking to leverage technology for improved traceability. Before setting any conclusions, the results need to be discussed in the lens the respective theories.

5.0 Discussion

In this chapter, the discoveries from Chapter 4 are examined in conjunction with the theory presented in Chapter 2. By merging this information, we can address the SRQ: "*What is the* *current level of technology acceptance among Norwegian seafood producer, transporters, and retailers in relation to the adoption of blockchain technology?"* The discussion relies on the study's findings and compares them with existing implementations of the technology in seafood supply chains. To establish a fundamental comprehension of how blockchain can operate in Norwegian fish supply chains, the technology role will be briefly deliberated upon.

Blockchain technology can serve as a fundamental decentralized database system for storing the digital identity of fish using blocks. Within the blockchain, information pertaining to critical events in the supply chain is logged and distributed. Most projects identified in this study employ blockchain technology precisely in this manner. With the registration of new blocks, fresh information regarding the fish and its progression trough the supply chain is appended. The fish and the raw materials utilized in production are recorded as a digital layer employing IoT, enabling real-time mapping of the fish's condition. Data is interconnected into an extensive chain of information, enabling continuous traceability of the fish. This system offers a secure and trustworthy foundation for data sharing across supply chain participants, facilitating adherence to regulations and standards.

Producers – Early Adopters:

Perceived Usefulness: All producers had a positive attitude towards the technology as the benefits is key to some of their issues related to trade. Therefore, a positive attitude in regard to PU. Moreover, they acknowledged its ability to provide transparent and immutable traceability, ensuring product authenticity. The producers generally displayed a positive feedback when asking about their attitudes towards complexity and compatibility of the technology. Producer 1 said that they are always looking for new and more efficient ways to process the fish but emphasised that they just need the right person for the right job. Knowledge is always something they could require as they believe it all ends on an economic question. However, without the hired expertise, it could become too technical for them. Therefore, their PEU is considered moderate.

Compared with the sample studied, producers will in this research fit under the category "Early Adopters" in the theory of DOI. This is due to their emphasis on openness towards innovation, taking calculated risks, and actively seek out new solutions that can provide them with a competitive advantage. The producer has been proven as more of forward-thinkers and initiative-taking and are likely to recognize the potential benefits of adopting blockchain to improve their operations, enhancing efficiency, and ensuring sustainability in the seafood supply chain. They are willing to invest time, resources, and effort into testing and implementing innovative solutions, even if they may not be widely adopted in the industry yet.

The producers studied tends to embrace new technology, where the motivation lays in the willingness to differentiate themselves from competitors, streamlining their processes, improving traceability, and meeting the evolving demands of consumers and regulatory requirements. It is important to mention that the producers where superior in terms of financial stability which can influence their willingness to take risk such as adopting new technology. In that regards, it might be reasonable to emphasise that their early adoption can serve as a catalyst for the broader adoption of new technologies in the seafood industry, influencing other stakeholder and driving innovation throughout the supply chain.

The evidence derived from the interviews conducted in this study strongly supported the various drivers for innovation outlined in The Diffusion of Innovation theory. The findings revealed that factors such as perceived relative advantage, compatibility with existing practices, complexity, observability, and trialability played crucial roles in influencing the adoption and implementation of innovative practices among the participants. This alignment with the theoretical framework demonstrated the suitability of The Diffusion of Innovation theory for understanding and explaining the innovation processes within the context of this study. However, it is important to acknowledge that while the theory provided valuable insights, it had certain limitations. For instance, it primarily focused on the adoption and diffusion of innovations at the individual and organizational levels, potentially overlooking broader societal and contextual factors that may also impact innovation processes. Additionally, the theory assumes a linear and predictable diffusion process, which may not fully capture the complexities and dynamics of real-world innovation scenarios. Thus, while The Diffusion of Innovation theory served as a valuable framework for this study, it is essential to consider its limitations and supplement it with other perspectives to gain a more comprehensive understanding of innovation phenomena.

Based on the findings and participants' perceptions, it became possible to categorize them into the DOI theory’s distinct groups based on their openness and pace in adopting new technology:

Transporters – Early Majority:

The transporters recognized the perceived usefulness of blockchain in improving traceability throughout the supply chain. Transporter 2 and 3, who had moderate knowledge of blockchain, understood however that blockchain could provide real-time monitoring of temperature, location, and other relevant data, thereby enhancing the integrity of the transported seafood. The seafood transporters exhibited neutral attitude towards the ease of use towards blockchain. Their current systems generally revolve around the same routines. As they emphasised that their current routines only need transparency when the client asks for it. While some expressed concerns about the technical complexity, others recognized the potential benefits and were open to embracing necessary changes.

For seafood transporters, adopting new technology such as blockchain in the supply chain requires significant coordination and collaboration with various stakeholders, including producers, retailers and regulators. Transporters can be categorized as “Early Majority” using the DOI. This is due to the study’s recognition that transporters need to ensure seamless integration of technology into their existing logistics and transportation systems while maintaining efficiency and minimizing disruptions. Therefore, they are likely to observe the successful implementation of technology by early adopters, assess its impact on the industry, and me informed decisions based on the evidence of its benefits and ease of use.

Moreover, transporters have emphasised to be more risk-averse compared to producers, however, are open to embracing modern technology once they become more established and proven. The reasons for this might be the discoveries of transporters having more of a pragmatic approach, in need of market validation, minimising risk mitigation and emphasising industry standards and collaboration.

Overall, seafood transporters strike seems to balance between mitigating risks and adopting modern technology. They would like to observe the innovators and early adopters, seek market validation, and systematically weigh the benefits and possible drawback before adopting new technology into their already existing systems.

Retailers – Early Majority:

All the retailers, despite their lack of knowledge, saw blockchain as beneficial and understood its features. However, due to their scepticism and sustainability concerns, made their PU categorized as moderate. The retailers showed a generally negative attitude towards the ease of using blockchain technology. However, the nature of their business states that they generally can’t compared with the size of a seafood producer, so cost and knowledge is too factors impacting their ease of use as they do not hold expertise to utilize the technology.

Seafood retailers, like transporters, also fall under the “Early Majority” category in the DOI as they have underscored their tendency to assess the market demand and potential advantages of adopting blockchain technology. They have proven their motivation by factors such as improving supply chain transparency, ensuring product quality and safety, and meeting the expectations of increasingly informed consumers. Retailers has also shown an emphasis on the ease of use and complexities regarding integration of modern technology within their existing operations, such as inventory management, labelling, and customer engagement.

Moreover, like seafood transporters, retailers value industry collaboration and adherence to standards. They have emphasised that the adoption of technology must align with the industry practices and is supported by the industry associations and regulatory bodies. However, retailers and producers seemed to be one of the most critical regarding regulatory interference when it comes to new standards and regulations from a top-down approach. They would be more open to regulatory influence if the expertise from the industry itself were considered when setting new practises. Lastly, retailers emphasised customer engagement linked to sustainability as they believe that traceability and transparency can create more food waste as the customer always would want the freshest fish in the desk.

Based on these aspects within the seafood industry and the DOI and Institutional theory, we can again shed light on the main RQ: “*What are the perceptions, experiences, and challenges of stakeholders in the Norwegian seafood supply chain regarding the adoption of blockchain technology* “. Overall, while affective states can vary among stakeholders and their nature of business in the seafood industry, it is plausible that a combination of enthusiasm, cautiousness, and curiosity exists. Early adopters within each stakeholders’ category may be more willing to embrace blockchain technology, driven by the potential benefits it offers. However, addressing concerns, fostering collaboration, and establishing industry-wide standards are crucial in gaining consensus and encouraging broader adoption throughout the Norwegian seafood supply chain.

6.0 Conclusion

Openness for blockchain adoption varied among stakeholders, with producers demonstrating the highest PU and PEU, transporters showing being moderate, and retailers exhibiting moderate. Stakeholders perspectives were influenced by the role of institutions, with concerns raised about the expertise and understanding of government regulations and monitoring bodies in the seafood industry. Factors such as technology readiness, trust, information sharing, cost, and sustainability as important considerations in the adoption of blockchain. The benefits were raised as blockchain technology has the potential to enhance traceability, transparency and trust in the seafood supply chain.

The implications for the seafood industry underscores the need for awareness and educations among stakeholders to understand the benefits and challenges of blockchain adoption. Collaboration and coordination among industry players, regulators, and technology providers are essential to address barriers and facilitate successful implementation. Stakeholders should consider the scalability, interoperability, and data governance aspect of blockchain solution to ensure long-term viability and sustainability.

One suggestion for future research could be investigation of the economic and environmental impacts of blockchain implementation on different stakeholders and the overall seafood supply chain. A second suggestion could be the role of blockchain in promoting sustainability practises and supporting certification schemes in the seafood industry. Lastly, investigating the use of smart contracts in regard to trust and security within the seafood supply chain.

The findings emphasised the need for a collaborative approach among stakeholders and provide insights for policymakers, industry professionals, and researchers seeking to leverage blockchain technology for improved traceability and sustainable practices in the seafood industry. Further research in the identified areas will continue to advance knowledge and ease the successful integration of blockchain technology in the seafood supply chain.

7.0 References

Simatupang, T. M., & Sridharan, R. (2002). The Collaborative Supply Chain. *The International Journal of Logistics Management*, 15-30.

Aadland, C. (2019, September 11). Retrieved from https://www.fiskeribladet.no/tekfisk/kvaroy-fiskeoppdrett-skal-samle-informasjon-om-laksen-i-blokkjede/2-1-669523

Aadland, C. (2019, December 2). *Fiskeribladet*. Retrieved from https://www.fiskeribladet.no/tekfisk/de-ville-selge-ekte-norsk-laks-til-kina-det-forte-til-egenutviklet-blokkjede-teknologi-/2-1-712991

Abeyratne, S. A., & Monfared, R. P. (2016, September). Blockchain Ready Manufacturing Supply Chain Using Distributed Ledger. *International Journal of Research in Engineering and Technology,, 5*(9). Retrieved from https://www.researchgate.net/profile/Radmehr-Monfared/publication/308163874_Blockchain_Ready_Manufacturing_Supply_Chain_Using_Distributed_Ledger/links/57fe2dde08ae7275640133b0/Blockchain-Ready-Manufacturing-Supply-Chain-Using-Distributed-Ledger.pdf

Amini, M., & Abukari, A. M. (2020, December). ERP Systems Architecture For The Modern Age: A Review of The State of The Art Technologies. *Journal Of Applied Intelligent Systems & Information Sciences, 1*(2), 70-90. Retrieved from https://journal.research.fanap.com/article_111141.html

Angelis, J., & Da Silva, E. R. (2019, June). Blockchain adoption: A value driver perspective. *Business Horizons, 62*(3), 307-314. Retrieved from https://doi.org/10.1016/j.bushor.2018.12.001

Asche, F., Guttormsen, A., Nøstbakken, L., Roll, K., & Øglend, A. (2014, October 13). Organisering av verdikjeder i norsk sjømatnæring // Organization of value chains in the Norwegian seafood industry. *The Norwegian Government*. Retrieved from https://www.regjeringen.no/contentassets/2210a1545141461d8d4789da59659c32/delrapport_nou.pdf

Atea. (2020, January 16). *Atea.no*. Retrieved from https://www.atea.no/siste-nytt/havbruksteknologi/mer-baerekraftig-med-blockchain-teknologi/

Aune, L. (2021, September 1). *Northern Delights*. Retrieved from https://northerndelights.com/editorial/what-is-sustainable-fishing/

Aung, M. M., & Chang, Y. S. (2014, May). Traceability in a food supply chain: Safety and quality perspectives. *Food Control, 39*, 172-184. Retrieved from https://www.sciencedirect.com/science/article/pii/S0956713513005811

Austevoll Seafood ASA. (2021). White Fish. *Fishin. Processing. Distribution*. Retrieved from https://www.auss.no/our-investments/value-chain/white-fish/

Azzi, R., Chamoun, R. K., & Sokhn, M. (2019, September). The power of a blockchain-based supply chain. *Elsevier*, 582-592. Retrieved from https://www.sciencedirect.com/science/article/pii/S0360835219303729

Azzi, R., Kilany, R., & Sokhn, M. (2019, June 17). The power of a blockchain-based supply chain. *Computers & Industrial Engineering*, 582-592. Retrieved from https://doi.org/10.1016/j.cie.2019.06.042

Bavassano, G., Ferrari, C., & Tei, A. (2020, March). Blockchain: How shipping industry is dealing with the ultimate technological leap. *Research in Transportation Business & Management, 34*. Retrieved from https://www.sciencedirect.com/science/article/pii/S2210539519301646?casa_token=xl8ZMJCvJGkAAAAA:w_moOYnHK2wiEVh7a8pBBVUxpiYnW9tsXCgZCnOuE0xATqXq563UkP9Kl-Q9K2yK_0v6GsdbsA

Beretta, C., Stoessel , F., Baier, U., & Hellweg, S. (2013, March). Quantifying food losses and the potential for reduction in Switzerland. *Waste Management, 33*(3), 764-773. Retrieved from https://www.sciencedirect.com/science/article/pii/S0956053X12005302

Bhatt, T., Cusack, C., Dent, B., Gooch, M., Jones, D., Newsome, R., . . . Zhang, J. (2016, January 19). Project to Develop an Interoperable Seafood Traceability Technology Architecture: Issues Brief. *Comprehensive Reviews in Food Science and Food Safety, 15*(2), 392-429. Retrieved from https://ift.onlinelibrary.wiley.com/doi/full/10.1111/1541-4337.12187?casa_token=fIsc_pkgsoAAAAAA%3AvK9j1EqKTO14r4rfAa6NZF2PIcq8Qad_bZqozMwKn78_UIdR-GqK_hwcoLDhgDoIRsZuCD2dm7xdEw

Bryman, A. (2016). *Social Research Methods* (5 ed.). London: Oxford University Press.

Cermaq. (2020). The value chain - from fjord to table. Retrieved from https://www.cermaq.no/v%C3%A5r-produksjon/verdikjeden

Chauhan, C., Dhir, A., Akram, M. U., & Salo, J. (2021, May 1). Food loss and waste in food supply chains. A systematic literature review and framework development approach. *Journal of Cleaner Production, 295*. Retrieved from https://www.sciencedirect.com/science/article/pii/S0959652621006582

Chen, Y., & Chang, S. E. (2020). When Blockchain Meets Supply Chain: A Systematic Literature Review on Current Development and Potential Applications. *Research Gate*, 99. Retrieved from https://www.researchgate.net/publication/340214661_When_Blockchain_Meets_Supply_Chain_A_Systematic_Literature_Review_on_Current_Development_and_Potential_Applications

Christiansen, H., Fournier, N., Hellemans, B., & Volckaert, F. A. (2018, March). Seafood substitution and mislabeling in Brussels' restaurants and canteens. *Science Direct*, pp. 66-75. Retrieved from https://www.sciencedirect.com/science/article/pii/S0956713517304383?via%3Dihub

Cruz, E. F., & Cruz, A. M. (2020). Using Blockchain to Implement Traceability on Fishery Value Chain. *Instituto Politecnico de Viana do Castelo, 15th International Conference on Software Technologies*. Retrieved from https://d1wqtxts1xzle7.cloudfront.net/91037254/98897-libre.pdf?1663149984=&response-content-disposition=inline%3B+filename%3DUsing_Blockchain_to_Implement_Traceabili.pdf&Expires=1684968816&Signature=OztZAKO1SrgvCTeFUUZgVNyAeHTMAxlpwozcd6P76I7d3gJCjC713HEk

Deloitte. (2021, December 7). *Blockchain: Ready for business*. Retrieved from Deloitte.com: https://www.deloitte.com/global/en/our-thinking/insights/topics/technology-management/tech-trends/2022/blockchain-trends.html

DiMaggio, P. J., & Powell, W. W. (1983, April 2). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review, 48*(2), 147-160. Retrieved from https://www.jstor.org/stable/2095101?casa_token=Tv7yCQh4G_gAAAAA%3AZllawWlyJJ

M7zlHcOtKbrmqyl_CUUPWt-tc8qGmBkj4x_59-cloQXqmrHv3ynDJPnywzdL9kGxRtqY1vo_NhQHMOWoXJc9AjP7yBEA2qP7RjP-Ms-p8

Directorate of Fisheries. (2022). *Regulations*. Retrieved from Fiskeridir.no: https://www.fiskeridir.no/English/Fisheries/Regulations

Duan, J., Zhang, C., Gong, Y., Brown, S., & Li, Z. (2020, March 9). A Content-Analysis Based Literature Review in Blockchain Adoption within Food Supply Chain. *International journal of environmental research and public health, 17*(5). Retrieved from https://www.mdpi.com/1660-4601/17/5/1784

FAO. (1988). *Definitions.* Retrieved from https://www.fao.org/3/x6941e/x6941e04.htm

FAO. (2020). The State of World Fisheries and Aquaculture. *Sustainability in action*. Retrieved from http://www.fao.org/documents/card/en/c/ca9229en

FAO. (2022). *Technical Platform on the Measurement and Reduction of Food Loss and Waste*. (U. Nations, Producer) Retrieved April 6, 2023, from Food and Agriculture Organization of the United Nations: https://www.fao.org/platform-food-loss-waste/flw-data/en/

FAO. (2023). Salmo salar Linnaeus. *Fisheries and Aquaculture Division*. Retrieved April 26, 2023, from https://www.fao.org/fishery/en/aqspecies/sal

Fawcett, S. E., Osterhaus, P., Magnan, G. M., Brau, J. C., & McCarter, M. W. (2007). Information sharing and supply chain performance: the role of connectivity and willingness. *An International Journal*. Retrieved from https://www.emerald.com/insight/content/doi/10.1108/13598540710776935/full/html

Febrianto, T., & Soediantono, D. (2022, June). Enterprise Resource Planning (ERP) and Implementation Suggestion to the Defense Industry: A Literature Review. *Journal of Industrial Engineering & Management Research, 3*(3). Retrieved from https://jiemar.org/index.php/jiemar/article/view/278

Flick, U. (2018). *The SAGE Handbook of Qualitative Data Collection.* Sage.

Galletta, A., & Cross, W. E. (2013). *Mastering the Semi-Structured Interview and Beyond: From Research Design to Analysis and Publication.* New York City.

Gausdal, A. H., Czachorowski, K. V., & Solesvik , M. Z. (2018, June 7). Applying Blockchain Technology: Evidence from Norwegian Companies. *Sustainability, 10*(6). Retrieved from https://www.mdpi.com/2071-1050/10/6/1985

Gibbens, S. (2019). *What is seafood fraud? Dangerous—and running rampant, report finds.* National Geographic. Retrieved from https://www.nationalgeographic.co.uk/2019/03/what-is-seafood-fraud-dangerous-and-running-rampant-report-finds

Glavee-Geo, R., & Engelseth, P. (2018, April 3). Seafood export as a relationship-oriented supply network: Evidence from Norwegian seafood exporters. *British Food Journal*. Retrieved from https://www.emerald.com/insight/content/doi/10.1108/BFJ-04-2017-0249/full/html

Grønland, S. E. (2017). Logistic Management. Oslo, Norway: Cappelen Damm Akademisk. Retrieved from https://www.akademika.no/okonomi-administrasjon-og-ledelse/ledelse/logistikkledelse/9788202525927

Grotty, M. J. (2003). *The Foundations of Social Research : Meaning and Perspective in the Research Process* (3rd ed.). London: Sage Publications Ltd. Retrieved from https://www.torrossa.com/en/resources/an/5019222

Guba, E. G., Lincoln, Y. S., & Denzin. (1994). *Hanbook of Qualitative Research: Paradigmatic Controversies, Contradictions, and Emerging Confluences.* CA: Thousand Oaks, Sage.

Haider, M., & Kreps, G. L. (2010, August 17). Forty Years of Diffusion of Innovations: Utility and Value in Public Health. *Journal of Health Communication, 9*, 3-11. Retrieved from https://www.tandfonline.com/doi/full/10.1080/10810730490271430

Haller, K., Lee, J., & Cheung, J. (2020). *Meet the 2020 consumers driving change.* IBM, Research Insights.

Huang, Y., Han, W., & Macbeth, D. (2020). The complexity of collaboration in supply chain networks. *Supply Chain Management: An International Journal.* Retrieved from https://www.emerald.com/insight/content/doi/10.1108/SCM-11-2018-0382/full/html

IBM. (2020, June 4). *Kvarøy Arctic Using IBM Blockchain to Trace Norwegian Farmed Salmon to North American Stores*. Retrieved from Newsroom.ibm.com: https://newsroom.ibm.com/2020-06-04-Kvar-y-Arctic-Using-IBM-Blockchain-to-Trace-Norwegian-Farmed-Salmon-to-North-American-Stores

IBM. (2023). *What are smart contracts on blockchain?* Retrieved February 4, 2023, from IBM.com: https://www.ibm.com/topics/smart-contracts

IntraFish. (2019, March 6). *IntraFish.* Retrieved from https://www.intrafish.no/pressemeldinger/ny-teknologi-kan-gi-bedre-tillit-hos-sjomatkonsumentene/2-1-558889

Jahre, M., Persson, G., & Gripsrus, G. (2006, September). Supply Chain Management—Back to the Future? *International Journal of Physical Distribution & Logistics Management*. Retrieved from https://www.researchgate.net/publication/235322673_Supply_Chain_Management-Back_to_the_Future

Jeyaraj, A., Rottman, J. W., & Lacity, M. C. (2006). A review of the predictors, linkages, and. *Journal of Information Technology*, 1-23. Retrieved from https://journals.sagepub.com/doi/pdf/10.1057/palgrave.jit.2000056

Johannessen, A., Christoffersen, L., & Tufte, P. A. (2011). *Research Methods for Economics and Administrative Courses* (3 ed.). Oslo: Abstract Publisher.

Johnsen, J. P. (2022, November 28). *Fishery.* Retrieved from The great Norwegian lexicon: https://snl.no/fiskeri

Kalfagianni, A. (2006, February 24). Transparency in the food chain: policies and politics. Retrieved from https://research.utwente.nl/en/publications/transparency-in-the-food-chain-policies-and-politics

Kamilaris, A., & Fonts, A. (2019, September). The rise of blockchain technology in agriculture and food supply chains. *Trends in Food Science & Technology, 91*, 640-652. Retrieved from https://www.sciencedirect.com/science/article/pii/S0924224418303686

Khan, M. (2016, November). Information sharing in a sustainable supply chain. *International Journal of Production Economics*, 208-214. Retrieved from https://www.sciencedirect.com/science/article/pii/S0925527316300354

Kouhizadeh, M., Zhu, Q., & Sarkis, J. (2019, December 9). Blockchain and the circular economy: potential tensions and critical reflections from practice. *Production Planning & Control, 31*(11-12), 950-966. Retrieved from https://www.tandfonline.com/doi/full/10.1080/09537287.2019.1695925

Kshetri, N. (2018, April). Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management*, 80-89. Retrieved from https://www.sciencedirect.com/science/article/pii/S0268401217305248

Kværnstuen, B. (2021, October 19). *Norwegian Seafood Council*. Retrieved from https://seafood.no/aktuelt/nyheter/digitalt-grep-skal-trygge-fremtidens-fiskekjopere/

Kvile, K. (2019, November 20). *Fiskeribaldet*. Retrieved from https://www.fiskeribladet.no/tekfisk/cermaq-satser-pa-blokkjede-teknologi/2-1-709817

Laksefakta. (2021, October 4). Tranport of Salmon. *Transport av oppdrettslaks tar hensyn til både fiskehelse, miljø og mattrygghet.* Retrieved from https://laksefakta.no/lakseoppdrett-i-norge/transport-av-laks/

Larson, P. P. (2007). A beginner's Guide to logistics Management. *Journal of Business Management*, 1.24. Retrieved 4 14, 2023, from https://www.futurelearn.com/info/courses/international-logistics-introduction-et/0/steps/204270

LeMay, S., Helms, M. M., Kimball, B., & McMahon, D. (2017, November 13). Supply chain management: the elusive concept and definition. *The International Journal of Logistics Management*, 1425-1453. Retrieved from https://www.emerald.com/insight/content/doi/10.1108/IJLM-10-2016-0232/full/html

Lofti, Z. (2013). Information Sharing in Supply Chain Management. *Elsvier*, 298-304. Retrieved from https://www.sciencedirect.com/science/article/pii/S2212017313003484

Mills, A. J., Durepos, G., & Wiebe, E. (2010). *Iterative. Encyclopedia of case study research.* Sage.

Moe, T. (1998, May). Perspectives on traceability in food manufacture. *Trends in Food Science & Technology, 9*(5), 211-214. Retrieved from https://www.sciencedirect.com/science/article/pii/S0924224498000375

Moosavi, J., Naeni, L. M., & Fathollahi-Fard, A. M. (2021, February 27). Blockchain in supply chain management: a review, bibliometric, and network analysis. *Environmental Science and Pollution Research*. Retrieved from https://link.springer.com/article/10.1007/s11356-021-13094-3

Morat, A. A., Andersson, K., & Schelen, O. (2019). A Survey of Blockchain From the Perspectives of Applications, Challenges, and Opportunities. *Journal & Magazines, 7*. Retrieved from https://ieeexplore.ieee.org/abstract/document/8805074

Mowi. (2022). Salmon Farming Industry Handbook. Retrieved from https://mowi.com/wp-content/uploads/2022/07/2022-Salmon-Industry-Handbook-1.pdf

Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System.* www.bitcoin.org. Retrieved from https://bitcoin.org/en/bitcoin-paper

NFD; OED;. (2017). The government's ocean strategy. *Ministry of Industry and Fisheries (NFD) & Ministry of Oil and Energy (OED)*. Retrieved from https://www.regjeringen.no/contentassets/097c5ec1238d4c0ba32ef46965144467/nfd_havstrategi_uu.pdf

Nisbet, R., & Yale, K. (2018). *Handbook of Statistical Analysis and Data minin Application* (2nd ed.). Retrieved from https://www.sciencedirect.com/topics/mathematics/deductive-approach

Norges Råfisklag. (2021). About Norges Råfisklag. Retrieved from https://gammel.rafisklaget.no/portal/page/portal/NR/Omoss/Om_Norges_Rafisklag

Norwegian Government. (2021, October 10). *Transparency Act*. Retrieved from Lovdata.no: https://lovdata.no/dokument/NLE/lov/2021-06-18-99

Norwegian Seafood Council. (2023, January 4). *Norwegian Seafood Council*. Retrieved from https://seafood.no/aktuelt/nyheter/norge-eksporterte-sjomat-for-1514-milliarder-kroner-i-2022/

Nour, B., Sharif, K., Li, F., Biswas, S., Moungla, H., Guizani, M., & Wang, Y. (2019, June 15). A survey of Internet of Things communication using ICN: A use case perspective. *Computer Communications, 142-143*, 95-123. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140366418309228?casa_token=miLSf1Giu8sAAAAA:2pQAS5n0NOwAG9vmFujkZL33zNI2vbdVJRGYMKG-80TQgwq7MoRO5O_0ir2lM8Q0EEzkNXs3jQ

Ocean Economist. (2020, August 6). *Connecting a chain of trust in the seafood supply chain*. Retrieved from https://ocean.economist.com/innovation/articles/connecting-a-chain-of-trust-in-the-seafood-supply-chain

Ólafsdóttir , G., Mehta, S., Richardsen, R., & Cook, D. (2019, September). Governance of the farmed salmon value chain from Norway to the EU. *Aquaculture Europe, 44*(2). Retrieved from https://valumics.eu/wp-content/uploads/2019/10/Valumics-AES-vol44-2-sept2019.pdf

Ólafsdóttir, G., Andrade, G. P., Nielsen, T., Larsen, E., Ingolfsdottir, G. M., Yngvadottir, E., & Bogason, S. G. (2013). Key environmental challenges for food groups and regions representing the variation within the EU, Ch.3 Salmon Aquaculture Supply Chain. *Department of Planning*. Retrieved from https://vbn.aau.dk/en/publications/key-environmental-challenges-for-food-groups-and-regions-represen

Olsen, P. (2018). *Food traceability in theory and in practice.* UiT Munin - Open Research Archive. Retrieved from https://munin.uit.no/handle/10037/15408

Olsen, P., & Borit, M. (2013, February). How to define traceability. *Trends in Food Science & Technology, 29*(2), 142-150. Retrieved from https://www.sciencedirect.com/science/article/pii/S0924224412002117

Olsen, P., Borit, M., & Syed, S. (2019). *Applications, limitations, costs, and benefits related to the use of blockchain technology in the food industry.* CRIStin. Retrieved 04 17, 2023, from https://nofima.brage.unit.no/nofima-xmlui/handle/11250/2586121

Olteanu, V. (2003). *Management Marketing.* Bucharest: Ecomar PH.

Opdahl, L. M., & Saric, S. (2021, Janurary 14). Fisheries and aquaculture | Sustainability initiatives in the seafood industry. *NEWSLETTER*. Retrieved from https://bahr.no/newsletter/fiskeri-og-havbruk-baerekraftsinitiativer-i-sjomatnaeringen

Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods: Integrating Theory and Practice* (3rd ed.). CA: Sage Publications; Thousand Oaks.

Prajogo, D., & Olhager, J. (2012, January). The effects of long-term relationships, information technology and sharing, and logistics integration. *International Journal of Production*

Economics(1), 514-522. Retrieved from https://www.sciencedirect.com/science/article/pii/S0925527311003872

Puthal, D., & Malik, N. (2018, July). Everything You Wanted to Know About the Blockchain: Its Promise, Components, Processes, and Problems. *IEEE Consumer Electronics Magazine, 7*(4), 6-14. Retrieved from https://www.researchgate.net/publication/326102908_Everything_You_Wanted_to_Know_About_the_Blockchain_Its_Promise_Components_Processes_and_Problems

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2020, February 24). Blockchain and supply chain management integration: a systematic review of the literature. *Supply Chain Management: An, 25*(2). Retrieved from https://www.emerald.com/insight/content/doi/10.1108/SCM-03-2018-0143/full/html

Rangan, K. V., Shapiro, B. P., & Rowland, M. T. (1995). Cases, Concepts and Applications. In *Business Marketing Strategy.* London: Richard d Irwin.

Rogers, E. M. (1995, March). The Origins and Development of the Diffusion of Innovations Paradigm as an Example of Scientific Growth. *Science Communication, 3*. Retrieved from https://doi.org/10.1177/1075547095016003002

Saberi, S., Kouhizadeh, M., & Sarkis, J. (2018, March). Resources, Conservation & Recycling: Blockchain technology: A panacea or pariah for resources conservation and. *Elsevier*, 80-81. Retrieved from https://www.sciencedirect.com/science/article/pii/S0921344917304111?via%3Dihub

Sander, K. (2022, March 25). Phenomenology and phenomenological design / analysis. Retrieved from https://estudie.no/fenomenologisk-design/

Slevitch, L. (2011, February 6). Qualitative and Quantitative Methodologies Compared: Ontological and Epistemological Perspectives. *Journal of Quality Assurance in Hospitality & Tourism*, 73-81. doi:https://doi.org/10.1080/1528008X.2011.541810

Standard Norway. (2021). *Increased investment in fisheries and aquaculture*. Retrieved from Standards.no: https://www.standard.no/nyheter/nyhetsarkiv/fiskeri-akvakultur-og-mat/2021-nyheter/okt-satsning-innen-fiskeri-og-havbruk/

Stebbins, R. A. (2001). *Exploratory Research in the Social Sciences.* SAGE. Retrieved from https://books.google.no/books?hl=no&lr=&id=hDE13_a_oEsC&oi=fnd&pg=PA5&dq=Stebbins,+R.A.:+Exploratory+Research+in+the+Social+Sciences.+Sage,+Thousand+Oaks+(2001)&ots=NmXIW0AIrF&sig=PTsZpyuiXg7F_b2LdVcogPKcYoo&redir_esc=y#v=onepage&q=Stebbins%2C%20R.A.%3A%2

Stranieri, S., Riccardi, F., Meuwissen, M., & Soregaroli, C. (2021, Januray). Exploring the impact of blockchain on the performance of agri-food supply chains. *Food Control, 119*. Retrieved from https://www.sciencedirect.com/science/article/pii/S0956713520304114

Sunny, J., Undralla, N., & Pillai, V. M. (2020, December). Supply chain transparency through blockchain-based traceability: An overview with demonstration. *Computers & Industrial Engineering, 150*. Retrieved from https://www.sciencedirect.com/science/article/pii/S0360835220305829?casa_token=28SHSdJH_1oAAAAA:JHJW-647OH2Lld6eyKmFnGm4dF6Zr3pC0DI0k14lJcYKIdCB6YzE63R4eujMq_gJXhCiDSvQuA

Svendsen, K. (2020, February 16). *IntraFish*. Retrieved from https://www.intrafish.no/nyheter/leroy-seafood-group-og-fransk-supermarkedkjede-samarbeider-om-sporbarhet-pa-laks/2-1-754870

Swan, M. (2015). *Blockchain: Blueprint for a New Economy.* O'Reilly Media, Inc.

Tan, B., & Yan, J. (2018). The Impact of Blockchain on Food Supply Chain: The Case of Walmart. In *Smart Blockchain* (pp. 167-177). Retrieved from https://link.springer.com/chapter/10.1007/978-3-030-05764-0_18

The Norwegian Government. (2019). *Taxation of aquaculture activities - About the aquaculture industry.* Retrieved from Regjeringen.no: https://www.regjeringen.no/no/dokumenter/nou-2019-18/id2676239/?ch=4

Tian, F. (2016). An agri-food supply chain traceability system for China based on RFID & blockchain technology. *International Conference on Services Systems and Services Management, ICSSSM* (pp. 1-6). Institute of Electrical and Electronic Engineers (IEEE).

Tian, F. (2017). A supply chain traceability system for food safety based on HACCP, blockchain & Internet of things. *2017 International Conference on Service Systems and Service Management* (pp. 1-6). IEEE. Retrieved from https://ieeexplore.ieee.org/abstract/document/7996119

Tjora, A. (2021). *Qualitative Research Methods in practise* (3rd ed.). Oslo: Gyldendal Norsk Forlag AS.

Towill, D. R. (1997, Janurary 1). The seamless supply chain - the predator's strategic advantage. *International Journal of Technology Management, 13*(1), 37-56. Retrieved from https://doi.org/10.1504/IJTM.1997.001649

Tuli, F. (2010). The Basis of Distinction Between Qualitative and Quantitative Research in Social Science: Reflection on Ontological, Epistemological and Methodological Perspectives. *Ethiopian Journal of Education and Sciences, 6*(1). Retrieved from https://www.ajol.info/index.php/ejesc/article/view/65384

United Nations . (2020). *UN*. Retrieved from https://www.un.org/sustainabledevelopment/development-agenda/

Van der Vorst, J. (2000). Effective Food Supply Chains: Generating, Modelling and Evaluating Supply Chain Scenarios. *The Humanities and Social Sciences Collection*. Retrieved from https://www.proquest.com/dissertations-theses/effective-food-supply-chains-generating-modelling/docview/2571905262/se-2

Volini, A., Shah, A. A., Koch, R., & Moradian, S. (2019). *Using blockchain to drive supply chain innovation.* Deloitte. Retrieved from https://www2.deloitte.com/us/en/pages/operations/articles/blockchain-supply-chain-innovation.html

Wognum, P., Bremmers, H., Trienekens, J. H., & van der Vorst , J. G. (2011, January). Systems for sustainability and transparency of food supply chains – Current status and challenges. *Advanced Engineering Informatics*(1), 65-76. Retrieved from https://www.sciencedirect.com/science/article/pii/S1474034610000455

WWF. (2023, April 26). *Word Wild Life*. Retrieved from https://www.worldwildlife.org/industries/sustainable-seafood

Yadav, S., & Singh, S. P. (2020, January). Blockchain critical success factors for sustainable supply chain. *Resources, Conservation and Recycling, 152*. Retrieved from https://www.sciencedirect.com/science/article/pii/S0921344919304112?casa_token=rLvDSCzNUMwAAAAA:v-wYJsmqTT_1rq4C01UT8wZxdVAymD36EJeqehQjVNa6uRrXvq6nY5ljrJ_BapvQZ_Sw2SoIng

Yang, C. S. (2019, November). Maritime shipping digitalization: Blockchain-based technology applications, future improvements, and intention to use. *Transportation Research Part E: Logistics and Transportation Review, 131*, 108-117. Retrieved from https://www.sciencedirect.com/science/article/pii/S1366554519307045?casa_token=W3QtxYV4uGkAAAAA:tdqoSJzZ3St8zIwkAWnpWA_vXnAwV6pMxyxARr_7hdceRzba3QaTgRx8ZYiPFUXg96U_FsG_QA

Yiannas, F. (2018, July 1). A New Era of Food Transparency Powered by Blockchain. *Innovations Technology Governance Globalization*, pp. 46-56. Retrieved from https://direct.mit.edu/itgg/article/12/1-2/46/9839/A-New-Era-of-Food-Transparency-Powered-by

Zheng, Z., Xie, S., Dai, H.-N., Chen , X., & Wang, H. (2018, October 17). Blockchain challenges and opportunities: a survey. *International Journal of Web and Grid Services, 14*(4), 353-375. Retrieved from https://www.inderscienceonline.com/doi/abs/10.1504/IJWGS.2018.095647

Zijm, H., Klumpp, M., Heragu, S., & Regattieri, A. (2019). Definitions and Objectives. In *Operations, Logistics and Supply Chain Management* (pp. 27-42). Springer International Publishing. Retrieved from https://www.springerprofessional.de/en/operations-logistics-and-supply-chain-management-definitions-and/16082900

Summary of Master Thesis

Introduction.

The purpose of this master thesis is to address the perceptions of stakeholders in the seafood supply chain to embrace a unified traceability system, which can lead to decreased possibilities of fraud and unethical practices during the product journey. Seafood traceability is crucial due to global consumer trends that prioritize transparency, traceability, and accountability. It enhances consumer confidence, ensures food safety, promotes sustainability, addresses ethical concerns, and facilitates regulatory compliance in the seafood industry.

Inconsistent utilization of the network among stakeholders creates data gaps, emphasizing the need for uniformity in technology adoption throughout the seafood supply chain to mitigate such risks. The thesis argues that it is crucial for all stakeholders to utilize the same network by the potential of adopting blockchain technology. Due blockchains feature of being a decentralised system, it is possible to ensure transparency and accountability in the seafood industry. Blockchain are currently being experimented within seafood supply chains all over the world and serves as a foundation of further investigation of factors who drives adoption of blockchain within stakeholders in the seafood supply chain.

The research focuses specifically on the world leading Norwegian seafood fishing industry, where limited research exists on the adoption of blockchain technology among different stakeholders. The main research questions formulated to address this issue is: *"What are the perceptions, experiences, and challenges of stakeholders in the Norwegian seafood supply chain regarding the adoption of blockchain technology?"*

Literature and Theoretic Review:

The thesis structure begins with a comprehensive presentation of relevant literature related to the research domain, including supply chains, the Norwegian fishing industry, traceability and blockchain technology. The theoretical foundation serves as the basis for the analysis, discussion, and conclusion of the thesis. The theory used to analyse the adoption of blockchain technology in the Norwegian seafood industry was The Diffusion of Innovation by Everett Rogers (1995). The theory is a good tool as it emphasises five dimensions of which driver adoption: *compatibility, relative advantage, observability, and trialability.* The dimension can also help to categorize the stakeholders according to their openness and how fast individuals adopt new technology. Rogers categorized adopters into five unique groups: *Innovators, early* *adopters, early majority, late majority* and *laggards*. As early adopters influence others to adopt the innovation, a critical mass of adopters is formed, leading to widespread diffusion throughout the population until it reaches a saturation point.

In order to moderate the relationship between DOI and adoption of blockchain, the Institutional Theory (DiMaggio & Powell, 1983) were used. By incorporating institutional theory as a moderator, the study acknowledges that the adoption of blockchain technology is not solely influenced by individual stakeholders or the characteristics of the innovation itself. Instead, it recognizes that broader institutional forces such as industry norms, regulations, and social expectations, can shape the adoption of process and determine its success.

Methodology:

In terms of the research design, this master thesis utilized an linear approach in data collection and analysis, allowing for a more firm structure. The structure provided by this linear approach enabled the adaption of data collection and analysis methods as the study progressed. The advantage of this process lies in its ability to hold a straight focus of the needs of the study. In terms of the relationship between theory and data, the thesis followed a deductive approach. Deductive reasoning involves starting with topic of interest followed by theory and then develop HQs and then collecting and analysing data. This exploratory approach provided A deeper understanding of the phenomenon under study and allowed for the development of new research areas. By employing an linear data collection an analysis approach and adopting an deductive reasoning approach, the thesis took a comprehensive an exploratory stance, enabling a nuanced investigation of the research topic.

This thesis adopts a qualitative approach to capture diverse perceptions and thoughts on the adoption of blockchain in the Norwegian fish supply chains. The methodology is guided by interpretive epistemology and relativistic ontology, focusing on subjective perceptions and individual interpretations. As the study aims to explore varied attitudes towards blockchain adoption and acknowledges the challenge of quantifying its integration due to limited industry implementation.

The research began with an exploration of existing theories and concepts related to technology adoption and blockchain. Interviews were conducted to gather information on attitudes towards adopting blockchain for tracing Norwegian fish using the Diffusion of Innovation theory. The study also considers the influence of the regulatory environment on adoption intentions in the seafood supply chain. The analysis of interview data focused on perceived usefulness and ease of use of blockchain. The findings highlighted variations in adoption and utilization of blockchain technology. Factors determining blockchain adoption were further examined, considering its potential to streamline the fish journey in the supply chain. The literature review emphasized the benefits of blockchain technology in seafood supply chains. The research process involved an deductive approach, with an deductive structure from theory to data collection. The empirical information, combined with theoretical insights, informed the discussion and conclusion of the research question.

The main research question of this study is focused on exploring the perceptions, experiences, and challenges of stakeholders in the seafood supply chain regarding the adoption of blockchain technology. Additionally, a sub-question aims to assess the current level of technology acceptance among seafood producers, transporters, and retailers in relation to blockchain adoption. Based on these research questions, the following hypothesis is proposed:

Hypothesis (HQ1): The ease of use of blockchain technology in the seafood supply chain will be influenced by stakeholders' perceptions of governmental interference. This hypothesis suggests that stakeholders' perceptions of institutional characteristics, including regulatory requirements and industry standards, will play a significant role in their decision to adopt blockchain technology. The institutional pressures will act as moderating factors, either facilitating or hindering the adoption process.

The data used in this thesis is gathered from primary and secondary data. The primary data consists of interview, theory and the literature review. Further, the secondary data have given valuable information which have helped shaped the scope of the research. In this study, in-depth interviews were conducted as part of the qualitative research approach. These interviews focused on leaders in the Norwegian seafood industry and aimed to explore their perceptions of traceability systems using blockchain technology. The interviews provided valuable insights into the industry's operations and stakeholders' thoughts on implementing tracking and blockchain solutions. The participants for this study were purposefully selected based on the necessary information to be collected. The sample consisted of individuals on a managerial level who had been actively collaborating with the Norwegian seafood supply chain for at least five years. The focus was on stakeholders within the fishery industry, excluding the aquaculture industry, to gain a specific insight into a particular segment of the seafood industry. The stakeholders studied included processors, transporters, and retailers who were not currently utilizing blockchain technology in their daily operations.

The selection process involved identifying potential participants through online searches, professional networks, and industry referrals. The referrals were obtained by starting with the producers and then gathering information about their transporters and buyers to identify relevant stakeholders. By targeting these key players within the supply chain, the study aimed to gain a comprehensive understanding of the factors influencing the adoption of blockchain technology in the Norwegian seafood supply chain.

Diversity in terms of gender and age was also considered in the participant selection to ensure a range of perspectives and experiences related to blockchain adoption. The table provided in the study showcases the participants and the timeframe of the interviews, further highlighting the selection process and timeline of the study.

A semi-structured interview approach was used, allowing for flexibility and unexpected discussions while following a guide. The individual interviews provided a deeper understanding without external influence. A pilot test with a similar group was conducted to improve the clarity and comprehensiveness of the interview guide. Feedback from the pilot test led to minor adjustments, ensuring high-quality data in the actual interviews.

A customized interview questionnaire (Attachment 1) was developed to align with the objectives of the interviews. The questionnaire aimed to encourage open dialogue while ensuring all essential inquiries were covered. Participants received the questionnaire in advance, promoting reflective responses and preventing hasty answers. The questions were systematically categorized for easy reference and analysis. The questionnaire underwent assessment by the designated advisor at LUISS University, and the researchers reviewed and refined the questions for relevance and coherence prior to conducting the interviews.

The interviews were conducted over a three-week period, both in-person and via Microsoft Teams. The use of Teams allowed for recording the interviews, which aided in transcription. However, the digital approach limited the perception of non-verbal cues and body language. Participants provided consent for the interviews and recording. Some questions required clarification, leading to modifications in the interview guide. Insights were continually gained throughout the interviews, with some participants displaying enthusiasm and engaging in extensive conversations while others were more succinct. Open-ended questions were initially posed to encourage free expression, but in hindsight, more follow-up questions could have been asked for specific answers. It's worth noting that the participants may have been influenced by receiving the interview guide in advance, which included potential benefits of traceability that may have shaped their responses.

After completing the interviews, the transcripts were transcribed, and a concise summary of each interview was created based on the interview guide. This summary focused on relevant information related to the research question. Coding was then applied to identify central categories and keywords related to the adoption of new technology. These factors were organized in a table, linking them to the contributing companies. The initial groups were reviewed, and similar terms were merged into overall categories. Everett Rogers' five drivers for technology adoption served as a starting point for categorization, which was modified and adapted to the findings. The categories provided insights into the factors influencing the adoption of blockchain in tracking Norwegian fish and allowed for comparisons between stakeholders in the seafood supply chain.

The study's quality was assessed through control, planning, and reflection on choices. The chosen criteria for quality assessment were credibility, transferability, dependability, confirmability, and reflexivity. Credibility relied on shared opinions and alignment with theoretical findings. Transferability focused on transmitting knowledge to comparable phenomena. Dependability considered the replicability of the research in similar conditions. Confirmability emphasized the link between data and findings, while reflexivity involved continual engagement with the researcher's position and research context. Through these criteria, the study aimed to ensure high quality and credibility in its findings.

Results:

This chapter presents the interview findings categorized into subsections: DOI, Regulatory Corporation, Sustainability, and a summary. It examines respondents' awareness of blockchain, identifies adoption drivers, explores government regulations and collaboration, and uncovers a sustainability issue. The chapter concludes with a summary linking blockchain features to tracing benefits.

The study found that all nine participants had some knowledge of blockchain technology, although the level of understanding varied. Retailers showed a lower awareness, possibly influenced by negative associations with criminality and bitcoins. Retailer 1 had limited knowledge and expressed concerns about reputation. Producers had more extensive knowledge, with one producer serving as a catalyst for others' interest in blockchain. Transporters had a moderate level of familiarity, focusing on traceability rather than technical aspects. Transporters had a high understanding of traceability but a neutral understanding of blockchain.

The complexities of adopting blockchain technology were explored among different stakeholders. Producers highlighted integration challenges, data standardization, and cost considerations. Transporters discussed traceability complexities, data synchronization, and regulatory compliance. Retailers emphasized supply chain visibility, interoperability challenges, and consumer education. While some stakeholders saw complexity as a potential barrier, others recognized the benefits it could bring to their operations. The importance of consumer education and trust in promoting adoption was also highlighted.

When talking about trust and security, transporter 1 explains that blockchain retains transaction information, providing a transparent and trustworthy narrative of how a final value is obtained. Producers emphasize the burden of B2B trust in the seafood supply chain, bearing the cost of complaints to maintain positive relationships. Retailer 2 and Producer 3 highlight the marketing benefits of continuous documentation and accessible information through blockchain. Transporter 2 emphasizes the verifiability of data as a primary driver for adopting blockchain, instilling credibility and assurance for customers. Blockchain can also foster accountability and demonstrate that wrongdoing is not pervasive in the industry. Producers benefit from accurate information and can demonstrate control over the supply chain through sensors linked to the blockchain. Transporter 2 suggests leveraging sensors and providing direct access to log reports for everyone involved.

Traceability offers observability and marketing benefits, allowing products to showcase advantageous characteristics and contribute to compelling storytelling. Reputation building and narrative promotion are associated with informing consumers about the content and command over the supply chain. Traceability helps address factors that undermine the industry's reputation, such as order complaints, carbon emissions, and fish fraud. It can shed light on responsible companies and provide reliable indications of quality, particularly for frozen fish. Reducing carbon emissions is crucial for reputation enhancement, and Norwegian seafood has a captivating narrative in terms of emissions. Conveying the story behind the fish enhances consumer awareness and promotes sustainable choices. Marketing efforts should focus on sustainability, experience, and nature, and leveraging traceability can increase the value of each individual fish.

Traceability is crucial for ensuring compliance with regulations and standards in the seafood industry. Various laws and ISO standards exist to guide companies in documenting their supply chain and ensuring food safety. The need for unified standards and guidelines for tracking technologies is highlighted by transporter 2. Producer 2 looks forward to the development of new standards that adapt technology to the fish, making traceability more accessible and cost-effective for the entire supply chain. However, both producers and retailers express concerns that government authorities implementing regulations lack expertise and industry knowledge. They believe that technology should adapt to the industry's needs, rather than forcing the industry to conform to new technologies without proper understanding.

Traceability is seen as a crucial tool for ensuring sustainability in the seafood industry. Participants believe that traceability can promote openness and transparency in meeting sustainability goals, such as those set by the UN. However, there is a nuanced perspective among retailers who express concerns about potential drawbacks. They emphasize the importance of empowering consumers to verify the fish they purchase independently. Retailers also raise concerns about potential food waste and the perception of freshness if traceability systems are implemented. They question whether new environmental problems may arise in the process of solving existing ones. Retailer 3 highlights the need to display and sell fish before it becomes perceived as "old," leading to potential waste. Overall, while traceability is seen as beneficial for sustainability, there is a need to carefully consider its implementation to address potential challenges.

The study examined the perceptions, experiences, and challenges of stakeholders in the seafood supply chain regarding the adoption of blockchain technology. The findings revealed that stakeholders had varying levels of perceived usefulness (PU) and perceived ease of use (PEU) of blockchain. Producers and transporters showed higher levels of PU and moderate levels of PEU, while retailers demonstrated lower levels of PU and PEU. The role of institutions, such as government regulations and monitoring bodies, had a significant impact on stakeholders' attitudes toward blockchain adoption. Lack of expertise and understanding in the seafood industry led to scepticism and hesitation among stakeholders. These results support the hypothesis that stakeholders' perceptions of governmental interference influence the ease of use of blockchain technology. The findings emphasize the need to consider stakeholders' perspectives, the role of institutions, and their influence on blockchain adoption in the seafood supply chain. The study provides valuable insights for policymakers and industry stakeholders interested in leveraging blockchain for improved traceability in the industry. Further discussions and analysis of the results are required within the relevant theoretical frameworks to draw conclusive insights.

Discussion:

This chapter examines the findings from Chapter 4 and relates them to the theoretical framework presented in Chapter 2. The aim is to address the specific research question regarding the current level of technology acceptance among seafood producers, transporters, and retailers in relation to the adoption of blockchain technology. The discussion is based on the study's results and compares them with existing implementations of blockchain in seafood supply chains. The chapter also provides a brief overview of how blockchain technology can function in Norwegian fish supply chains. It explains that blockchain serves as a decentralized database system, storing digital information about fish in blocks. Critical events in the supply chain are logged and distributed within the blockchain. Many projects in the study use blockchain in this way. The technology enables real-time mapping of the fish's condition through the use of IoT, creating a digital layer for recording and tracing the fish and its raw materials. This interconnected system ensures secure and trustworthy data sharing among supply chain participants, facilitating compliance with regulations and standards.

The use of DOI had a great impact on the study’s structure and findings in regards to the research question. However, it was clear that not all drivers from the theory were emphasized by the data gathered from the interviews. However, it became evident that the producers in this study are considered "Early Adopters" according to the theory of Diffusion of Innovation (DOI). They demonstrated a positive attitude towards blockchain technology, recognizing its usefulness in addressing trade-related issues and providing transparent traceability. They viewed blockchain as a solution that can enhance their operations, improve efficiency, and ensure sustainability in the seafood supply chain. While they expressed openness to innovation and a willingness to invest in new solutions, they also highlighted the need for expertise to handle the technical aspects of the technology. Their perceived ease of use was considered moderate. The producers' financial stability and their proactive approach to differentiation, process improvement, and meeting consumer and regulatory demands contribute to their willingness to embrace new technology. As early adopters, their adoption of blockchain could serve as a catalyst for broader adoption within the seafood industry, driving innovation throughout the supply chain.

The transporters in this study can be categorized as "Early Majority" according to the Diffusion of Innovation (DOI) theory. They recognized the usefulness of blockchain technology in improving traceability and ensuring the integrity of transported seafood. While they had moderate knowledge of blockchain, they understood its potential for real-time monitoring of critical data. Transporters expressed a neutral attitude towards the ease of use of blockchain, as their current systems revolve around established routines and transparency is only provided upon client request. Some transporters expressed concerns about the technical complexity, while others were open to necessary changes.

As part of the early majority, transporters prioritize the seamless integration of technology into their existing logistics and transportation systems. They observe the successful implementation of technology by early adopters, assess its impact on the industry, and make informed decisions based on evidence of its benefits and ease of use. They tend to be more risk-averse compared to producers and seek market validation before adopting new technology. Transporters prioritize industry standards and collaboration while balancing the need for risk mitigation and embracing modern technology.

Overall, transporters demonstrate a pragmatic approach, weighing the benefits and potential drawbacks of adopting new technology. They seek market validation and observe the experiences of innovators and early adopters before making decisions about integrating technology into their established systems.

The retailers in this study can be categorized as "Early Majority" according to the Diffusion of Innovation (DOI) theory. Despite their limited knowledge of blockchain, they recognized its potential benefits and understood its features. However, their perceived usefulness (PU) was categorized as moderate due to their scepticism and concerns about sustainability. Retailers displayed a generally negative attitude towards the ease of use of blockchain technology. The size and nature of their business, along with cost and lack of expertise, influenced their perception of the technology's ease of use.

Similar to transporters, seafood retailers fall under the Early Majority category as they assess market demand and the potential advantages of adopting blockchain technology. Their motivation stems from improving supply chain transparency, ensuring product quality and safety, and meeting the expectations of informed consumers. Retailers also emphasize the complexities of integrating modern technology into their existing operations, such as inventory management, labelling, and customer engagement.

Collaboration within the industry and adherence to standards are valued by retailers. They believe that regulatory influence should consider industry expertise when setting new practices, and they express concerns about top-down approaches to new standards and regulations. Retailers also highlight the importance of customer engagement and sustainability, recognizing that traceability and transparency may lead to increased food waste as customers tend to prefer the freshest fish.

Overall, retailers demonstrate a cautious approach to adopting new technology, considering market demand, ease of use, and potential impacts on their operations. Collaboration, industry standards, and customer engagement are key factors influencing their decision-making process.

Considering the aspects within the seafood industry, Diffusion of Innovation (DOI) theory, and Institutional theory, we can gain insights into the perceptions, experiences, and challenges of stakeholders regarding the adoption of blockchain technology. The stakeholders in the seafood supply chain exhibit a combination of enthusiasm, cautiousness, and curiosity towards blockchain adoption. Early adopters within each stakeholder category show a greater willingness to embrace the technology, motivated by the potential benefits it brings.

However, addressing concerns related to ease of use, compatibility, and sustainability, as well as fostering collaboration among stakeholders, are crucial in gaining consensus and promoting broader adoption of blockchain throughout the Norwegian seafood supply chain. Establishing industry-wide standards and involving industry expertise in regulatory decisions can also contribute to the successful implementation of blockchain technology. By considering these factors and addressing the challenges, the seafood industry can leverage blockchain to enhance traceability, transparency, and efficiency in the supply chain.

Conclusion:

The openness towards blockchain adoption varied among stakeholders in the seafood industry, with producers being the most receptive, transporters exhibiting moderate openness, and retailers showing moderate receptiveness. The perspectives of stakeholders were influenced by the role of institutions, with concerns raised about the expertise and understanding of government regulations and monitoring bodies. Key factors influencing blockchain adoption included technology readiness, trust, information sharing, cost, and sustainability considerations.

The benefits of blockchain technology, including enhanced traceability, transparency, and trust in the seafood supply chain, were acknowledged. However, there is a need for awareness and education among stakeholders to understand the potential benefits and challenges associated with blockchain adoption. Collaboration and coordination among industry players, regulators, and technology providers are crucial for overcoming barriers and ensuring successful implementation.

Future research suggestions include investigating the economic and environmental impacts of blockchain implementation on different stakeholders and the overall seafood supply chain, exploring the role of blockchain in promoting sustainability practices and supporting certification schemes, and examining the use of smart contracts for trust and security within the seafood supply chain.

Overall, the findings highlight the importance of a collaborative approach and provide insights for policymakers, industry professionals, and researchers aiming to leverage blockchain technology for improved traceability and sustainable practices in the seafood industry. Further research in the identified areas will advance knowledge and facilitate the successful integration of blockchain technology in the seafood supply chain.

Attachments:

Attachment 1: Questionnaire Guide

- **Formal welcome to the interview.**

Demographics

1. What is the nature of your business in the seafood industry? (e.g., supplier, distributor, retailer, processor, etc.)
2. How many employees does your company have?
3. What role do you play in your company?
4. How long has your company been in operation in the seafood industry?
5. What is the annual revenue of your company?
6. How many locations does your company have?
7. Where is your company based?
8. What is the geographical scope of your company's operations?
9. What types of seafood products does your company handle?
10. Does your company have any certifications or accreditations related to sustainability or responsible sourcing?
11. What is the average length of time for a transaction to take place within your company's supply chain?
12. Have you heard of Blockchain technology?
13. Do you know how it can be used in your supply chain management?

If little knowledge about blockchain

Blockchain is a decentralized, digital ledger that records transactions in a secure, transparent and immutable way. Each block in the chain contains a unique cryptographic code and a record of transactions, which are validated by a network of nodes before being added to the chain. Blockchain technology can be beneficial for the seafood industry supply chain management by providing greater transparency, traceability and accountability of seafood products from ocean to plate. By using blockchain, seafood companies can record and track every stage of the supply chain, including catch location, vessel and crew information, processing, transportation and storage. This enables consumers to have access to verifiable information about the origin, quality and sustainability of the seafood they purchase, while also helping to prevent fraud, mislabelling and illegal fishing practices.

Perceived Usefulness & Perceived Ease of Use

1. **Complexity:** How complex do you perceive the implementation of blockchain technology in the seafood industry to be?
2. **Compatibility:** In what ways do you think blockchain technology is compatible with the seafood industry's existing systems and processes?
3. **Relative advantage:** What advantages do you think blockchain technology can bring to the seafood industry compared to traditional methods?
4. **Observability**: How visible do you think the use of blockchain technology will be in the seafood industry, and how will it impact stakeholders' perceptions of transparency and accountability?
5. **Trialability**: How willing are you to experiment with blockchain technology in the seafood industry, and what would motivate you to do so?

Regulatory Environment

1. How important do you consider the regulatory environment when deciding to adopt blockchain technology in the seafood industry?
2. In your opinion, what are the biggest regulatory challenges that need to be addressed for successful adoption of blockchain technology in the seafood industry?
3. How do you think the regulatory environment can be improved to better support the adoption of blockchain technology in the seafood industry?
4. How do you think regulatory compliance and blockchain adoption can work together to enhance trust among seafood players?
5. How do you think the regulatory environment affects the level of risk associated with adopting blockchain technology in the seafood industry?
6. In your opinion, what role should regulatory bodies play in facilitating the adoption of blockchain technology in the seafood industry?
7. How do you think regulatory frameworks can be tailored to meet the needs of different seafood players when it comes to adopting blockchain technology?

8. Do you think the current regulatory environment is sufficient to address the concerns and challenges related to the adoption of blockchain technology in the seafood industry?
9. In your opinion, how can regulatory bodies collaborate with industry stakeholders to support the adoption of blockchain technology in the seafood industry?

Intention to adopt blockchain.

1. How do you perceive the complexity of blockchain technology? Do you think it is easy to understand and use?
2. How do you perceive the relative advantages of blockchain technology compared to other technologies or systems currently used in the seafood industry?
3. How visible and observable do you think blockchain technology is in the seafood industry? Have you seen it being used or discussed by others in the industry?
4. Based on what you know about blockchain technology, do you see any potential barriers to its adoption within the seafood industry?
5. Would you be willing to adopt blockchain technology in your own operations or business? Why or why not?

Other than what I have asked you, do you have anything else you would like to add?

Thank you for your time.

Attachment 2: Declaration of Consent

Do you want to participate in this research project?

Blockchain in the Seafood Industry: An assessment of adoption in the Norwegian seafood supply chain

This is a question for you to participate in a research project where map the benefits of tracking Norwegian seafood/fish. In this writing, we provide you with information about the goals of the project and what participation will entail for you.

Purpose

This is a master's thesis in the study program Master in Management at LUISS University in Rome, where I want to shed light on the topic of tracking of Norwegian seafood. The purpose of the thesis is to map the attitudes towards new technology and blockchain in Norwegian seafood supply chain.

Issue: *What are the perceptions, experiences, and challenges of stakeholders in the Norwegian seafood supply chain regarding the adoption of blockchain technology?*

Collected data will only be used in the master's thesis.

Who is responsible for the research project?

Luiss University is responsible for the project.

Kim Jørgen Andreassen, student at Luiss University, is writing the master thesis.

Why are you being asked to participate?

The selection has been selected based on companies/individuals in the seafood industry that are of interest to the project. I want to interview people with different skills and backgrounds, who can provide a good data basis.

What does it mean for you to participate?

If you choose to participate in the project, an interview will last 30-60 minutes. Digital and physical interviews will be recorded with audio. There may be a need for several interviews during the project period, which will be done by agreement.

Participation is voluntary.

Participation in the project is voluntary. If you choose to participate, you may withdraw your consent at any time without giving any reason. All your personal data will then be deleted.

There will be no negative consequences for you if you do not want to participate or later choose to withdraw.

Your privacy – how we store and use your information.

We will only use your information for the purposes we have explained in this letter. We treat the information confidentially and in accordance with the privacy regulations.

- The students and the supervisor have access to the information stored during the project period.

- Measures taken to ensure that the information we store is secure will be stored with a password.

It is optional whether you wish to be recognized in the publication or not. Any information that will be published is job title and company.

What happens to your data when we conclude the research project?

The project ends on 31.05.2023. The information will be deleted at the end of the project.

What gives us the right to process personal data about you?

We process information about you based on your consent. On behalf of Luiss University has assessed that the processing of personal data in this project complies with the privacy regulations.

Where can I learn more?

If you have any questions about the study, or wish to exercise your rights, please contact:

- Supervisor: Luiss University by Professor Luigi Nasta (lnasta@luiss.it)

- Student: Kim Jørgen Andreassen (Kim.andreassen@studenti.luiss.it

Sincerely,

Kim Jørgen Andreassen

(Student)

Declaration of Consent:

I have received and understood information about the project *Value creation of tracking technology at Norwegian fish producers* and have had the opportunity to ask questions. I agree to:

- ❑ To participate in interview
- ❑ To participate in an interview with an audio recording
- ❑ Participating in interview with audio recording (Microsoft Teams)
- ❑ That information about me is published so that I can be recognised

I consent to my data being processed until the project is completed

---

(Signed by project participant, date)