University of South-Eastern Norway

Intentions to implement blockchain technology in shipping industry

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Abstract

The maritime industry is considered to be "slow" in the speed of development and introducing new methods to improve existing work processes. But with the emergence of a truly innovative technology like Blockchain, the industry seemed to wake up after a long hibernation and is now actively working on the study of a new technology.

The purpose of this work is to understand the basics of introducing new technology into the industry, the driving factors and barriers of implementing blockchain and to define whether intentions transferred to real actions. In this regard, a systematic literature review and exploratory multiple case analysis were carried out.

The maritime industry, long plagued by paperwork, information delays and disconnected supply chain parties, has begun to recognize the potential of the blockchain technology to transform transport management systems. Generating and executing agreements through the blockchain can allow for more accurate accounting, tracking of goods, and fleet management.

Like everything new, blockchain needs a comprehensive analysis of the advantages and disadvantages, possible risks etc. Is it as safe, transparent and can facilitate existing processes as many say? When there are few real cases, companies can refrain from implementing by being skeptical. Will they continue avoiding or will they take an example from such a giant as Maersk who is intensively working on the blockchain implementation process?

Key words: blockchain, digitalization, sustainability, digital platform, digital solutions,

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List of Terms and Abbreviations

CO_2	Carbon dioxide
DLT	Distributed ledger technology
FMCG	Fast moving consumer goods
IMO	International Maritime Organization
IoT	Internet of things
NSD	Norwegian Center for Research Data
SC	Supply chain
SLC	Systematic literature review
UNCTAD	United Nations Conference on Trade and Development

Contents

List of Tables and Figures

List of Tables

List of Figures

Chapter 1. Introduction

Background

In the maritime industry, it is very important to follow international rules and standards for efficient and trouble-free operation. According to IMO, maritime logistics account for more than 80% of all world trade, which proves how important and integral part of our life is (IMO, 2020). A banana transported by a shipping company from Ecuador can be found in a small rural village in Siberia. Is this not an indicator of how much the maritime industry is helping the market mechanism of countries to develop?

According to Stopford, the main customers of shipping industry are the companies working withing FMCG where the main roles are occupied by companies involved in retail, car producing, food industry, clothes), industry of oil, gas, coal etc (Stopford, 2009).

According to UNCTAD, maritime industry is now "changing, reflecting a shift to a new normal. This is characterized by a moderation in global economic and trade growth, the expanding regionalization of supply chains and trade patterns, a continued rebalancing of the Chinese economy, a larger role of technology and services in value chains and logistics, intensified and more frequent natural disasters and climate-related disruptions, and an accelerated environmental sustainability agenda with an increased awareness of the impact of global warming in particular" (UNCTAD, 2019).

Now in many industries there is a boom of innovative technologies, called the Digital Era, and many offshore companies have also begun to introduce new method to increase efficiency of supply chain processes in order to reduce costs, increase transparency etc.

People have always strived to make work easier: creating innovative products that could reduce the time of work being done, while not losing efficiency. Now the time has come when the shipping industry is undergoing a wave of changes, not only with the aim of simplification, but also with the aim of protecting nature and marine fauna. Indeed, due to pollution emissions, maritime companies are more and more thinking about reducing these emissions. It is also important to note that in addition to the direct emissions that ships make, there are many indirect pollutants. One of these factors is the bureaucracy and its inherent characteristics as a multitude of papers. To produce one pack of A4 sheets, 6% of one tree is required. Just think about how much paper is spent just to draw up contracts and papers for one voyage.

One of the innovative technologies in shipping industry that is bringing new changes is the blockchain technology. Though it is not only about reducing amount of paper but also

increased transparent supply chain. The scientific rationale for this work was the impact of changes on the marine industry. Such changes can be called changes of natural feature (climate change, global warming), industrial feature (pollution of atmosphere and nature by gas emissions and others), technological feature (creation of innovative technologies, products), human-behavioral feature (changing people's behavior). It will be more considered how exactly the technology impacts on the shipping industry in further chapters.

1.1. Research questions

Research question is a question or issue that requires a response in the form of a structured scientific inquiry. Not all problems are research problems because not every problem can be studied according to the rules of a scientific methodology (Frankfort-Nachmias, 2015).

The following questions are defined as research questions of the thesis:

RQ1: What factors do influence on intentions to adopt Blockchain technologies in maritime firms?

RQ2: What are barriers to implementing Blockchain technology in shipping companies?

RQ3: How intentions to adopt Blockchain technologies transferred to real actions?

In order to answer these questions interviews from maritime companies were conducted. And to get and to obtain the most accurate results, the collected data was compared with a systematic literature review.

1.2. Objectives

To answer the research questions, it is needed to set the following objectives:

1) Explore the relevant literature and identify key findings about shipping industry, innovation and blockchain.

2) Develop a research methodology by which the work will be carried out.

3) Collect data from shipping companies about implementation of blockchain in their companies.

4) Perform analysis of the collected data.

5) Discuss the results.

1.3. Structure

A structure of the research framework consists of 5 phases:

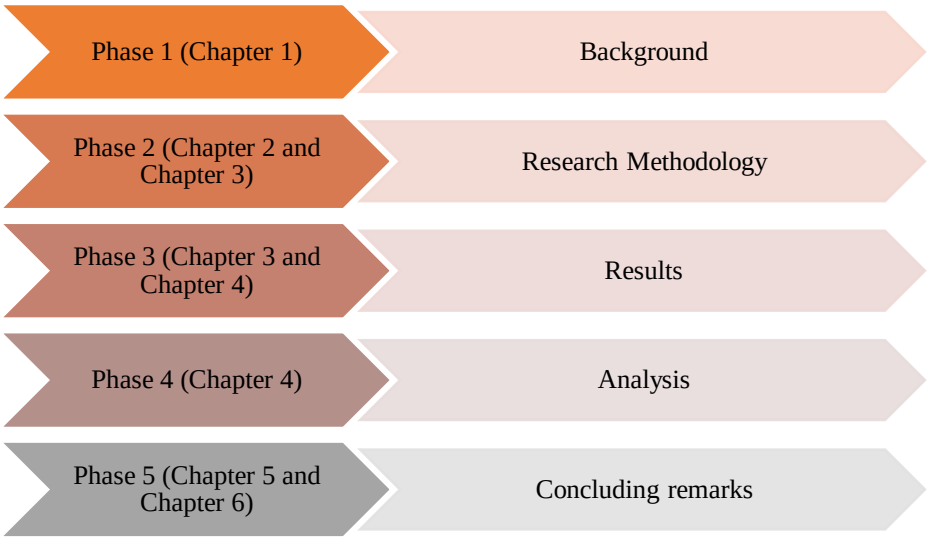

Figure 1. Thesis Structure

The first phase includes Chapter 1, which describes the topic's background, why this topic was chosen for this master's thesis and reveals objectives and research questions.

Further, the next phase gives a review of literature related to the topic and a research methodology, which clarifies methods of data collection and processing used in this work.

The third phase stands for data collecting through interviews and a systematic literature review.

The next one is devoted to analyzing the results.

The last phase comprises the discussions of the previous chapters and concludes on the research questions and gives recommendations for further research.

Chapter 2. Literature review

In order to better have a general overview of the structure and organization of the maritime offshore industry, it is needed to find out what is meant by this, and also to find out the theory behind the blockchain technology. And in order to achieve this goal, it is also important to highlight the definition of "innovation".

2.1. Innovation

Innovation is the driving force behind progress in any industry. Creating new innovative products and services helps companies compete with each other, while becoming better. Consideration of the topic of innovation needs to be understood in order to better understand where the blockchain technology came from, since it is an innovative product.

2.1.1. Definition of innovation

According to Barbaroux et al, they define innovation as «a process which implies the coordination of a set of scientific, technological, organizational, financial, political and managerial activities whose aim is to invent and then commercialize new knowledge» (Barbaroux, Attour, & Schenk, 2016).

Brynteson writes that “an innovation can be a product (iPod, double mocha skim latte), a service (text messaging, email addiction treatment), or process (new process for putting a product on the market in six months rather than two years)” (Brynteson, 2010).

On the other hand, Barlow looks at it from business perspective and comprehends as “… as the combination of invention and economic value. In other words, to be considered truly innovative, an invention needs to create new value” (Barlow, 2015).

As in most cases with the interpretation of complex processes, the word “innovation” does not have a clear single definition. Each author invests in it their own concept of this process, but one can agree that definition of the word “innovation” in many sources is interpreted as creation of a new product or service that provides increased efficiency for processes.

2.1.2. A place of innovations in the shipping industry

Occupying about 90 percent of all goods traded around the world, the shipping industry is growing rapidly (Lorange, 2020). Lately the industry has started investing more in innovative technologies and systems to minimize time delays and increase efficiency in general (Levins, 2017). Thus, the pace of development, unlike many other industries, lags behind.

The role of innovation plays as in-between phase in the business process:

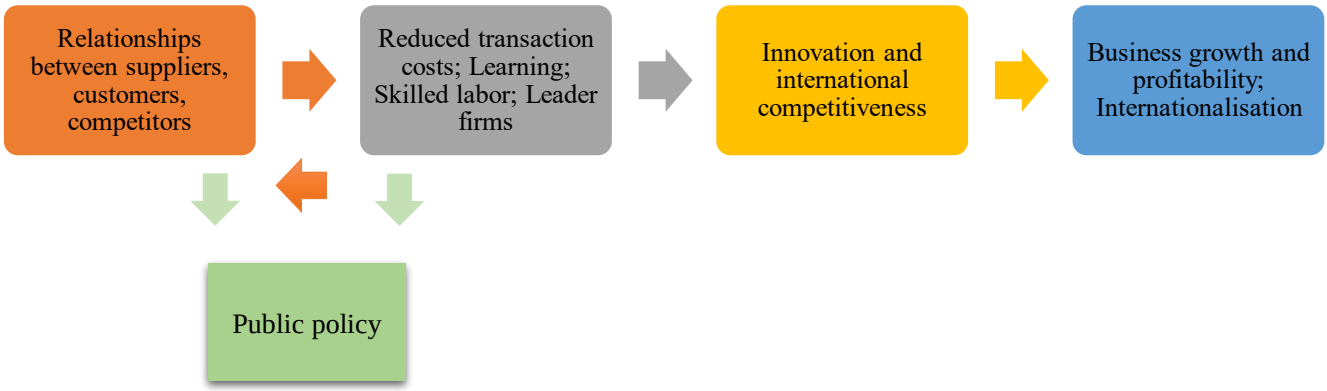

Figure 2. Industry and place of innovations in it adopted from Wijnolst & Wergeland (2008)

As it can be seen in Figure 2, innovations play an important role in the wealth creation process in any industry. By creating new things, they move forward towards an industry that creates competition between companies.

With regard to the maritime industry, in 20th century innovations were aimed mostly to make sailing safer, less considering about environmental issues. However, things have drastically changed in the past years. “Burning of fossil fuels generates a lot of green house gases, such as CO_2. The ratio is on average three tons of CO_2 for 1 ton of fuel (coal higher, gas lower)”. Due to the emission of CO_2 during shipping voyages, it leads to a negative impact on our environment, causing rising temperatures which in turn leads to the global warming, ice melting (*Wijnolst & Wergeland, 2008).*

Now, when the safety of shipping is more or less defined, new environmental changes are challenging the shipping industry to create innovative products, services that would help reduce pollution risks.

The shipping industry itself adopts changes slower than other industries due to its volume of processes, etc. But at the same time, in recent years, there is a clear trend in the development of innovative technologies in the field of digital transformations.

Lloyds Maritime Academy assigned 14 main terms regarding to digital products and services that changing the industry: AI, Autonomous vessel, Big data, *Blockchain*, Bot ("robot"), Cloud computing, Cybersecurity, Digital twin, Digitalization, Drone, IoT, Machine learning, Robotics or robotic technologies, Smart shipping (Lloyd's Maritime Academy, 2020).

2.2. Blockchain technology in the maritime industry

This section defines theoretical aspects of blockchain, and how the technology can be implemented in shipping industry.

2.2.1. Theory behind the blockchain technology

The idea of platforms of blockchain-like systems originates since 1970.

Year	***Description***
1970	James Ellis, public-key cryptography discovered at GCHQ in secret
1973	Clifford Cocks, RSA cryptosystem discovered at GCHQ in secret
1974	Ralph Merkle, cryptographic puzzles (paper published in 1978)
1976	Diffie and Hellman, public-key cryptography discovered at Stanford
1977	Rivest, Shamir, Adleman, RSA cryptosystem invented at MIT
1979	David Chaum, "Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups" (published in 1982)
1982	Lamport, Shostak, Pease, Byzantine Generals Problem
1992	Dwork and Naor, combating junk mail
2002	Adam Bach, Hashcash
2008	Satoshi Nakamoto, Bitcoin
2017	Wright and Savanah, nChain European patent application (issued in 2018)

Table 1. Timeline of selected discoveries in cryptography and blockchain technology (Sherman et al, 2018)

The first main work for a blockchain-like platform were proposed by cryptographer David Chaum in his work "Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups", where he described "vault system embodies many of the elements of blockchains" (Sherman et al, 2018).

The big event in digital world happened when an anonymous person (or a group of people) Satoshi Nakamoto released "Bitcoin: A Peer-to-Peer Electronic Cash System" in 2008.

There it has been described how bitcoin (decentralized digital currency) based on chains of blocks where each block has a secured information.

The blockchain is a type of DLT (distributed ledger technology), "which contains information about transactions or events. It can record transactions in a transparent, secure, decentralized, efficient, and low-cost way". According to Kitsantas et al, they are giving the definition of blockchain as "…a continuously growing list of records, called blocks, which are linked and secured using cryptography. Each block typically contains a cryptographic hash code of the previous block, a timestamp and transaction data, which as designed so that these transactions are immutable" (Kitsantas, Vazakidis, & Hytis, 2019).

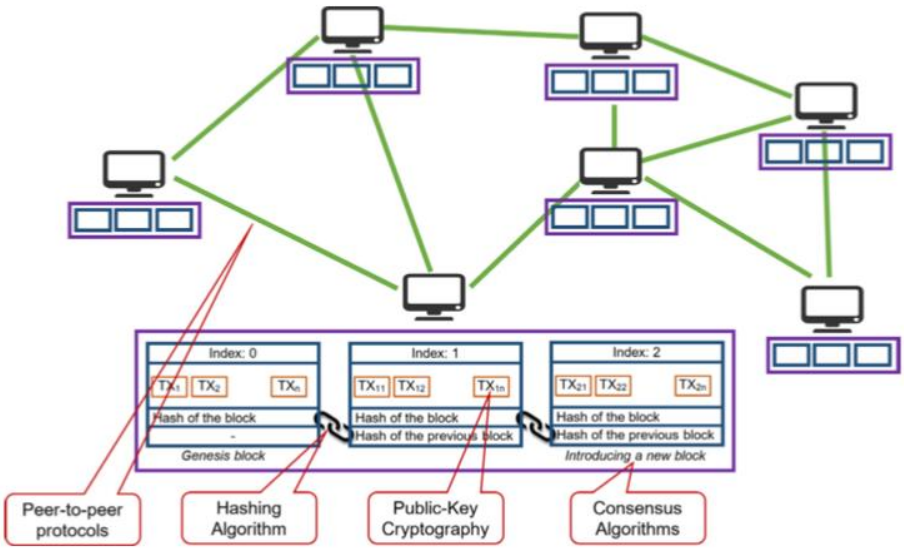

Figure 3. Overview of technologies behind blockchain (Perera et al, 2020)

According to Perera et al, they describe the process of blockchain as "all the nodes are connected on a flat topology without a hierarchy, central authority or main server, making the peer-to-peer network purely decentralized". In this kind of network, "a consensus mechanism is used to ensure that the block is valid before it is recorded on the ledger. Once the block is recorded on the ledger, the entire network will have a copy of the updated ledger. All nodes in the peer-to-peer network have access to data and create an autonomous network, to provide and share data among these nodes. The consequent blockchain then becomes the single source of truth" (Perera et al 2020).

Kitsantas et al define the main character features of this technology as following:

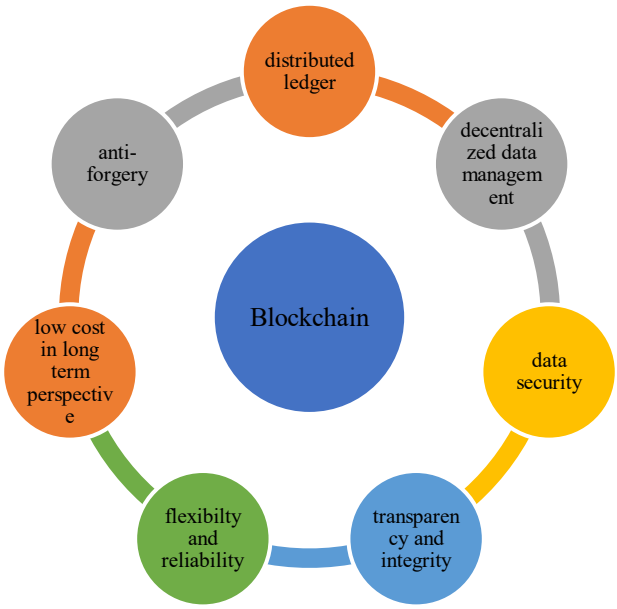

Figure 4. Main characteristics of blockchain (Kitsantas et al, 2019)

Perera et al highlight several different types of blockchains where they consider as the most essential Public Blockchain, Private Blockchain and Consortium Blockchain (hybrid Blockchain). Nowadays blockchain has three generations: blockchain 1.0 for digital currency, blockchain 2.0 for digital finance and blockchain 3.0 for digital society.

Blockchain 1.0 for digital currency is widely known for Bitcoin currency. The new currency largely contributed to identify "generating new markets and opportunities. Blockchain 1.0 was initially used for decentralization of money and payments" (Perera et al 2020).

Blockchain 2.0 for digital finance is now forming a market with smart contracts and new financial applications. The industry uses blockchain for "economic, market and financial applications such as stocks, bonds, smart property and smart contracts". But smart contracts are going beyond finance sector and there is also usage of smart contract in shipping. It is considered in the following section.

Blockchain 3.0 for digital society. Not only currency and finance industries adopting the technology, but also other industries such as science, art, health, government. "Blockchain 3.0 has been introduced for non-financial applications of the distributed ledger technology. In Blockchain 2.0 and Blockchain 3.0 applications, a combination of other activities related to government, education and finance can make these non-financial activities express the property of currency" (Perera et al, 2020). Many use cases have been conceptualized and implemented in various industries, and particularly the technology has recently started its realization in shipping industry which is discussed in next section

2.2.2. Blockchain implementation in shipping industry

The main place where technology is needed is supply chain of shipping processes. Thus, the definition of supply chain is needed.

A supply chain can be described as "a system of organizations, people, activities, information, and resources involved in moving a good or service from the initial supplier to the final customer" (Kawaguchi, 2019). As any system, it requires that order and well-coordinated work of all involved objects, a management is needed for that. Supply chain management "is the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities to meet the customer's need. It also includes coordination and collaboration with channel partners, including suppliers, intermediaries, third-party service providers, and customers" (Kawaguchi, 2019).

Blockchain and supply chain management are inextricably linked to each other, as blockchain is intended to improve operational processes inside of supply chain management.

Usage of blockchain in maritime industry can be used to "increase sustainability, reduce fraud, reduce paperwork delays, reduce waste and identify problems faster. Accordingly, this could increase world GDP by almost 5% and total trade volume by 15%. In addition, and according to the information published on DHL's official web pages, up to 10% of the bills of lading contain incorrect data that can give rise to litigation. Blockchain technology could play an important role in reducing these problems and improving logistics processes" (Khiat et al, 2019).

Blockchains can be used in shipping in three ways: as smart contracts, digital supply chain and ecosystem (network).

A smart contract is a computer-based program, where blockchain has "a set of rules agreed upon by the parties involved in a mutual transaction". These smart contracts are helping to define "the terms and conditions, rights and obligations the parties consent to… Computer can automatically perform the rights and obligations stated in the smart contract as soon as the parties involved reach an agreement and meet its terms. Smart contracts facilitate self-checks and automatically impose negotiations and performance" (Jugović et al, 2019). It can facilitate the existing managerial work in many times.

As for digital supply chain, it is shown from an example of cooperation of IBM and Maersk, which introduced a global commercial blockchain platform TradeLens. The platform is created to provide "assistance from third party solution providers to determine what is known as organizational identity for subjects participating in the platform. TradeLens uses Digital

Bazaar software (Blacksburg, Virginia), which develops identity management and payment solutions for companies based on the blockchain".

And as ecosystem (network) blockchain helps to unite all parties who should cooperate without third parties and it creates safe zone from frauds to steal information. Jugović et al consider these relations as a space where participants can trust each other "…by providing instantaneous value and truth of information sharing to partners in the global supply chain" (Jugović et al, 2019).

2.3. Theory of planned behavior

To understand a company's attitude towards new implementations, namely blockchain, we will look a theory of planned behavior.

A conceptual model of consumers' behavior or theory of planned behavior was proposed by Ajzen and Fishbein in 1980. They formulated a theory of reasoned action, which aimed to assess the discrepancy between attitude and behavior, using a conceptual framework capable of predicting human behavior on the basis of the attitude toward an object (Vieira & Leles, 2014).

Chatzisarantis and Hagger define the theory of planned behavior as "a social cognitive model that explains how deliberative decisions, that is, effortful decisions that involve a consideration of the advantages and disadvantages of the target behavior prior to action" (Chatzisarantis & Hagger, 2007).

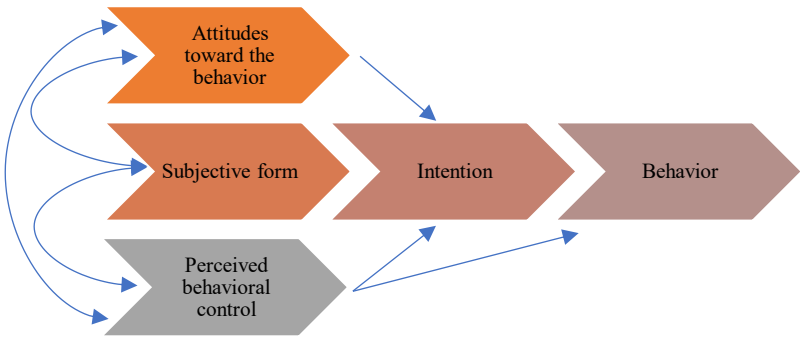

Figure 5. Conceptual framework of the theory of planned behaviour (Vieira & Leles, 2014)

Ajzen clarifies that logically, the stronger the intention of people, the more efforts they are willing to put in to achieve the goal. It is also necessary to understand that to achieve a goal,

not only personal volitional qualities are needed, but also a lot depends on non-motivational external factors such as the presence of materiality (enough money), the presence of time and space to achieve the goal. The totality of these internal (will, intentions) and external factors are "represent people's actual control over the behavior" (Ajzen, 1991).

Subjective form defines that a subject is looking into society-imposed norms, and it decides its behavior in regard of how society would think about it. As for shipping industry, maritime firms can see blockchain see it as a solution for greener shipping as Maersk (a giant of maritime industry) is actively working on implementing blockchain and as a result smaller companies can adjust to this attitude. This creates *attitudes toward the behavior*. The idea that they can succeed by implementing blockchain can motivate those companies to achieve better results. While at the same time *perceived behavioral control* is being created where a subject understands its abilities to achieve or not this or that result. As a result, together these three components lead to a subject's intention which in turn leads to needed behavior (Ajzen, 1991).

As an example, if a shipping company does not have enough budget for implementing blockchain, they will understand that at that moment of time they are not able to provide all needed conditions even they are highly willing to. That is why it is necessary when it comes to blockchain that companies understand all three points before going deeper into implementing a new system, service or product. In case of the research paper, the theory of planned behavior helps to explain the awareness of advantages and disadvantages of the blockchain technology for shipping companies.

Chapter 3. Research Methodology

The chapter describes research strategy and design, reliability and validation, research limitation, data collection process and data analysis.

3.1. Research strategy

According to Bryman & Bell, they identify two research strategies: quantitative and qualitative. And by research strategy they mean "a general orientation to the conduct of business research" (Bryman, 2011).

Thus, quantitative research can be construed as a research strategy that emphasizes quantification in the collection and analysis of data and that:

- entails a deductive approach to the relationship between theory and research, in which the accent is placed on the testing of theories;
- has incorporated the practices and norms of the natural scientific model and of positivism in particular;
- embodies a view of social reality as an external, objective reality.

By contrast, qualitative research can be construed as a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data and that:

- predominantly emphasizes an inductive approach to the relationship between theory and research, in which the emphasis is placed on the generation of theories;
- has rejected the practices and norms of the natural scientific model and of positivism in particular in preference for an emphasis on the ways in which individuals interpret their social world;
- embodies a view of social reality as a constantly shifting emergent property of individuals' creation (Bryman, 2011).

But there is also mixed methods research can be used in research work, which shows that a research cannot be limited to just one type of design.

For this type of the work, qualitative method of research strategy will be used as a main one. For example, a research question such as "what is the implementation process of the blockchain technology in a shipping company?" needs a qualitative answer for it. The desired approach to answer the research question is to obtain in-depth knowledge with close interaction

with participants in a natural environment. It leads this study to use the qualitative strategy, where the analysis of data is more interpretative.

3.2. Research design

Research design is a framework and guide for a scientific investigation. It helps to "build" a structure, a scheme that leads us to answer research questions. In order to answer them a researcher sets aims, goals and objectives, they must be established, and appropriate methods chosen to make relevant observations or collect data for analysis. This requires a suitable sampling strategy that considers some or all of the following: objects to be measured, sample size, location, instrumentation and analytical procedures. The data or information generated can be analyzed using quantitative or qualitative techniques (Goundar, 2012).

Thus, the qualitative method is considered more relevant for answering the research questions qualitative methods of research were chosen - multiple case study design and systematic literature review. "Qualitative research methods can be useful in providing in-depth information to understand target behaviors" (Condon & Coulson, 2017).

Case study design. A case study is a methodological approach that involves the in-depth exploration of a specific bounded system, utilizing multiple forms of data collection to systemically gather information on how the system operates or functions (Mills, Durepos, & Wiebe, 2010). In the case of this thesis, multiple case study is used.

Multiple case study has become increasingly common in business and management research. It is an extension of the case study design. The multiple case study is considered in the section on 'Comparative design' because multiple case studies are largely undertaken for the purpose of comparing the cases that are included. As such, they allow the researcher to compare and contrast the findings deriving from each of the cases. This in turn encourages researchers to consider what is unique and what is common across cases, and frequently promotes theoretical reflection on the findings.

Systematic literature review (SLR) is a "methodologically rigorous review of research results. The aim of an SLR is not just to aggregate all existing evidence on a research question; it is also intended to support the development of evidence-based guidelines for practitioners". (Kitchenham et al, 2009)

According to Bryman, *comparative design* is a design that "entails the study using more or less identical methods of two or more contrasting cases. It embodies the logic of comparison; in that it implies that we can understand social phenomena better when they are compared in relation to two or more meaningfully contrasting cases or situations. The comparative design may be realized in the context of either quantitative or qualitative research" (Bryman, 2011).

To better understand the research design of the thesis, the following Figure 6 illustrates how two methods are combined in order to answer the research questions.

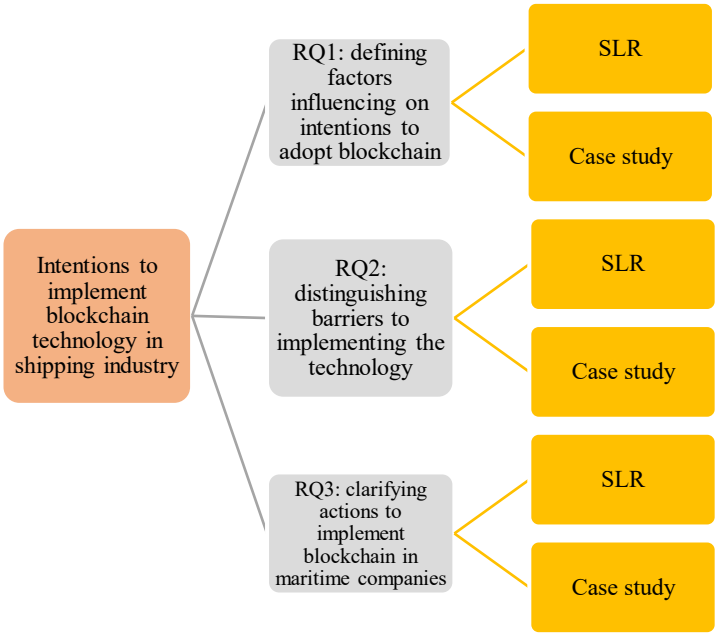

Figure 6. Research design

3.3. Research framework

Research framework is a structured plan of how the research will be conducted. First, a SLR is carried out; secondly, an exploratory multiple case study, and after which the data from these two methods will be compared to each other on order to obtain results.

A plan for data collection is presented based on the research strategy and design.

Chapter	***Process***	***Period***
1, 2	Theory part from literature	January-April, 2020
3	Collecting data from companies (interviews)	July, 2020
4, 5	Process of data analysis	August-September, 2020
5, 6	Discussions based on the results from the data	September-October, 2020

Table 2. Thesis plan

3.3.1. Systematic literature review

SLR is a "methodologically rigorous review of research results. The aim of an SLR is not just to aggregate all existing evidence on a research question; it is also intended to support the development of evidence-based guidelines for practitioners" (Kitchenham et al, 2009).

SLR is designed to answer the research questions:

RQ1: to find out factors influencing on intentions to adopt Blockchain technologies in maritime firms.

RQ2: to define barriers to implementing Blockchain technology in shipping companies.

RQ3: to determine how intentions of implementing blockchain in shipping companies transferred to real actions.

For the SLR 3 main databases were defined for data analysis: Scopus, Taylor & Francis Online and ProQuest. All three databases are approved by University of South-Eastern Norway; thus, they are reliable source of data collection.

After considering databases the next step is to find relevant studies to the topic. In order to achieve it, advanced searching functions were used on databases. The search strings are given below in Table 3.

Database	Key words	Number of results
Scopus	RQ1: TITLE-ABS-KEY((factors OR features) AND (blockchain OR "digital ledger" OR "digital platform" OR "distrubuted ledger" OR "cryptographic ledger") AND (influenc* OR impact OR effect) AND (shipping OR maritime))	7
	RQ2: TITLE-ABS-KEY((barriers OR challenges OR difficulties) AND (implement* OR realiz* OR appl* OR perform* OR execut*) AND (blockchain OR "digital ledger" OR "digital platform" OR "distrubuted ledger" OR "cryptographic ledger") AND (shipping OR maritime))	24
	RQ3: TITLE-ABS-KEY((blockchain OR "digital ledger" OR "digital platform" OR "distrubuted ledger" OR "cryptographic ledger") AND (intention* OR purpos* OR plan* OR aim*) AND real* AND (shipping OR maritime))	7
Taylor & Francis Online	RQ1: [[All: factors] AND [[All: blockchain] OR [All: "digital ledger"] OR [All: "digital platform"] OR [All: "distrubuted ledger"] OR [All: "cryptographic ledger"]] AND [[All: influenc*] OR [All: impact] OR [All: effect]] AND [[All: shipping] OR [All: maritime]]	226
	RQ2: [[All: barriers] OR [All: challenges] OR [All: difficulties]] AND [[All: implement*] OR [All: realiz*] OR [All: appl*] OR [All: perform*] OR [All: execut*]] AND [[All: blockchain] OR [All: "digital ledger"] OR [All: "digital platform"] OR [All: "distrubuted ledger"] OR [All: "cryptographic ledger"]] AND [[All: shipping] OR [All: maritime]]	234

	R3: [[All: blockchain] OR [All: "digital ledger"] OR [All: "digital platform"] OR [All: "distrubuted ledger"] OR [All: "cryptographic ledger"]] AND [[All: intention*] OR [All: purpos*] OR [All: plan*] OR [All: aim*]] AND [All: real*] AND [[All: shipping] OR [All: maritime]]	239
ProQuest	RQ1: Blockchain AND (factors OR features) AND (influence OR impact OR effect) AND (shipping OR maritime)	376
	RQ2: Blockchain AND (barriers OR challenges OR difficulties) AND (implement OR apply OR realize) AND (shipping OR maritime)	346
	RQ3: Blockchain AND (intention OR plan OR aim OR purpose) AND real AND action AND (shipping OR maritime)	264
	Total	1156
	After specification of inclusiveness and exclusiveness	16

Table 3. Search strings for SLR

In order to do a screening and to define relevant and necessary studies for data analysis, it is needed to determine what factors effect on inclusiveness and exclusivity.

Inclusions	Exclusions
Studies have full access	Studies have limited access
Studies that have a connection to blockchain in maritime industry	Studies that are irrelevant to relation of maritime studies and blockchain
Original research studies that can be found in only one database	Duplicate studies of the same research
Defined literature survey	Informal literature survey
Studies in English language	Non-English studies

Table 4. Specification of inclusions and exclusions for SLR adopted from Lund et al, 2019

Screening for the search of needed studies is carried out in several stages. At the first stage total number of 1156 studies was found. In the second stage of screening papers that were not written in English and/or did not have access to the full text were eliminated. As a result of second screening 471 studies were selected for the next stage. The next stage included sorting out those papers that were already repeated and/or were not completely relevant to the topic of the thesis. In total 16 articles were chosen for the SLR that will be discussed in Chapter 4 and 5.

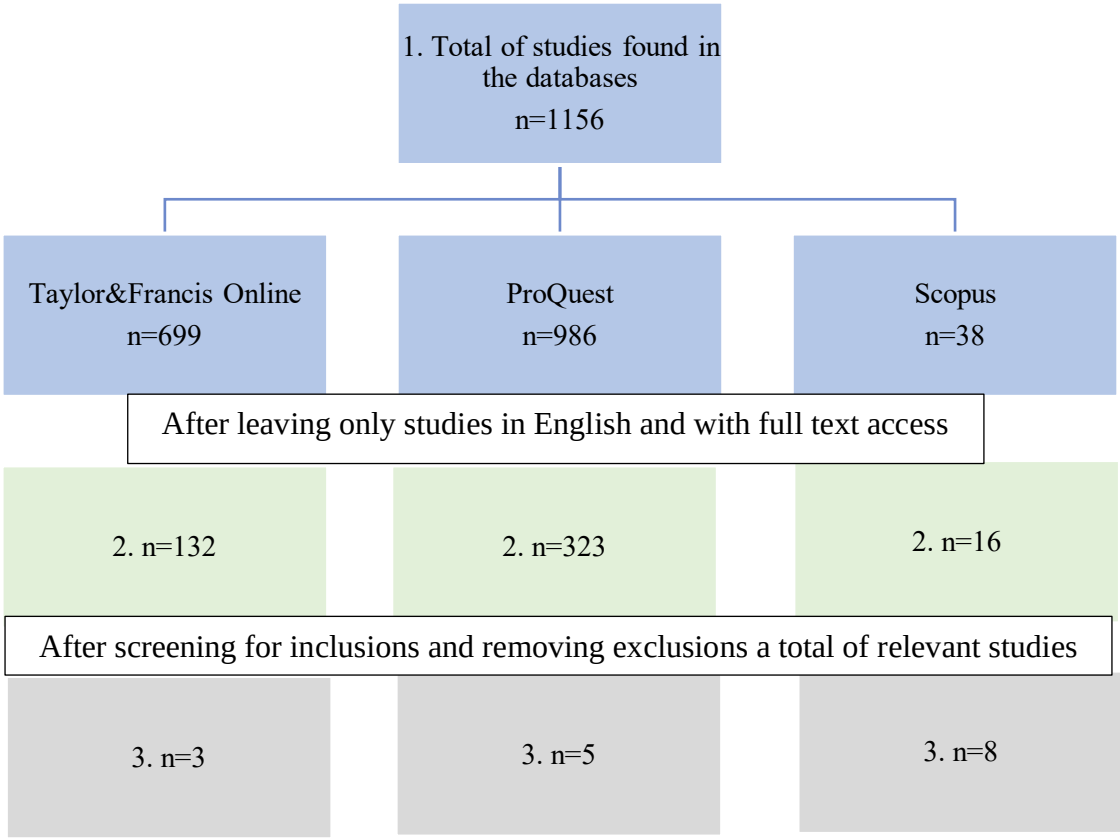

Figure 7. SLR execution process steps adopted from Moher et al (2009)

3.3.2. Exploratory multiple case study

This method of data analyzing and processing will help to explore each company case and to find out of how maritime firms are reacting when there are technological changes happening in the industry, their attitude to them (Weishäupl et al, 2018).

The case studies were conducted through semi-structured interviews.

3.3.2.1. Interview guide

A semi-structured interview is conducted on the basis of the interviewer's knowledge, and in order to obtain the necessary answers to confirm or refute your hypothesis.

According to Bryman, a semi-structured interview is “a term that covers a wide range of instances. It typically refers to a context in which the interviewer has a series of questions that are in the general form of an interview schedule but is able to vary the sequence of questions”. Unlike a structured interview, in a semi-structured interview, the interviewer can ask questions that are not included in the guide (that is, it is not necessary to strictly follow the

guide, thus questions still should be inside the area of the topic). Besides, questions can be asked in no particular order.

Before the interview the interviewer has to prepare an interview guide, where will be main questions that are going to be asked to cover topics (Bryman, 2011).

"The interview guide covers the main topics of the study. It offers a focused structure for the discussion during the interviews but should not be followed strictly. Instead, the idea is to explore the research area by collecting similar types of information from each participant, by providing participants with guidance on what to talk about" (Kallio et al, 2016).

The interview guide of for this thesis case studies consists of 4 sections of questions: opening, introductory, key and closing questions (Table 5).

Type of questions	Explanation
Opening questions	They should give a general image of a company including questions about the main field of work of the company, and a current position of a respondent.
Introductory questions	They are needed in order to create a connection with a respondent, introduce him/her the main topic of the interview and create smooth transition to key questions.
Key questions	They are asked in order to reveal the essence of using the technology in a company, to answer research questions.
Closing questions	This type of questions is needed in case, if a company representative still has questions after the interview, so she/he could reach out the researcher after the interview.

Table 5. Types of questions for the interview

The questions and their key points are in the following Table 6:

№	Questions	Points
1	Could you give a short introduction of the company?	Intro
2	What is your current position in the company?	Approach
3	How quickly does the shipping industry adopt digital innovative technologies in your opinion?	Attitude
4	What is your attitude to implementing digital innovative technologies in your company? If so, which technologies are prioritized in the company?	Attitude
5	Are you using any digital innovative technologies in your company that are designed to increase the transparency of current operations and the efficiency of information flow?	Actions
6	Has your company made attempts to introduce the blockchain technology in the company? Are you taking any actions to implement the technology, or are you considering in the future?	Attitude, Actions

7	In what way can the blockchain technology facilitate existing processes in your company?	Results
8	What factors can influence on your decision to implement the blockchain?	Driving factors
9	What factors can influence the refusal to introduce the blockchain technology in your company?	Barriers
10	In your opinion, in what way the blockchain technology facilitates existing processes in shipping industry?	Results
11	What do you think, should maritime companies consider an implementation of the blockchain technology in their companies?	Attitude
12	In your opinion, what challenges can maritime companies face when implementing the blockchain technology?	Challenges
13	What do you think, is it possible in the future that shipping industry will completely switch to the blockchain technology, or is it likely that the topic is too "hyped" at the moment, and completely different technologies will be created?	Results

Table 6. Interview guide

The interviews should take approximately 30-40 minutes and can be conducted in any convenient way for the participant.

3.3.2.2. Sample

After defining what questions will be asked during the interview, it is necessary to find out who we are going to interview. Sampling is a consideration in both qualitative and quantitative research. Survey methodology, interviews, focus groups, bibliometrics, content analysis, usability testing, etc., all rely on an appropriate number of people or items being selected and examined.

There are various types of sampling methods, including nonprobability sampling and probability sampling (Wilson, 2014).

In this work the nonprobability sampling is used to find participants for the interview. Purposive sampling is a non-probability sampling method and it occurs when the researcher chooses participants by her/his own judgment criteria (Business Research Methodology, 2020).

In order to select a sample for an interview, a systematic search was conducted for companies that would be suitable for the research sample.

A sample of companies which must be chosen is be based on several criteria such as their position in the industry, their field of interests, their attitude to innovations etc.

About 170 Norwegian maritime companies in general were found on a website of Euro-Maritime for the search for the interview (Euro-Maritime, 2020). In order to filter out suitable companies that would be suitable for analysis, a systematic search for likely participants was carried out.

To conduct the systematic search, an excel document (Table 7) was created, where those (about 170) companies were placed there with links to their websites. And to find possible suitable options among them, the criteria for systematic search were justified by which it was possible to sort companies ("suitable" / "not suitable").

	A	B	C	D	E	F
1	***Norwegian Shipping Companies. Yellow - should contact. Pink - might contact. Red - already sent message***	***Short description***	***Does it work in a way of sustainability, green shipping?***	***Does it work with finding solutions for green shipping***	***Does a site look 'confiding'?***	***Does it have a blockchain?***
2	*Company name*	*e.g. field of operations, position in the market etc.*	*If an answer is 'yes', we should go further and answer the next question. If no, should not continue*	*If an answer is 'yes', we should go further and answer the next question. If no, should not continue*	*If an answer is 'yes', we should go further and answer the next question. If no, should not continue*	*yes or no*

Table 7. Criteria for companies search for the interviews

As it is shown in Figure 8, the search was based on four main criteria:

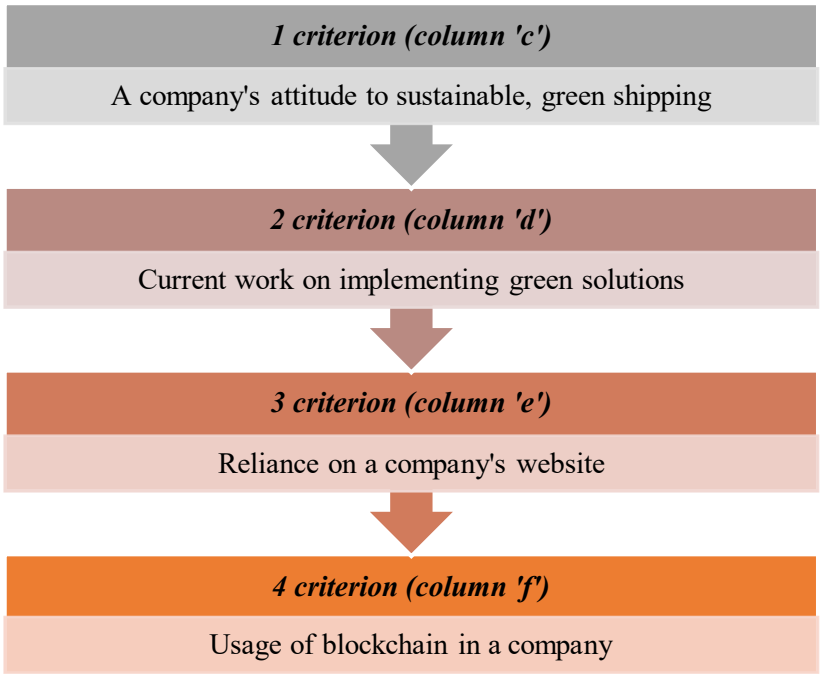

Figure 8. Criteria for the systematic search of companies

Criteria of systematic search is explained as following:

1) the first criterion (column ‘c’) is needed to find out whether a company can be related to green shipping concept, since the blockchain is a component part of it;

2) the second criterion (column ‘d’) is necessary to find out whether a company is directly related to the solution of problems in shipping, and the blockchain can be one of the solutions;

3) the third criterion (column ‘e’) is responsible for the researcher’s attitude whether rely on a company’s site;

4) the fourth criterion (column ‘f’) determines the company's use of the technology.

The number of potential participants of the interview was reduced to 26 companies based on the first 3 criteria. The last fourth criterion was not a mandatory criterion for the selection of participants, since those companies that have not yet implemented the blockchain, but may be at the stage of considering implementation, were also suitable for the research.

After contacting those companies through emails, 2 companies were agreed to participate in the research.

Company	***Participant’s position***	***Gender***	***Format of meeting***
A	Senior business analyst	Male	Teams meeting
B	Business process manager	Male	Skype meeting

Table 8. Participants’ profiles

3.4. Research ethics

Ethical compliance is an essential part of scientific research. When it comes to research, there is also rules and norms like in professional field of activity. These norms can be “specific to disciplines and others are shared by all scientific communities… It is expected from researchers is scientific as well as moral responsibility in the conduct of their work” (Pellé & Reber, 2016).

In regard of it, ethics of privacy concepts and informed consent from all participants of data collection were followed (Markham & Buchanan, 2017). Since the data collection for case study needed interviews being involved, it was necessary beforehand to notify NSD (Norwegian Center for Research Data) that the research is going to involve video/audio recordings. Before giving information participants of interview had to read and sign informed consent form and could withdrawal from the research at any moment of time.

All research work should be done with in compliance with all necessary anonymity and confidentiality policies.

3.5. Validity and reliability

According to Kirk and Miller, they define reliability as “the extent to which a measurement procedure yields the same answer however and whenever it is carried out; “validity” is the extent to which it gives the correct answer. These concepts apply equally well to qualitative observations” (Kirk & Miller, 1986).

Other authors, as Kimberlin and Winterstein, consider reliability as an instrument that needed to “to evaluate the stability of measures administered at different times to the same individuals or using the same standard (test–retest reliability) or the equivalence of sets of items from the same test (internal consistency) or of different observers scoring a behavior or event using the same instrument (interrater reliability)”. And what about validity, they define is also as an “instrument measures what it purports to measure. Validity requires that an instrument is reliable, but an instrument can be reliable without being valid’ (Kimberlin & Winterstein, 2008).

That is why there is two research methods (SLR and exploratory case study) are used for data analysis, to make the results of analysis more valid and reliable.

3.6. Research limitations

The main limitation of the research was a quite limited number of companies agreed to participate in the interview. Because of the Covid-19 the maritime industry, shipping companies, were facing major challenges. As it was said 3.3.2.2 only 2 companies out of 26 agreed to give the interview. Thus, there can be a lack of necessary data from companies to fully see the picture and lack of objectivity, there is needed more companies for further studies. Also, a small number of companies that are working on implementing the blockchain technology.

There can be a language misunderstanding since mother language of both, the researcher and the participants, was not English.

Limited number of databases can be the reason that some research papers were missed out and were not considered. As well limited access to library to physical books that do not have electronic versions.

Chapter 4. Findings and results

4.1 Systematic literature review results

In total 16 studies were found for the SLR. Each work relates to one of the research questions and is needed in order to help to answer them.

No.	Author	Study title	Driving factors/ barriers/ actions	Key finding
1	Pu & Lam (2020)	*Blockchain adoptions in the maritime industry: a conceptual framework*	Actions / driving factors	Gives an overview of blockchain in the maritime industry, how they are used now and how they should be used in the future
2	Koh et al (2020)	*Blockchain in transport and logistics – paradigms and transitions*	Actions / driving factors/ barriers	Gives an overview of the technology. Emphasis on security, sustainability fundamentals
3	Saberi et al (2019)	*Blockchain technology and its relationships to sustainable supply chain management*	Barriers	Defines the theoretical foundations of the technology, as well as barriers of implementing blockchain
4	Lambrou et al (2019)	*Shipping digitalization management: Conceptualization, typology and antecedents*	Actions	Discusses the place of digitalization in the industry, a comparison of the model with cases to clarify the attitude of companies to digital changes
5	Öz & Gören (2019)	*Application of blockchain technology in the supply chain management process: Case studies.*	Actions	General overview of existing companies who implemented blockchain
6	Vance et al (2019)	*From the oceans to the cloud: Opportunities and challenges for data, models, computation and workflows*	Driving factors / Barriers	Discusses digital technologies that may face obstacles in implementation
7	Mihajlov et al (2019)	*Towards the application of blockchain technology for improving trade facilitation in CEFTA 2006 **	Driving factors	Defines how blockchain can simplify existing processes in the industry
8	Christodoulou et al (2018)	*A decentralized application for logistics: Using blockchain in real-world applications.*	Driving factors	The prospects of using smart contracts in the transportation of goods are discussed
9	Dutta et al (2020)	*Blockchain technology in supply chain operations: Applications, challenges and research opportunities*	Driving factors / barriers	general blockchain technology fundamentals in different industries are discussed
10	Tan & Sundarakani (2020)	*Assessing Blockchain Technology application for freight booking business: a case study from Technology Acceptance Model perspective*	Actions	A case study based on a shipping company was carried out and blockchain solutions were proposed

11	Jović et al (2019)	*A review of blockchain technology implementation in shipping industry*	Driving factors / barriers	A general review of the blockchain in shipping industry
12	Philipp et al (2019)	*Blockchain and Smart Contracts for Entrepreneurial Collaboration in Maritime Supply Chains*	Driving factors	Discussed main points of implementing smart contracts and blockchain in maritime firms.
13	Nasih et al (2019)	*Blockchain technology impact on the maritime supply chain*	Actions	A general overview of the technology
14	Allen et al (2019)	*International policy coordination for blockchain supply chains*	Driving factors	Explores the topic of profit from cost reduction when using blockchain in the shipping
15	Nasaruddin & Emad (2019)	*Preparing maritime professionals for their future roles in a digitalized era: Bridging the blockchain skills gap in maritime education and training*	Barriers	An overview of blockchain implementation from the management side; due to the complexity of the technology itself, many professionals can face difficulties that entail higher risks
16	Gausdal et al (2018)	*Applying Blockchain technology: Evidence from Norwegian companies*	Driving factors / barriers	The drivers and barriers of blockchain implementation in companies are discussed, also in what areas of the industry it can be beneficial

Table 9. SLR findings

As it given in the Table 9, each article was related to one or the other key points (driving factors, barriers or actions).

	Articles		
	Type	**Main finding**	**Article**
Driving factors	*Transparency and security*	- trusted platform; - easy to share data; - more secure than existing methods; - easy to use platform; -fraud-resistance	[2]; [7]; [8]; [9]; [12]; [16]
	Managerial processes	- better SC processes; - smart contracts;	[9]; [12]; [16]
	Market opportunities	- low entry barriers in a reason of disintermediation; - integration of small entrepreneurs in the market; - new trading patters	[12]; [14]
	Green shipping	- better ecosystem - less paperwork	[1]; [2]; [12] [7]; [8]; [9]; [12]; [14]; [11]
	Cost	- possibility of cost saving when third parties are not involved (banks etc); - lowering trade costs	[12]; [14]; [16]; [6]

Barriers / Challenges	*Managerial processes*	- lack of competence in companies; - low level of digital diffusion within the supply chain; - old-aged decision makers; - multi-faceted issues of involved parties' relationships; - lack of standards; -immature system	[2]; [3]; [6]; [9]; [16]; [11]
	High cost	- possibility that high costs are not reimbursed	[3]; [6]; [9]; [16]
	Lack of adaptation to new market changes	- old-fashioned way of operational processes;	[16]
How authors suggest intentions to implement blockchain to be transferred to real actions	Adoption remains challenging among researched companies		[1]
	The speed of blockchain spread is fast "*…the work to do is to solve three major points: Scalability of data, connection with external networks and implementation in traditional maritime supply chain.*"		[13]
	"…Managing digitalization is more complicated than acquiring, bundling and orchestrating physical and digital resources. The relationship between analog shipping and digital technology efforts can be examined further."		[4]
	"…the basic principles of block chain logistics will be used not only in transporting institutions but also in all stages of agriculture industry and service sector."		[5]
	"The authors have recommended the use of blockchain technology with smart contract which will overcome some of the challenges…The new system is able to provide end to end visibility of the cargoes with full transparency for their supply chain partners"		[10]

Table 10. Summation of articles by key points

The number of articles by each key point is almost even. Yet, number of articles related to intentions to adopt blockchain transferred to real actions are more than driving factors of and challenges implementing blockchain in shipping companies.

4.2. Multiple case study results

For the results of exploratory case studies data collected through semi-structured interviews was extracted in Appendices C and D. Key findings of the collected data were divided into the following sections: attitude, actions, driving factors, barriers / challenges, results.

4.2.1. Company A

The company is working with a wide range of maritime operations. The extracts and key findings of collected data for the company A can be found as Appendix C.

Attitude. In general, shipping industry's attitude to implementing new services, technologies is quite challenging. The industry is "…*very product-oriented and they* (shipping companies) *don't know how to sell services*". The company's attitude to digital innovative technologies is very positive and respected.

As for blockchain, the company refers blockchain as a positive one. The participant was mentioning several times that blockchain is secure platform and can provide transparency and can be both a solution for both their company and industry in general.

Actions. The company A "*had some collaborations with the companies providing the blockchain technology were mostly related to increasing the security and bunkering operations".* Also, the company believes it can be worth for *"companies operating internationally"*

Driving factors. Blockchain should be easy to use and the company has to have enough expertise to use it. Relations with suppliers can be easier with the blockchain technology, since it can save money.

Barriers / challenges. High cost, uncertainty, not enough proofs, limitation that both parties (shipping company and supplier) have to implement it.

Results. Blockchain can reduce risks, and it is more secure than what they are doing now. In the future *"there will be alternatives, for sure".*

4.2.2. Company B

The company operates within Norway, where main objectives "*shipping, offshore operations, sale of vessels"*. The extracts and key findings of collected data for the company B can be found as Appendix D.

Attitude. In general, the participant describes the shipping industry as a "*slow industry*" in regard of implementing digital technologies. As for the company, digital technologies are very welcomed, and they are "*considering some new digital solutions in the future*."

Actions. At the moment, many projects are freezed due to Covid-2019, including projects related to implementing digital technologies. They are more focused on daily running processes.

Driving factors. They consider blockchain as a convenient tool to make operations transparent and secure. Also, the blockchain technology should meet the company's expectations in order to be implemented.

Barriers / challenges. The participant describes blockchain as a "*high cost*" technology, and it needs more "*proof of effectiveness".* Besides, the complexity of the system is one of the points that holds back the implementation.

Results. All in all, the company is positive about the blockchain but has doubts whether consider implementing or not. They point out several barriers that are also relevant as barriers of the company A.

Chapter 5. Discussion

Down below in Table 11 is given a comparison between results from SLR and exploratory case studies.

	SLR	Company A	Company B
Driving factors			
Transparency and security	+	+	+
Managerial processes	+	+	+
Market opportunities	+	+	
Green shipping	+	+	
Cost	+		
Barriers			
Managerial processes	+	+	+
High cost	+	+	+
Lack of adaptation to new market changes	+		
Intentions to real actions			
Adoption remains challenging among researched companies	n/a	+	+
The speed of blockchain spread is fast "*…the work to do is to solve three major points: Scalability of data, connection with external networks and implementation in traditional maritime supply chain.*"	n/a	- Was not directly mentioned (Appendix C, extract 3)	- On the contrary, participant highlighted that digital process are slow
"…Managing digitalization is more complicated than acquiring, bundling and orchestrating physical and digital resources. The relationship between analog shipping and digital technology efforts can be examined further."	n/a	+ Appendix C, extract 3	- Not mentioned
"…the basic principles of block chain logistics will be used not only in transporting institutions but also in all stages of agriculture industry and service sector."	n/a	Not mentioned	Not mentioned
"The authors have recommended the use of blockchain technology with smart contract which will overcome some of the challenges…The new system is able to provide	n/a	-	-

end to end visibility of the cargoes with full transparency for their supply chain partners"			

Table 11. Comparative analysis of data collected by SLR and exploratory case studies

From Table 11 it is seen that both SLR and case studies have common attitude in most of points. Although, some points have not been considered by the company B.

SLR and company A have reasonably common points. This may indicate that data obtained by semi-structured interview with companies has been proved by SLR for which the research thesis was carried out by two methods: to establish evidence collected in one way based on data collected from another way.

Driving factors:

Transparency and security. Both interviewed companies agree that blockchain can facilitate existing processes by obtaining trust and security. Company A mentioned several times that main challenge for them is to transfer data from onboard to on shore and vice versa. It can be an opportunity to consider implementing blockchain since it provides easy access to shared data, wherein guaranteeing security. Company B mentioned that blockchain in general can make data sharing processes safer.

Managerial processes. Company A mentioned that processes regarding payments, money transactions would be easier to perform with blockchain. Company B did not mention.

Smart contracts were not mentioned in both interviews.

Market opportunities were not touched during the interviews.

Green shipping. Topic of green shipping was mentioned only by Company A (Appendix C, extract 1).

Cost. It was not mentioned as a driving factor.

Barriers:

Managerial processes. Both companies highlighted that there is a lack of competence and expertise due to complexity of the technology.

High cost. Both companies agree that implementing blockchain can be highly costed.

Lack of adaptation to new market changes. Both companies said that shipping industry adapts digital changes slowly.

Chapter 6. Conclusion and recommendations for further studies

To sum up, 3 research questions that must be answered:

RQ1: What factors do influence on intentions to adopt Blockchain technologies in maritime firms?

RQ2: What are barriers to implementing Blockchain technology in shipping companies?

RQ3: How intentions to adopt Blockchain technologies transferred to real actions?

To answer them 2 methods of data analysis and processing were used in this thesis: systematic literature review (SLR) and exploratory multiple case study. Both methods were able to give answers and explanations to research questions, yet, limitation are not allowing to see picture fully.

For SLR 16 articles were analyzed from 3 different databases (Scopus, ProQuest, Taylor & Francis Online). For exploratory case study 2 semi-structured interviews were conducted from 2 different shipping companies, both Norway-based.

RQ1. Factors. Both SLR and Case study highlighted common driving factors when it comes to blockchain implementation in maritime firms. Both methods made it possible to draw the following conclusions:

- Blockchain is a transparent platform that can allows parties to share information without third parties being involved.
- Security. Because the system is protected by special private keys, it is impossible to change information that is in blocks of information. It provides security from cyber-attacks and frauds.
- According to SLR, in far perspectives blockchain can reduce costs of managerial work.

RQ2. Barriers / challenges. In this section both SLR and participants of the interviews agreed on the following barriers that interfere the implementation of blockchain in their company or in industry in general:

- Cost. The implementation can be costly for the companies. Plus, there is still doubts, if the costs will not justify themselves
- Lack of expertise. A new technology requires in deep knowledge how to use and work with, thus, not many experts and specialists in blockchain area.
- Not proven efficiency of the technology.

RQ3. Real actions. The interviewed companies are quite positive about intentions to implement the blockchain in the future. Surely, they have doubts about it, but they have already started to work in that direction, which will help to further blockchain development. Results from SLR and case studies are the following:

- Both two companies are in some extent are interested in implementing blockchain company, but still have doubts about it.
- According to SLR, many companies are not implementing the technology since there is lack of proof that blockchain will work effectively.

Based on the data analysis from SLR and case studies all three questions were answered but in the reason of research limitations there is a lack of objectivity and further studies are needed. The number of companies should be widened up to get more information about blockchain intentions in shipping companies. The topic needs further development in regard to avoid bias.

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Appendices

Appendix A: Interview guide

For master's thesis "Intentions to implement blockchain technology in shipping industry"

The purpose of the project is to collect data for master's thesis of a student in the final year of University of South-Eastern Norway (Universitetet i Sørøst Norge). The collected data is essential for analytical part of the thesis.

The main research topic of the thesis is an implementation of a digital technology within a shipping company (the blockchain technology). Conducting the study will help to find out how relevant this topic is in the maritime industry.

A sample for the research is based on criterion:

- an operating shipping company based in Norway and with focus on cargo shipping.

Your company was requested to be a part of the sample because it fits the main criterion and would highly contribute to our research.

The interview will take about 30-40 minutes.

Opening questions:

1. Could you give a short introduction of the company?
2. What is your current position in the company?

Introductory questions:

3. How quickly does the shipping industry adopt digital innovative technologies in your opinion?
4. What is your attitude to implementing digital innovative technologies in your company? If so, which technologies are prioritized in the company?

Key questions:

5. Are you using any digital innovative technologies in your company that are designed to increase the transparency of current operations and the efficiency of information flow?
6. Has your company made attempts to introduce the blockchain technology in the company? Are you taking any actions to implement the technology, or are you considering in the future?
7. In what way can the blockchain technology facilitate existing processes in your company?
8. What factors can influence on your decision to implement the blockchain?
9. What factors can influence the refusal to introduce the blockchain technology in your company?
10. In your opinion, in what way the blockchain technology facilitate existing processes in shipping industry?
11. What do you think, should maritime companies consider an implementation of the blockchain technology in their companies?
12. In your opinion, what challenges can maritime companies face when implementing the blockchain technology?
13. What do you think, is it possible in the future that shipping industry will completely switch to the blockchain technology, or is it likely that the topic is too "hyped" at the moment, and completely different technologies will be created?

Closing questions:

14. Would you like to add something that I haven't asked?
15. If there will be any additional clarification regarding the answers, may I contact you in the future?

Thank you for your participation and integral contribution to writing this thesis!
If you have any questions, please contact me:
Aiyyna Petrova, tel.: 413 33 948, e-mail: aiyyna.petrova95@gmail.com

Appendix B: Consent form

Consent for participation in the study

I have received information about the project and am willing to participate.
I give consent for my personal data to be processed until the end date of the project, approx. 15 of October 2020.

(Signed by participant, date)

Appendix C: Interview extracts Company A

No	Interview extract	Key findings
1	*"…we build vessels, our is largest activity is building vessels in Norway, but we also have large operation and designing vessels and building them in other countries. So, we do design and project management during the construction and then vessels are built in … or any other country… The company I am working for, does business development and strategic management, we collaborate with the managers of different operations to give instructions of what to do and what directions to follow. In relation to new services that company developing, we are also strongly involving that. Currently, we are pushing forward activities on digital services. So, getting data from the vessels, storage in data then utilize the data for better decision making on board of vessels and also from shore.* *And not least, we use data for including our design, so future vessels are consuming less power and are safer and smarter."*	Support of new services Working with digital services Interested in solutions for data storage Green shipping
2	*"I am working as a Senior Business Analyst."*	Not directly working with digital technologies
3	*"It is difficult to implement that is not physical. Above because shipping companies are used to operate with vessels with assets, and also because companies serving the industry are very product- oriented and they don't know how to sell services. And we are talking about digital services, or digitalization, everything is intangible both suppliers and shipping companies are not able to give values to those services, so it is very difficult, you have to demonstrate something before you sell it."*	Barriers of implementing new digital technologies Challenges of intangible services
4	*"Very positive, and we respect. My role is to push on that direction, so I am very positive.* *Currently, is mostly about utilization of data onboard for improving decision making.* *And we are talking about technologies, about sensors that…extract data from vessels is cloud solutions, store data in cloud, have them available, but also is about satellite, to send data from the vessels to the cloud at any point in time, so we have light data all the data all the time."*	Positive attitude towards digital technologies Great attention to data storage and security
5	*"Yes… most of the information we had inside the company was being kept on different parliaments, but now we are lifting that data to our share platform, where everyone that has responsibility is able to access to data and analyze to make improvements. We are trying to make it transparent the data inside the company, or at least, inside the management structure, and each parliament has its own data. But we are able to leave data like was kept downstream – upstream analyzing and from service perspective being able to get the data from vessels to operations on shore is also way of making it more transparent. Because up to 3-4 years ago, even now many companies don't know how their vessel are being operated, and even don't know the speed of the vessel, it*	Improving transparency of data flow Challenges of limited data between onboard and on shore

	gives a lot of limitations of how they can utilize whether the fleet if they don't know the information and we are trying to make that possible."	
6	*"Not directly. We have had some collaborations with the companies providing the blockchain technology were mostly related to increasing the security and bunkering operations… Because when vessels are going to different ports and different areas of the world and then they have to make sure that the quality of fuel they are getting on board is enough and they are getting amounts that they are paying for. It is of course a lot of about bank transitions… You have to pay when you are getting fuel. And there have been some involvements in that area, but we haven't really pursued that formerly. We had some discussions but not implementations."*	Actions towards implementation Increasing security Data transparency
7	*"For our company I believe it mostly related to payment. My understanding of this technology is increasing the security, so for our company is about payments, making sure that we receive money when we should, the money is coming in correct amount. But for shipping companies is a lot about transitions of cargoes. There are some discussions on when we get the data from the vessels to the cloud there is always a risk that someone can access that data and do wrong things with data, so maybe implementing the blockchain… also to data being extracted from the vessels is a way of making them more secure for shipping companies. Because some of them are aware they are not very certain that keeping data on their vessels is secure way."*	Awareness of information Blockchain can be safer solution
8	*"I guess, if we have to implement it internally, we need to have a competence, an expertise that… our experiences of implementing this types of technologies with suppliers is not really not, every time you need to do something that have to involve them and it is very expensive. Second one, how easy it is to not only implement but use. And cost of course."*	Barriers of implementing Cost Necessary expertise
9	*"I believe it is mostly about uncertainty, not knowing what it is…"*	Barrier Uncertainty
10	*"… It is rather about risks. Making transactions, payments, to understand… to make more secure."*	Less risks, more secure
11	*"I believe it is worth mostly for companies operating internationally. For example, for companies operating only inside of Norway where transactions are within the same bank, is often less criticality but for companies operating internationally is more important."*	Actions depend on area of operations
12	*"Here I don't have promptly sufficient knowledge about the blockchain technology, but to my knowledge is that it hasn't been enough proof of it, although there have already been some implementations and then we touched this technology 3 years ago it has already been carried out quite a few tests…*	Not enough proofs Already had discussions about blockchain Limitations

	Challenge... Maybe there is some limitations as well. You and your supplier have to accept or have to both of you implement and it is a limitation."	
13	*"I believe there will be alternatives, for sure. And many will continue easing the existing technologies not looking in new. My experience from shipping industry is that we will not see a major any new technology in less than 20-25 years. It takes a lot of time."*	Alternatives of blockchain
14	*"No, I am not familiar enough with blockchain. I work with digital solutions on daily basis. But I hope I have given my best."*	-
15	*"Yes, for sure."*	-

Appendix D: Interview extracts Company B

No	Interview extract	Key findings
1	*"… our main objectives are shipping, offshore operations, sale of vessels. We mostly operate within Norway."*	Operating in local area
2	*"my position is a Business Process Manager."*	Not directly working with digital technologies
3	*"I think, shipping industry is not very adaptable to digital changes, but it still tries to adapt new changes… It is not as fast as food-moving consumer goods, for example, for sure."*	Slow industry
4	*"I am very positive about it. We are considering some new digital solutions in the future. At the moment, we are prioritizing more related to daily basis operations. Because of Coronavirus we had to postpone some our projects related to digital ones."*	Coronavirus affected Postponed projects
5	*"No, but we are planning in the future…"*	Future plans on digital technologies
6	*"We had discussions about it inside our company but haven't considered to take actions. You know, it was just thoughts between colleagues. But maybe in the future again…"*	Team discussions
7	*"I guess it can make data transferring more transparent and secure."*	Transparency and security
8	*"It should meet our expectations that it will make easier our processes, and it should be convenient to use."*	Meeting expectations Convenience
9	*"Probably high cost… and maybe not enough competence among employees to work with it."*	High cost
10	*"… as I mentioned make processes more "clear" and secure but there should be more analyzing on that technology."*	Transparency and security
11	*"Only if it is proven that it is an effective tool, otherwise not very helpful I guess."*	Proof of effectiveness
12	*"Privacy issues, high cost, quite complex system…"*	Privacy Cost Complexity
13	*"I believe it will continue developing, and who knows, maybe in 5 years all companies will be using blockchain? We'll see."*	Positive attitude about implementing blockchain
14	*"…no, I've tried to give my best of knowledge."*	-
15	*"Yes."*	-