

Drivers and Barriers in adoption of digitalization in Commercial Shipping (Ship Chartering and Shipbroking)

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MASTER THESIS

November 2021

Abstract

Digitalization of the services industry is much talked about phenomenon in present times. Within the maritime industry too digitalization is catching pace with the other industries. Although digitalization is still in its nascent stages in maritime industry it definitely is gaining pace. Given the size of the industry and the variety of stakeholders who have stakes in the movement of cargo and physical assets such as the vessels, start at some level is required. Technical operations of the vessels are way ahead of the commercial operations of the vessel in adoption of digital solutions. When comparing with other industries, financial industry has widely adopted to algorithmic trading where the role of financial brokers is ceasing, but the commercial shipping industry is still conducting negotiations for the freight rates and that still remains a very humanistic process with prominent role of intermediaries i.e. the shipbrokers.

The purpose of this thesis is to identify the drivers and barriers in adoption of digitalization in commercial shipping operations i.e. Shipbroking and ship chartering. To study this complex issue Systematic literature review and interview analysis has been conducted in qualitative way.

The findings suggest that regardless of the pace of digitalization chartering and ship broking will likely remain human intense processes in the near future. The thesis also suggests the ways in which the major barriers can be overcome if at all.

The research includes theoretical and practical implications and emphasizes on the further studies in this domain.

Keywords: digitalization, digital transformation, ship chartering, shipbroking, commercial shipping, drivers and barriers in adoption of digitalization.

Acknowledgements

I whole heartedly express my sincere gratitude to my supportive supervisor, Prof. Hyungju Kim. Without his support, this study would have been a distant dream for me. His constant support, encouragement, and unconditional help was definitely one of the strongest support mechanisms for writing this thesis.

I want to give special thanks to everyone who supported me during this tumultuous journey.

At last, I want to express my heartiest gratitude to my family and my ultimately wife, who like in my life supported this endeavour patiently.

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List of acronyms

OMC- Operations and maintenance costs

CAPEX- Capital costs

SLR- Systematic Literature Review

ROI – Return on investments

Chapter 1- Introduction

1.1 Background

Shipping industry is known to be a conservative one with limited proclivity for adopting innovation. There are multiple factors that dampen the industry's desire to innovate, such as, fluctuating fuel prices, high level of competition, and low earning environment. Digitalization is an innovation process and entails the continuous knowledge and awareness of shipping markets and competitors.(Lambrou et al., 2019). Thus, maritime industry as a whole must endeavor to improve the management processes and upgrade its information systems.

Maritime companies are forced to spend a huge amount of time in collecting, processing and rendering information to and from the partners.(Hvolby et al., 2021), digitalization is thus necessary in providing seamless integration of information and data flow.

Digitalization and digital transformation must not be treated just as an accessory to obtain competitive advantage, but as a tool to improve and streamline business processes. It might also serve as an effective tool to check nefarious and fraudulent events in shipping, such as forging letter of credits and bills of lading (Hackius & Petersen, 2017). Experts have coined a term 'Industry 4.0' for the ensuing digital revolution around the world. The other three industrial revolutions were also important but the fourth revolutions is changing all the aspects of human behavior. The first industrial revolution used steam power in order to mechanize production processes. The second industrial revolution was based on the usage of electricity to create mass production in manufacturing segment. The third industrial revolution employed electronics and IT to automate production processes. The fourth industrial revolution or 'Industry 4.0' is building upon the third. This is the data or digital revolution. This digitalization is unique in many ways because the speed of the breakthroughs in today's world are unprecedented. The fourth revolution is evolving exponentially rather than linearly. In today's world no industry is left out where the digitalization cannot be used. In today's world digitalization is all pervasive and it is disrupting almost all the industries. In some industries the advent of the digitalization has been tremendously fast such as in the banking, airlines, communication technology, etc. Other industries such as trading, shipping, broking, etc. have been the late adopters of the digitalization.

The digitalization in general allows for flexible methods of delivering right information to the right person at the right time. There is an enormous gap in the clearance and planning

processes between the ship, port, operators, charterers, and authorities.(Rødseth et al., 2020). This adds to the cost of the transshipment of the cargo by the ships. Thus, digitalization can add value to the concerned parties by reducing the costs associated with the logistics process as well, while at the same time increasing the cargo visibility.

Digitalization is changing the ways in which the businesses are conducted around the world. It is also changing the ways the businesses perceive the world and particularly the customers. Technology is also changing the dimensions of the competition in the respective industries. It is arming the competitors with numerous potent tools and strategies. Thus, the businesses must reinvent themselves at a speed they have never imagined before.(Krouskos, 2019)

1.2 Scope and limitations

The scope of this thesis is to assess the drivers and barriers in adoption of digitalization in commercial shipping, specifically in ship chartering and shipbroking sectors. The technologies which are the most applicable for the commercial shipping will also be identified based on the discussion and their relevance put in order with the industry's perspective. By doing this, the link between commercial shipping, the drivers and barriers, and the ways to overcome the barriers will be established and explored respectively. The terms digitalization, digitization, and digital transformation in maritime perspective will also be investigated, since the terms are mostly misunderstood and are interchangeably used and often confused with each other. One of the most prominent limitation of the research is that no specific literature relevant to study the effects of digitalization in commercial shipping is present in wide range of databases. This limitation downplays the authenticity of research as it becomes increasingly difficult to benchmark the pre-existing body of knowledge. Another limitation of the thesis can arise from the participants (from commercial shipping) in the thesis who are less informed about the increasing technological trend in the maritime industry. Though utmost care has been taken to choose the participants from the organizations and companies which are well known for the adoption of new innovation in the industry.

1.3 Method

The thesis tries to identify the drivers and barriers in adoption of digitalization in commercial shipping. For the study a qualitative approach has been chosen. Qualitative assessment can provide deeper understanding as to what factors the professionals from the industry perceive as the drivers and the barriers. Qualitative design is used when a topic needs a complex, detailed understanding of the issue. The intricate nature of detail can only be ascertained by talking directly to the people, allowing them to share their experiences, share their stories. (Creswell & Poth, 2018).

In this thesis, SLR and Interview & webinar analysis has been employed as two separate research methods. Both these are carried out in qualitative way. Later in the thesis the finding of both the methods are compared to discuss aggregate findings.

1.4 Research problem/questions

The primary purpose of this research is to identify the drivers and barriers in adoption of digitalization in commercial shipping, i.e. in ship chartering and Shipbroking.

The thesis includes:

Research Objective: Identification of driver and barriers in adoption of digitalization in Commercial shipping companies, with a focus especially on ship chartering and Shipbroking segments.

Research Questions:

(RQ1) *What are the drivers in adoption of digitalization in Ship Chartering and Shipbroking?*

(RQ2) *What are the barriers in adoption of digitalization in Ship Chartering and Shipbroking?*

(RQ3) *How can the barriers be overcome?*

1.5 Structure of the thesis

The Thesis consists of five parts: Background, Methodology, Analysis and Results, Discussion and conclusion (Figure 1. Thesis overview).



(Figure 1. Thesis overview)

Chapter 2 Literature review

2.1 Ship Chartering and Ship Broking

Chartering is a commercial shipping activity which broadly deals with matching of the transport need of the cargo with the commercial trading of the vessel. In the transport industry, chartering refers to the lease contract between two parties i.e. the ship owner and the charterer. The lease contract between the two parties is called the “charter party”. The chartering agreement is primarily a rental contract involving Shipowner, the registered legal owner of the means of transport and the Ship charterer, defined as the firm/organization/company/individual which hires the ship for transporting their cargo. The shipowner leases his ship to the charterer for a definite amount of time or a voyage in exchange of the financial compensation called “freight” or “hire” respectively.

The most common types of charters are: -

- Voyage Charter or spot charter: - This is a short-term charter.
- Time charter
- Bareboat or demise charter
- Contract of Affreightment

In the shipping business practice, “chartering” can be simply defined as an act or procedure which deals with the commercial employment of the vessel, international transportation of the cargo, and in many instances appropriate matching of both of them.(Plomaritou & Papadopoulos, 2018, p. 3)

In Chartering and shipbroking business, chartering information is the most important and critical factor. The chartering process involves thorough exchange of information among various stakeholders.

2.1.1 Role of a Charterer

Charterers are basically the controllers of cargoes. They keep the world's fleet in business. Some of the charterers own the fleets as well, while the other charterers hire the ships or the spaces on the ships on a temporary or permanent basis to move their goods, products or even sometimes the passengers. Ship charterers often liaise either with the ship brokers, who are the intermediaries or may sometimes contact the ship

Owners in order to arrange for the ships. The primary role of the ship charterer is thus to find the most suitable and most cost effective transport option. For this function they need to be in the constant touch with the market.(Plomaritou & Papadopoulos, 2018)

The nature of the ship chartering companies is very diverse. They range from the world's largest oil companies to the international commodity traders, the large grain houses, mining companies, etc. Charterers deal in almost all types of commodities such as iron ore, bauxite, crude oil, highly refined petroleum products, to petrochemicals, and aviation fuels, etc.

Yet another model of Ship chartering exists. A charterer might occasionally also be a party who has no cargo and who takes a vessel on charter for a specific period of time from the owner and then trades the ship for the carriage of cargo at a profit margin above the hire rates. Alternatively, he may re-let the ship to other charterers if the market is rising.

Depending on the type of the ship and the nature of the charter, the broker or either of the party draws up a contract form called charter party. Charter party records the exact rate, duration and the terms and conditions agreed between the shipowner and the charterer. The Charter Party also includes the dispute resolution mechanism, if such arises.

Ship chartering requires a strategic and committed attitude in obtaining results. This is because of the nature of complexity of the international logistics, which leave zero margin for error. A difference in the price of commodity by cents may lead to total expenditure of fortunes in the final price.(Wilson Sons, n.d.). Such intricate nature of Chartering business highlights the importance of the role of the ship charterers.

The role of the Ship charterer involves the following:-

1. Verification of the Shipowner's Credibility:-

Any commercial transaction starts with the judiciously evaluating the credentials of the other party. Based on the same principle the

Charterer must also verify the credibility of the ship owner. The charterer must thoroughly research the following about the ship owner- any ships belonging to the owner have been recently arrested, his ability to perform a contract, and his ability to honor the contract of carriage. The professional integrity of the ship owner must present unquestionable credibility.(Gorton et al., 2018)

2. Define the type of shipping contract

International markets are characterized by the seasonal demands, which directly affect the prices of the commodities and also the customs duties. All round the year the charterer must be ready to seize any opportunity to reduce the operational costs by choosing the right type of chartering contract. Sometimes, when bunker prices are volatile, the voyage charter is beneficial for overall organizational savings while sometimes the time charter or even contract of affreightment might be preferred.(Plomaritou & Papadopoulos, 2018)

3. Maintain discretion with regards to the business

Acting stealthily is a still much preferred way of functioning in the international market. Many charterers prefer to work in a low-profile environment. They prefer working in such a way because if they openly go looking for the partners in the market, they give their competitors the organization's strategy. This also signals the competitors where to look for to harm the company.(Wilson Sons, n.d.)

4. Accumulate the information about all the shippers of the consignment

Different shippers have different functioning styles mandated by the rules of their own loading terminals. Thus, the charterer is obligated to enquire about the operational dynamics of the load port and the discharge ports.

5. Lead the negotiation process from all the fronts.

Charterer is not only responsible to fix the cargo from port A to Port B but is also involved in various other phases of the cargo movement. Commodities and agricultural markets and operations involve the

movement of massive amounts of cargoes. Usually, the movement of the cargo is preceded by the tenders or a bidding process which is open to the international markets. The Government and large corporations offer subsidies to the parties who assume the risk of international logistics(Wilson Sons, n.d.). In this phase the charterer can further increase the profitability of the company by not only considering what is offered to the exporter but by fabricating a cost grid including the logistics, taxes, and eventually, the price of the commodity being transported, and finally also considering the situation in the various countries.

Even in this phase the discretion is utmost important the charterer must continue to work with the known associates and partners. This is because if the charterers open the cargoes to the market at this juncture the shipowners would inflate the freight rates thus eating into the profit margins of the charterer. Thus, the negotiation has to encompass all the fronts.

6. Evaluate and undertake the opportunities in other charters.

A charter party is a contract of transport. The charterer pays a shipowner, in exchange for the services of the vessel. Owner puts the vessel at the disposition of the charterer to transport the cargo from A to B or from time P to Time Q. This principle is basically the same principle of urban mobility.

In urban transport the passengers pool to reduce the per head costs. Similarly in international trade this sort of strategy might be useful in Ship chartering business. The “pool” of the charterers can substantially reduce the costs of operations. This is valid only if the rationality of the partners is established.

This “pooling” of the cargo also has one added advantage i.e. if the costs are shared by someone who already has a closed deal, the newer party reduces his risk of exposition in relation to final negotiations.(Wilson Sons, n.d.)

7. Have full regard to the international market condition.

Negotiating in the international market is not an easy task. Especially when everyone is trying to make money. This means that the positions of the players is ever changing. In the international arena the Intergovernmental politics and policies have a major impact on the markets. Countries are regularly being boycotted by the others; some countries are subject to economic embargoes. This makes charterers' job even more challenging. Other factors which affect the market are climatic conditions, droughts, floods, hurricanes, tsunamis, etc.

2.1.2 Role of a Ship Broker

“Shipbroking” is the act and the mediating profession which facilitates the business contacts between shipowners and charterers in order vessel charters to be fixed.(Plomaritou & Papadopoulos, 2018, p. 3). Since, the profession requires the Shipbroker to remain in contact with both the Charterer and Shipowner, gaining mutual trust of both the parties becomes very crucial for creating business relationships.(Skallist, 2018)

A shipbroker undertakes multiple functions in his day-to-day job routine, such as, arranges for carriage of goods by sea, arranges employment of a vessel, and/or sells and buys ships on behalf of clients.

Shipbrokers may sometimes be part of a shipbroking division in a principal's organization or may be working for an organization specializing in Ship broking activities where in which many shipbrokers may be present and specialize as owner's or charterer's brokers.

Each broker involved in the fixture process receives a lumpsum commission (usually limiting to 1.25% or as arranged) on the gross freight or hire earned by the ship owner.

Ship broking shipping activities are mainly divided into three main disciplines,

- a). Dry Cargo Chartering,
- b). Tanker chartering,
- c). Ship sale and purchase.

In this thesis the author is mainly considering “Dry cargo chartering” activity.

Working of a shipbroker is divided in three phases (considering a case when a Charterer has approached the Ship broker for fixing his cargo):-

1). Pre-Fixture: - This involves gathering of the information from the charterer before going into the market.(George Tsoudis, 2021)

- Charterers’ and Shipper’s background information.
- Cargo quantity, S.F., and type.
- Load and discharge ports
- Loading and discharging rates as per the Charterer’s contracts of sale.
- Details of the commission for the shipbroker.
- Laycan (window period within which the ship has to be alongside the berth and ready in all respects to load the aforementioned cargo).

2). Fixture:- This is the process where the Broker contacts the shipowner and negotiates the freight it is also called the process of negotiation. After the deliberation with one/multiple shipowners the broker identifies the following information.(George Tsoudis, 2021)

- Sends initial rate offer to charterer
- If charterer accepts the initial rate offer then the broker receives complete terms and conditions for the charterer from the

shipowner. The conditions are then sent to the charterer for the review.

- The charterer may or may not accept the terms in entirety and may wish to make some changes to the conditions, which are again sent back to the shipowner for review.
- After the agreement is reached between both the parties, the broker makes available to the charterer the necessary ships certificates to the charterer.
- The broker then prepares the final fixture recap and get the confirmation of both the parties.
- Broker makes sure that all the “subjects” to the carriage of cargo are lifted and then the Charter Party is signed between both the parties.

The vessel is now said to be “Fixed”.

3). Post-Fixture (loading Phase):- Though the vessel has been fixed and the ship is ready to load the cargo. The broker has still many responsibilities.(George Tsoudis, 2021). The broker must still ensure the following:-

- The agent has been nominated for the port.
- The shipowner has send the nomination form to the load port agent in order to nominate the ship to the load port.
- The draft B/Ls have been confirmed.
- Daily monitoring of the agents, stevedores, and cargo progress.
- Daily updates of the loading speed, loading berth, weather reports, etc.
- Daily updates to the ship owner and the charterer about the loading.
- Check for the NOR and SOF on cargo completion and check if demurrage or despatch is payable.

- Review the freight invoice and then deliver it to the charterer.
- 4). Post-Fixture- (Discharging phase):- The responsibilities of the broker are not over yet. He must still ensure the following:-
- Freight and commission are paid in full.
 - Liaise with the discharge port agent to ensure that the nomination and ETA have been duly received.
 - Monitor the ships ETA and the vessel's queue on daily basis.
 - Monitor and report discharge, weather, etc.
 - Check for NOR and Statement of facts for discharging operations.
 - Check for demurrage or despatch.
 - Close the voyage by checking the discharge port demurrage is paid, if any.

Shipbroking is highly demanding and stressful profession, but rewards are often satisfying. Shipbroking is highly competitive field. A good shipbroker has to build a strong network of contacts around the world(www.shippingandfreightresource.com, (2016)). A broker's function to create personal relations is today a matter of basic relevance" (Gorton et al., 2018, p. 50). It is also important to rely on reliable connections and colleagues, as one broker cannot cover the whole sector with his or her network alone(Gorton et al., 2018)

2.1.3 Types of chartering information

2.1.3.1 Market reports(Plomaritou & Papadopoulos, 2018, p. 83)

2.1.3.2 Orders(Plomaritou & Papadopoulos, 2018, p. 84)

2.1.3.3 Position Lists(Plomaritou & Papadopoulos, 2018, p. 89)

2.1.3.4 Indications(Plomaritou & Papadopoulos, 2018, p. 89)

2.1.3.5 Offers/ Counter-offers(Plomaritou & Papadopoulos, 2018, p. 89)

2.1.3.6 General source of information(Plomaritou & Papadopoulos, 2018,

2.1.4 Information Centers

London, Tokyo, and New York have been considered as hubs for the commercial shipping activity i.e chartering centers for many years. In addition to these Oslo, Hamburg, Piraeus, Copenhagen, Paris and Geneva have held a reputed position among the chartering executives and Ship brokers.(Plomaritou & Papadopoulos, 2018, p. 91). In the last few decades, due to the growth of Asian economies, Singapore, Hong Kong, Shanghai, Seoul and Taipei have grown rapidly in importance, whilst other shipping locations worth mentioning are Vancouver, Hamilton, Istanbul, Monte Carlo, Antwerp, Rio de Janeiro and Mumbai.(*Shipping Intelligence Weekly*, 2015).

In recent days, the importance of the Information centers is diminishing. This is due to the fact that the digital communication has changed the scenario drastically. At present the high-volume pictures and video clippings, messages to multiple recipients can be sent easily and at negligible cost. In past the facsimile was used extensively for the chartering negotiations. (Prasad, n.d.)

Though, the digital communication methods such as e-mails have reduced the costs, it is insecure and inauthentic. In the days of the Telex communication for chartering negotiations ‘answer-back’ facility was the authentication of the other party. ‘Blockchain’ solves this problem of authenticity of present-day digital communication, emails, and much more, which is discussed later in the thesis.

2.1.5 Information Network

An information network is a network of people, as well as a technological network. Both can define, accommodate and facilitate communication and information exchange.(Pisaniyas & Willcocks, 1999).

Commercial shipping market is a giant intertwined network of information. It is a network of people as well as the technology which facilitates the exchange of information. Though the practices of the archaic industry are changing the majority of the business is still conducted in traditional ways. Information networks are very crucial aspect of commercial shipping. A core aspect of shipbroker's life is about informing the parties and getting informed by the parties. Most of such information is about vessels and cargoes. Though most important piece of information which is most valuable for a shipbroker and charterer is about the recent fixtures, trends in the markets, knowledge of concurrent events, and most important of all is the knowledge about the competitors.(Plomaritou & Papadopoulos, 2018, p. 96) A shipbroker garners this information from their contacts in the industry professionals, this function is very important for the shipbroker in order to harness the quality information from their contacts. The contacts of the shipbroker are often Charterers, shipowners, charterer's brokers, etc. These contacts operate often on reciprocal information exchange.(Pisaniias & Willcocks, 1999). This contact network allows the shipbroker to cover a larger market.

Though in the recent past the Information channels have considerably changed. In the distant past shipbrokers and charterers depended heavily on telephonic conversation to conduct their business. Nowadays, with advent of information technology platforms the process of knowledge accumulation by the shipbrokers has become very swift. The broker does not act simply as a transmitter of information flows, but also as an information processor and knowledge creator.(Pisaniias & Willcocks, 1999). With the use of Digital communication platforms-e.g. skype, Zoom, Facebook, WhatsApp – Are used to facilitate individual communication as well as interaction with multiple participants.(Wang et al., 2016). According to one study, in general brokers prefer face to face meetings with the clients as it provides very rich information, then they prefer telephonic

conversation and then in the end they rate written communication.(Skallist, 2018). Their experience may make the brokers better in assessing new information and thus increase the efficiency of their search, matching and bargaining activities(Strandenes, 2000). With the efficiency of present-day advanced analytics systems which can analyze enormous amount of “Big Data”, the intangible experience and the information of Shipbrokers can be analyzed and meaningful results can be derived from it.

2.2 Digitalization and Digital Transformation

In this thesis digitalization and digital transformation have been used interchangeably, regardless of the fact that both are different aspects. Since, in this thesis I am trying to explore adoption of digitalization it also encompasses the fact that it includes digital transformation of the commercial shipping industry in general and also the digitalization and digital transformation of the organizations within it.

Chapter 3 Digitalization in Maritime industry

3.1 Scope of maritime digitalization

3.1.1 Advantages of Digitalization

Digitalization in maritime industry is very new. Since ages maritime industry has been dependent on analogue processes. In recent times there has been immense focus on digitalization of shipping processes. Though more focus has been on the digitalization of the technical aspects of shipping such as safety, automation of the ships, remote controlled vessels, fuel optimization, etc., digitalization of commercial aspects of shipping has also started. Increasingly the managements are resorting to the digitalized processes because of the advantages it offers. The advantages of digitalization are: OPEX reduction, service quality improvements, reduction in the fuel costs and in GHG emissions(Lee et al., 2018), reduced (or eliminated) paperwork(Dede et al., 2021), increased communication with the stakeholders bring clarity to business processes(Dede et al., 2021), reduction in document frauds(Triepels et al., 2015). These are only the tangible advantages. There are also other intangible advantages such as the digitization of the analogue processes offer the exploration of the new data which was previously not available for analysis. These advantages can be beneficial for any maritime business. Regardless of these advantages there are also a few disadvantages as discussed below.

3.1.2 Disadvantages of Digitalization

There are always two sides of a coin. It is true that digitalization claims to offer various advantages, there are also various disadvantages of its adoption. First and most major of all is that digitalization open up the doors of the organization to unauthorized malicious intrusions into the system (hacking)(Alop, 2019). This is evident by the successful cyber-attacks on top four shipping companies of the world i.e. Maersk, MSC, COSCO, CMA CGM.(Cimpanu, 2020). Second, is loss of privacy and data leakages. Most of the shipping companies depend on the third party and fourth party service providers. These service providers have access to the sensitive and commercial information of the company and may

release the data to other parties or monetize the data themselves. Third and most concerning is that the digitalization can lead to a cybernetic incident such as a major environmental or economic disaster, or cyber terrorism disaster causing loss of life(Alcaide & Llave, 2020). These are just a few and most concerning of disadvantages. Others are discussed later in the study.

3.2 Ship Broking platforms

Ship Broking platforms nowadays are equipped with state-of-the-art vessel position monitoring capabilities via AIS data. Using such capabilities such as access to vessel information in the real time is beyond human ship brokers.

Some of the major Ship broking platforms in the market are listed below:-

- I. The ocean Freight Exchange (OFE)
- II. Vesselbot

Provides automatic vessel and cargo matching thus reducing the need for the Brokers in between. The brokers in between the shipowner and charter is largely believed to fragment the market data and increased the shipping costs. Using the platforms allows for better informed decision making by the ship owners and in addition to this allows for reduction in the costs.

There are multiple other platforms, but these are the major ones as per my knowledge.

Chapter 4 Research Methodology

Research methodology is basically a theory of how the inquiry should proceed(Schwandt, 2007, p. 193)

4.1 Research strategy

Defining a research strategy is very helpful for a researcher to answer the research question and reach his goal(Saunders et al., 2015). Regardless of the wide variation in the types of research strategies two basic strategies are quantitative and qualitative research methods(Frankfort-Nachmias et al., 2015). Quantitative research focuses on collection of data and data analysis which is highly focused on numerical aspects(Saunders et al., 2015), on the other hand qualitative methods lay a focus on softer methods of data collection such as words, sentiments, pictures, audio and video data(Bryman, 2016).

When a researcher adopts quantitative strategy he is basically trying to “falsify, modify, or provide support for existing theory”, whereas the aim of qualitative data is to develop theories when partial or inadequate theories exist for certain populations and samples or existing theories do not adequately capture the complexity of the problem we are examining.(Creswell & Poth, 2018).

Quantitative methods employ deductive approach to establish a linkage between theory and research. It uses tests, surveys and scales(Frankfort-Nachmias et al., 2015). Alternatively, the qualitative strategy is based on inductive approach. The data collected from the interviews, observations, etc. is inductively analyzed and coded and thereafter, findings are developed from coding the data inductively.(Kuper et al., 2008).

The researcher is not bound to adopt any of the two specific methods. For better understanding the researchers are employing increasingly varied methods. All researches are different in scope, or the research objectives, or the data collection methods. It is apt to say that no one size fits all types of studies. For a better understanding the researchers can

employ both qualitative and quantitative methods as well. Such a methodology is called “mixed method” research.

Pertaining to this thesis the purpose is to identify drivers and barriers in adoption of digitalization in commercial shipping (ship chartering and shipbroking). When it comes to the shipping domain in general most of the research is target towards maritime training, autonomous operations of the vessels, or the safety of the vessels all of which are the technical aspects. To researcher’s knowledge there are very limited studies focusing on the digitalization aspect of commercial shipping. Also, there is no study to identify drivers and barriers specifically for commercial operations of the ships. This research thus employs two methodologies, i.e. a systematic literature review (SLR) and an exploratory qualitative study. The “mixture” of analysis of the experience of the commercial shipping executives based on the interviews and webinars with the SLR can help obtain more concrete results.

4.2 Research Design

Research design is a plan which is guiding light for a researcher in way to find the answers to the research questions. It indicates sources of data collection as well as time, access to data and location(Saunders et al., 2015). The researcher’s research design is “blueprint” from him helping in finding the solutions for the research problems and guiding him during the whole study(Frankfort-Nachmias et al., 2015). In this thesis the answer to the research questions will be explored by applying two separate methods: Systematic Literature Review (SLR) as devised by Denyer & Tranfield (2009) and Qualitative data analysis.

Denyer & Tranfield (2009) say that SLR is not a simple literature review but is a self-contained research project “it locates existing studies, selects and evaluates contributions, analyses and synthesizes data, and reports the evidence in a manner” that assists to reach clarified conclusions. The inclusion and exclusion criterion for the articles in the SLR should be clear enough to reduce the biases and let the readers the opportunity to assess assumptions of the author rather than taking it on belief(Siddaway et al., 2019).

Another research method employed is Qualitative research method. Qualitative studies provide an opportunity to comprehend how and why the parameters in question are fulfilled or not by using open-ended questions and words rather than statistical numbers(Creswell, 2014). Qualitative study is conducted when we want to empower individuals to share their stories, hear their voices, and minimize the power relationships that often exist between a researcher and the participants in a study.(Creswell & Poth, 2018, p. 100). In this thesis we want the commercial shipping executives to share their experiences with digitalization in the shipping industry.

The researcher will endeavor to comprehend the drivers, barriers, and ways to overcome the barriers for adoption of digitalization in commercial shipping i.e. in ship chartering and shipbroking.

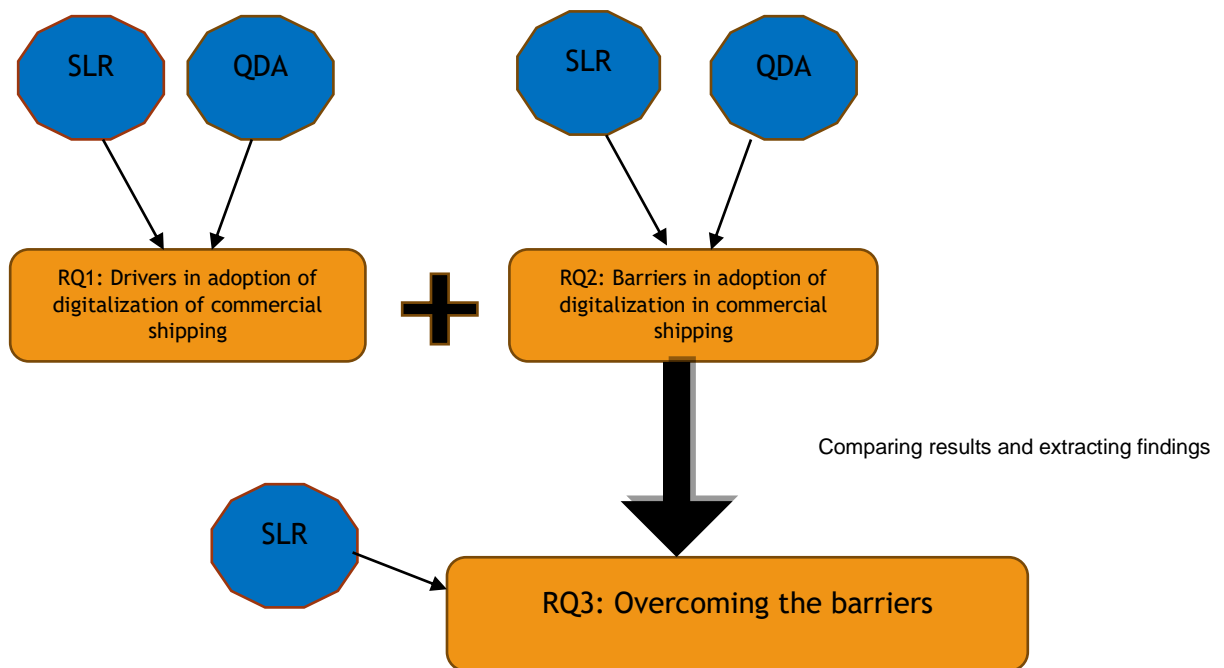


Figure 2. Research Design

4.3 Research Framework

4.3.1 Systematic literature review(SLR)

Most of the research begin with a simple literature review. If the literature review is not performed thoroughly and in a fair manner it does not uphold the scientific value associated with it. A systematic literature review bridges that gap and is view as very scientific process which synthesizes the existing work in a way which is seen to be fair by the scientific community. AN SLR is undertaken with a predefined strategy. The strategy ensures that the undertaken research is assessed with utmost completeness.

An SLR can be defined as a reliable, scientific overview of extant research on a subject area or topic(Petticrew & Roberts, 2006). Its purpose is to identify, appraise and synthesize all relevant studies using a transparent, replicable process(Tranfield et al., 2003). An SLR is aimed at bringing together as many existing evidence-based studies as possible that are relevant to the topic under investigation regardless of their background(Thorpe et al., 2005). By using the above, SLRs provide a wide range of the current state of the art research topics and thus provide a high quality evidence reviews since, it requires techniques which minimize biases and errors.(Tranfield et al., 2003)

A successful SLR is comprised of three major stages: planning the review, execution of the review, and the reporting of the results(Brereton et al., 2007). In the first stage the researcher identifies and select the relevant primary studies, extracts the information from the studies and then analyzes it, and in the end, he synthesizes that data. In the final stage the researcher writes the report to disseminate the findings from the Review(Xiao & Watson, 2019).

(Xiao & Watson, 2019) state that there are widespread differences in the procedures of the literature reviews, though all reviews can be conducted in the eight steps enumerated as follows: (1) formulating the research problem; (2) developing and validating the review protocol; (3) searching the literature; (4) screening for inclusion; (5) assessing quality; (6) extracting data; (7) analyzing and synthesizing data; and (8) reporting the findings.(Xiao & Watson, 2019)

In another study (Brereton et al., 2007) state that there are ten steps involved in conducting a systematic literature review.

In this thesis SLR is based on the protocol developed by Denyer and Tranfield (2009), who suggest five steps in the process of conducting of an acceptable SLR, stated as below:-

Step 1:- Formulation of a research questions

The first step in any research is formulation of research question/s. This allows the researchers to establish the focus of the research. It is done mostly by asking clearly framed questions(Cooper & Hedges, 1994). A clearly formulated research question makes the criteria for primary study inclusion in the SLR clear. Research questions, drive the entire literature review process(Kitchenham & Charters, 2007). Formulation of the appropriate research questions drive the entire review being conducted. All the efforts, methodology for data extraction and synthesis, and reporting, are geared toward answering the research questions.(Kitchenham & Charters, 2007). Identifying the appropriate research question may or may not be an iterative process. Nevertheless, it is the structure on which the entire systematic literature review depends.

With regards to this thesis the research questions were formulated and stated in Chapter 1 of this thesis.

Step 2:- Locating the studies.

Search for the authentic and meaningful literature goes on a long way to ascertain the quality of a SLR. The literature search is important for accumulating meaningful materials for the literature review; therefore, a systematic search is often undertaken to conduct a systematic literature search. (Kitchenham & Charters, 2007)

There are primarily three sources to find the literature: 1). Electronic databases, 2). Backward search, and 3). Forward search.

Electronic databases, in recent years, have gained a lot of traction of the researchers. They have become the primary preference of the researchers. They constitute the predominant source of published literature collections. (Petticrew & Roberts, 2006). No electronic database contains the comprehensive and complete set of published material, thus, a systematic search is recommended to be drawn from multiple databases. (Kitchenham & Charters, 2007).

For the present study the following databases were searched with many logical combinations of the word search strings that were derived from the formulated research questions, as indicated in the table 2. The databases that were used for the literature search are: Scopus, Web of science, ScienceDirect, and SpringerLink. These databases are the most prominent for the relevant topic.

The literature search has been conducted in two stages: - Stage 1 has a slightly soft approach to identify the relevant literature. The Boolean strings are connected via “OR” term which broadens the scope of the search. Also, this stage does not limit the date range of the relevant literature. Some exclusion criteria also were applied at the initial stage since the scope of the relevant literature is already known since the research question has been carefully crafted. The stage 2 is limited to the articles published in the last 5 years. This is due to the fact that digitalization is a very recent phenomenon and more mature literature has been produced in the last few years only. Also, a notable assertion by (Reis et al., 2020) is that the quality of the literature with respect to digitalization has become better in the last couple of years. Which was confirmed by the author via Scimago Journal Ranking (SJR indicator), which measures the

journal’s impact, influence and prestige that is measured from Q1 (best indexed journals) until Q4 (lowest indexed journals). (Reis et al., 2020). The number of the relevant documents pertaining to digitalization were found to have increased substantially over the years and mostly after 2016 onwards. This is due to the fact that document distribution has increased mainly due to the transition of digital technologies from computer science to the service and manufacturing industry. (Reis et al., 2020)

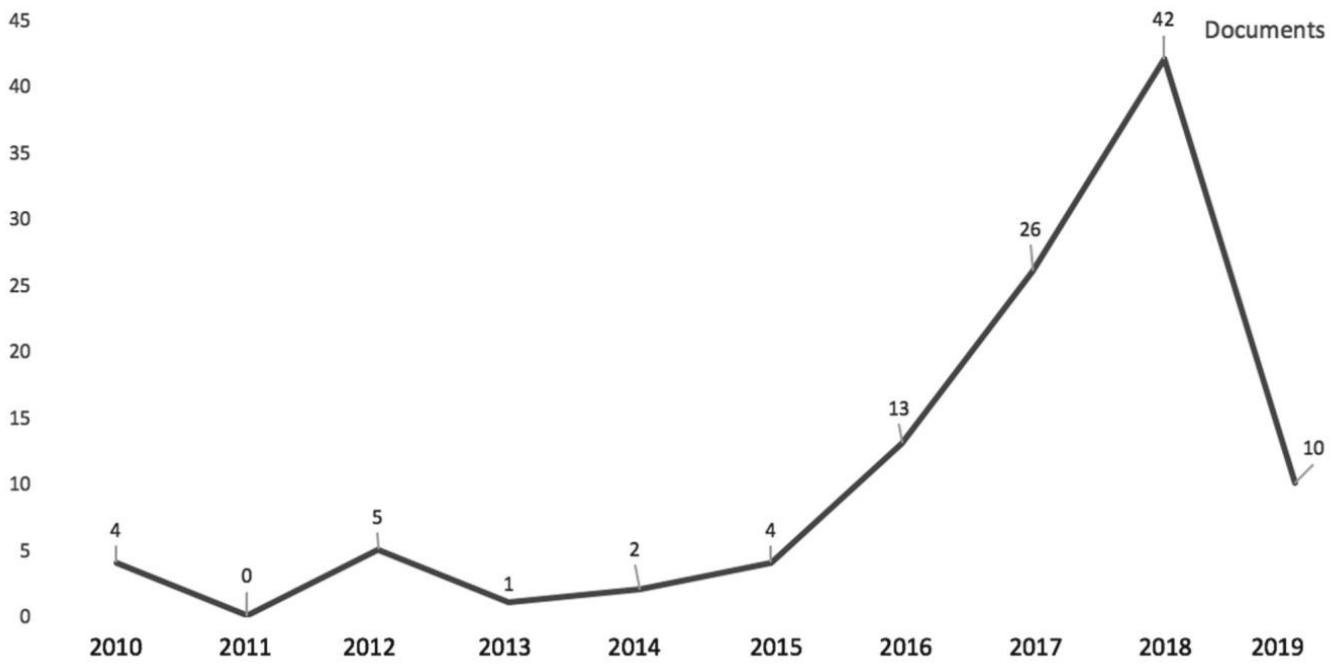


Figure 3. Digitalization related published articles' distribution by year (10 years' period) (Reis et al., 2020)

Table 1: Searching of Keywords and results in Databases

Database	Keywords	No: of results	Open access	Relevant-duplicates Removed	
STAGE 1	Scopus	(TITLE-ABS-KEY ("drivers" OR "Barriers" OR "opportunities" OR "Motives" OR "challenges" OR "Limitations" OR "enabler") AND TITLE-ABS-KEY ("Maritime" OR "Marine" OR "shipping") AND TITLE-ABS-KEY ("Digitalization" OR "digitization" OR "Digital transformation" OR "artificial intelligence" OR "machine learning" OR "deep learning" OR "blockchain" OR "cloud computing" OR "cyber security" OR "digital twin" OR "information Technology" OR "big Data" OR "smart shipping" OR "Chartering" OR "Shipbroking")) AND (EXCLUDE (SUBJAREA , "ENVI") OR EXCLUDE (SUBJAREA , "EART") OR EXCLUDE (SUBJAREA , "SOCI") OR EXCLUDE (SUBJAREA , "MATH") OR EXCLUDE (SUBJAREA , "PHYS") OR EXCLUDE (SUBJAREA , "AGRI") OR EXCLUDE (SUBJAREA , "BIOC") OR EXCLUDE (SUBJAREA , "CHEM") OR EXCLUDE (SUBJAREA , "CENG") OR EXCLUDE (SUBJAREA , "MEDI") OR EXCLUDE (SUBJAREA , "ARTS") OR EXCLUDE (SUBJAREA , "NEUR") OR EXCLUDE (SUBJAREA , "PHAR") OR EXCLUDE (SUBJAREA , "PSYC") OR EXCLUDE (SUBJAREA , "IMMU") OR EXCLUDE (SUBJAREA , "HEAL")) AND (LIMIT-TO (LANGUAGE , "English")) AND (EXCLUDE (DOCTYPE , "ch") OR EXCLUDE (DOCTYPE , "bk") OR EXCLUDE (DOCTYPE , "no"))	478	106	6
	Science Direct	(Drivers or barriers or challenges or limitations or enablers) and (digitalization or digital transformation) and (maritime or shipping or marine)	107	29	5
	Web of Science	("Drivers" or "barriers" or "challenges" or "motives" or "opportunities" or "enablers") AND ("digitalization" or "digital transformation" or "information technology") AND ("maritime" or "marine" or "shipping")	138	56	6
	Springer Link	("drivers" or "barriers" or "limitations" or "challenges" or "enablers") and (digitalization or "digital transformation" or "artificial intelligence" or "machine learning" or "information technology" or "data analysis") and (shipping or maritime) - (biology or physics or chemistry or health or political or social or "life sciences" or "earth sciences" or geological or military or environment or statistics or mathematics or psychology or philosophy)' within English , 2010 - 2021	1482	538	0
Total		2226	724		
After Removing Duplicates		1933	621	17	

Data base	Keywords	No: of results	Open access	Relevant-After removing duplicates	
STAGE 2	Scopus	(TITLE-ABS-KEY (digitalization* OR "digital transformation") AND TITLE-ABS-KEY (maritime OR shipping)) AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017)) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j") OR LIMIT-TO (SRCTYPE , "d"))	59	28	2
	Science Direct	(Digitalization or "digital transformation") and (maritime or shipping)	48	14	0
	Web of Science	Digitalization* or "Digital Transformation" (Title) and maritime or shipping (Title) Refined By:Document Types: Articles Open Access Timespan: 2017-01-01 to 2021-12-31 (Index Date)	8	5	0
	Springer Link	'(Digitalization* or "digital transformation") and (maritime or shipping) and ("chartering" or "shipbroking*" or "commercial shipping" or "ERP" within English; Article ; 2017 - 2021	53	52	5
Total		168	99		
After Removing Duplicates		136	56	7	

It can be seen from the table above the total number of articles found during the two stages is 2,394, whereas after removing the duplicates the number of articles amount to 2,069.

For demonstration of the criteria of selection of sources in SLR, PRISMA recommended flow diagram has been presented in *figure 4* below.

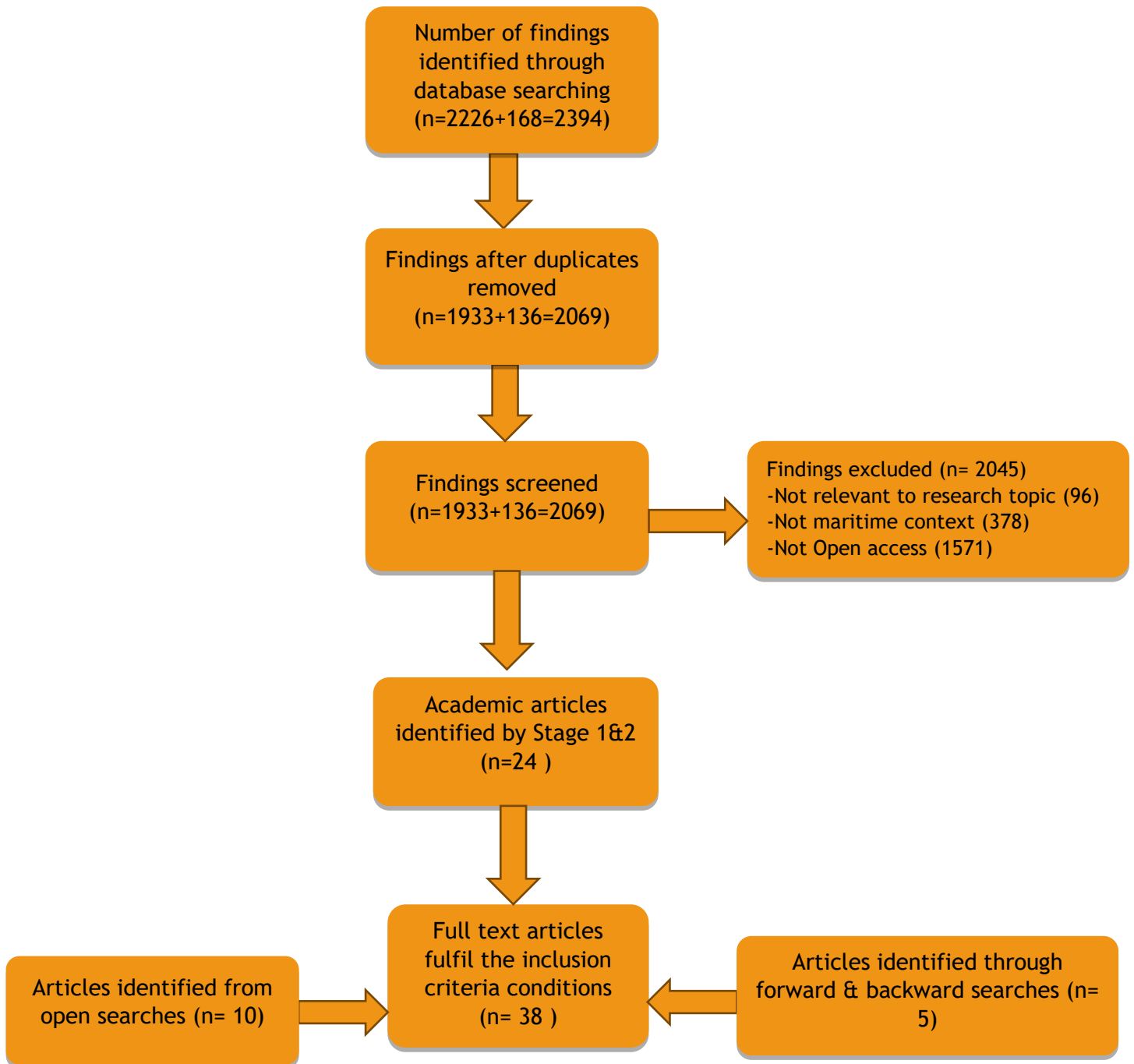


Figure 4. Flow diagram of preferred reporting items used in the systematic review adopted from (Moher et al. 2009)

PRISMA stands for Preferred Reporting Items for Systematic and Meta-Analyses (Page et al., 2021) (Moher et al., 2015)

Step 3:- Study selection and evaluation

This step is very important in the SLR. It allows the researcher to identify if each study addresses the review question. Assessing the relevance of papers included in a systematic review is a challenging task; these decisions should be driven in part by the quality of journals on the subject(Tranfield et al., 2003). Due to this reason, only the published papers in academic peer reviewed journals and some prominent conference articles were considered.

A number of key databases (Scopus, Science Direct, Web of Science, Springer Link) were searched using careful use and varied combination of search strings. The reason for selection of these databases is that the leading positions of these journals in terms of number of high-quality and peer-reviewed publications they index, abstract or to which they provide access(Bălan, 2020). Another reason for the selection of these databases is that the profile of these databases is relevant to the domain of the review. After the articles were identified in the databases, the articles which did not satisfy the inclusion parameters were rejected. Within a set of an explicit selection criteria there are inclusion and exclusion parameters, which define relevance of studies used in systematic literature review(Denyer & Tranfield, 2009).

The two stage procedure was adopted to screen the articles for inclusion: first was to start with a coarse review of the abstracts, followed by a refined quality assessment based on a full-text review.(Xiao & Watson, 2019)

Table 2: Inclusion and Exclusion Parameters of SLR

Inclusion Parameters	Exclusion Parameters
Availability of Full text access	Unavailability of full-text access
Primary language is English	Not English language article
Original and peer-reviewed research papers	Unoriginal and non-peer reviewed research papers
Keywords included in the title, abstract, or search terms	Keywords not included in Title, abstract, or search terms
Discusses the implementation of Digitalization in maritime industry (including container shipping, 3PL and 4PL logistics companies, supply chain industry, etc.)	Not specific to maritime sector or shipping.
Not a duplicate paper	Duplicate paper

Step 4:- Analysis and Synthesis

SLR is as a method of research has come from the medical field where quality in the synthesis of literature is of utmost importance to control the influx of new research and overarching themes.(Kastner et al., 2012). After the appropriate literature has been identified, the researcher can start with the synthesis of the research. The synthesis method guides the data extraction process, which often involves coding, especially for extending reviews.(Xiao & Watson, 2019). For a researcher it is important to establish of the coding will be of inductive or deductive nature(i.e., whether or not the coding will be based on the data or preexisting

concepts)(Suri & Clarke, 2009) . In the case this thesis the coding has been conducted in the inductive way, since, the motive of the thesis is identification of the drivers and barriers in adoption of digitalization. Coding has been conducted thoroughly since “an item that is not coded cannot be analyzed.”(Stock et al., 1996)

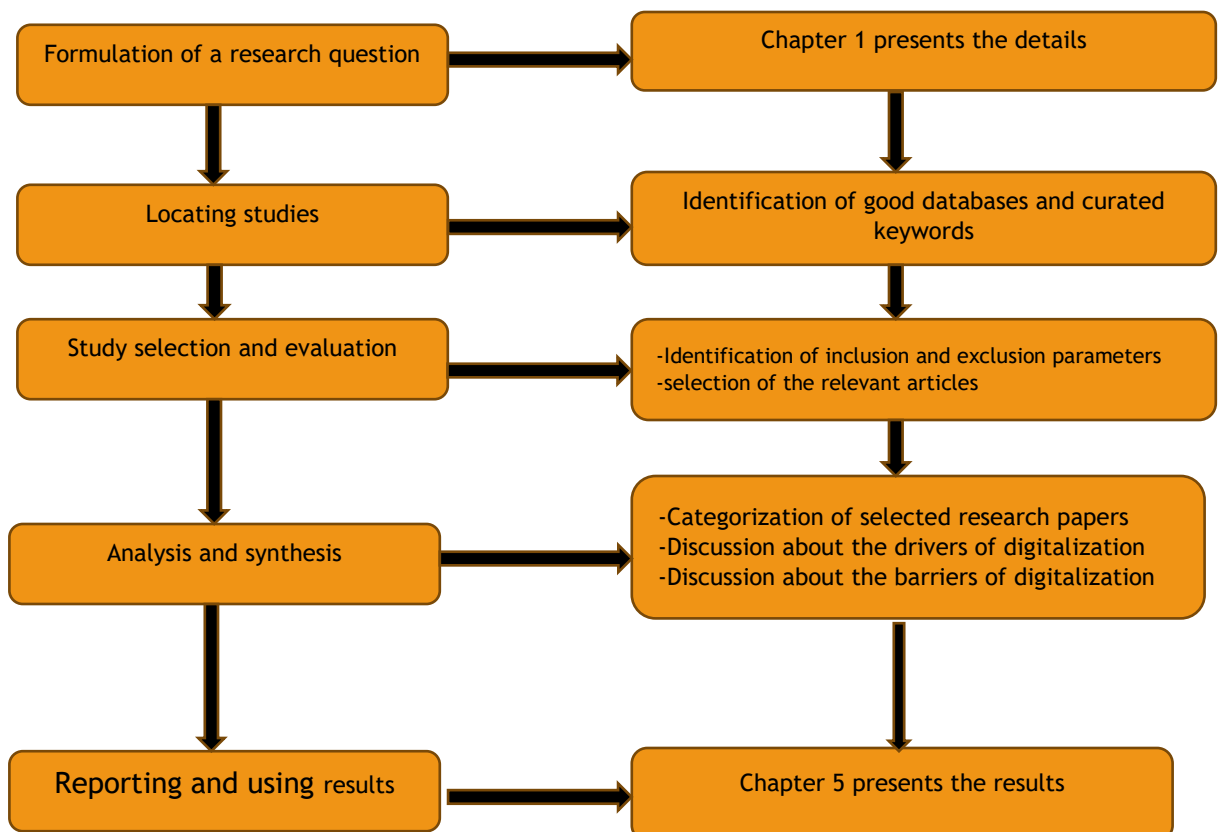
Next step after data extraction involves the reviewer organizing the data according to their review. Often, the review is in form of tables, charts or illustrative texts.(Xiao & Watson, 2019). Review contains the information of all relevant articles including title, author, date/ year, journal, language, industry, research methods and findings.(Denyer & Tranfield, 2009)

The aim of synthesis is to make associations or develop unobvious knowledge between individual studies(Denyer & Tranfield, 2009)

Step 5:- Reporting and using results

A systematic literature review must be reliable and independently repeatable. To ensure the repeatability the SLR must be reported with sufficient details.(Okoli & Schabram , 2010). Particularly the inclusion and exclusion criteria must be stated in detail so that the researchers can follow the steps and arrive at the same results.(Templier & Paré, 2015). Moreover, researchers should report the findings from literature search, screening, and quality assessment.(Noordzij et al., 2009).

Figure 4 shows a summary of five steps of the SLR process.



4.3.2 Exploratory Qualitative study- Interviews & Webinars

Qualitative study is conducted when a problem or issue needs to be explored. Pertaining to this thesis, the issue at hand is the underutilized technological resources in the commercial shipping industry. Digitalization or digital transformation of the commercial shipping industry is proceeding at a very slow pace compared to other industries such as financial, health care, etc. Moreover, there is very limited body of knowledge targeted towards the commercial shipping industry. Digitalization aspect of the commercial shipping is most likely one of the most under researched areas in the wider maritime industry. The exploration is thus needed to study the group and identify the variables which cannot be otherwise measured. The qualitative research is very obvious choice since the issue is very complex. This complexity can only be established by taking to the people.(Creswell & Poth, 2018, p. 100).

The qualitative research is mostly inductive. It is used to develop concepts, insights, and understanding from the patterns in the data rather than collecting data to assess preconceived models, hypotheses, or theories.(Taylor et al., 2016, p. 8). A qualitative research studies people and professionals in context of their experiences and situations in which they find themselves and how they perceive those situations.(Marshall & Rossman, 2016). This data collection for this thesis is designed to benefit these words of Marshall & Rossman(2016).

Data Collection

The data collection has been conducted with two methods: -

4.3.2.1 The Semi-Structured Interviews: -

The semi-structured interviewing is a tool which is employed because it can be employed for a wide range of research goals. It allows for a wide range of questioning, including prompting to have a more meaningful data collection. It is also useful for drawing the focus of the informant if the responses are tending to go away from the question's purview. Semi-structured interviews incorporate both open-ended and more theoretically driven questions, eliciting data grounded in the experience of the participant as well as data guided by existing constructs in the particular discipline within which one is conducting research.(Galletta, 2013, p. 45).

The questionnaire formulation took considerable time. Nevertheless, it was ensured that that the interview questions were clearly connected to the purpose of the research. The questions were kept open-ended so that the participants can get space required for sharing their experiences and knowledge. The semi-structured interviews provides a complete back to back communication cycle, where the interviewer most likely understands the answers, and also might ask some follow up questions.

An initial interview guide seeking out the main themes was developed before the data collection started. The interview guide was designed keeping in mind the following aspects such as age, education, and experience. In the qualitative research, data analysis occurs alongside data collection.(Galletta, 2013, p. 119). This aspect progressively affected the subsequent interview questions and probing technique. Some of the questions were reframed and on other occasion some additional questions were added, while removing the redundant ones. The interviews were conducted via Zoom Inc. or Microsoft Teams platform. All of the

interviews were recorded after obtaining the permission from the informants. Information backup was achieved through the recording on the audio recorder. Note were not taken during the interviews. All the interviews were transcribed within a week of the interview.

Sampling

Sampling strategy was formulated based on the main research questions and the initial literature review. A total of fifteen (15) invitation emails were sent to the participants directly. All the participants were personally known to the researcher. Out of the fifteen, six showed interests in the participation. Out of the six, one participant backed out citing the professional commitments as the reason. Finally, five participants were interviewed as per their convenience. To ensure that the Participants were representative of the regional practices, a widespread geographic representation was ensured.

Table 3: Overview of the Interview Participants

Participant S. Number	Duration (mm:ss)	Relevant Experience	Past and Present Roles	Education	Location	Interview Language
Participant 1	44:15	17 Years	Charterer, Ship Broker	B.Sc.- Shipping Management	Norway (Oslo)	English
Participant 2	28:59	4 Years	Commercial Operations Manager	M.Sc.- Maritime Management (Commercial)	India (Mumbai)	English
Participant 3	65:29	23 years	Ship's Officer, Vessel operator, Director Dry Bulk Operations	MBA- International Business	India (Dubai)	English
Participant 4	56:18	35 Years	Ship Operations, Chartering, Ship Broker, Educationist, ICS London (Course Coordinator and Designer)	PhD (ongoing)	UAE (Dubai)	English
Participant 5	41:57	35 Years	Ship's Officer, Vessel Operator, President (Independent Ship Broking firm)	MS-Maritime Transportation management	USA (Houston)	English

Data Analysis

Data analysis was conducted parallel to the collection of data (Creswell & Poth, 2018). A professional artificial intelligence-based software 'Descript' was employed for transcription of the interview. The interviews were analyzed on the the Qualitative Data Analysis (QDA) software "Atlas.ti v 9.1.3.0". On review of the transcript of the interview it was observed that the accuracy of transcription was unacceptable and there were chances of misperception of the data. The errors of the transcription were manually removed. While checking the transcripts since the first interview, the researcher started dealing cognitively with the data.

Interpretation and consideration of the relevance of the questions and of the responses also started. The process was very iterative in nature, the researcher went back and forth identifying categories, codes, themes, transcripts, checking for consistency, comparing with the findings of the SLR. Manual analysis is a very time-consuming process as Creswell & Poth (2018) point out, but on the account of low number of informants the analysis of the interviews was not cumbersome.

As the first step for coding the interview extracts were summarized and grouped in the categories as suggested by Creswell & Poth (2018). The summary was then employed to generate the codes inductively. Most of the codes corresponded with the codes already generated in the SLR. Nevertheless, the researcher had an open mind regarding the underlying themes and the possibility of assigning new codes to the relevant data. Some new codes also emerged inductively from the interview data to identify the drivers and barriers in adoption of digitalization. The method which was employed for this phase is referred to as “inductive coding” or “open coding”(Marshall & Rossman, 2016). A narrative analysis of the interview data was carried out simultaneously assigning the categories and codes. The summary related to each category and each code was stored in the linked notes section of the software.

4.3.2.2 Webinars on YouTube: -

Table 4: Overview and details of Webinars (as qualitative data)

S. Number	Duration (mm:ss)	Video Link	Participants	Interview Language
V1	44:25	Digitalization in Maritime Industry- Challenges & Opportunities https://www.youtube.com/watch?v=wjNJI_SVFss&t=929s June 19, 2021	Dr. Muddassir Ahmed(Supply chain expert,Academician), Rachael White(Advisor/Consultant Maritime trade, 25 years of experience)	English
V2	61:13	Digitalization in Shipping industry- The maritime development https://www.youtube.com/watch?v=3lqEVZnnw9E Apr 6, 2021	Captain Govind Kumar Gautam, Jerome Tillier, Pieter Kinds, Kaushik Reddy, and Vinicio Gonzales.	English
V3	75:29	Digitalisation in the Shipping Industry	M.S. Jagdeep Makkar(40 Years of commercial & Technical	English

		https://www.youtube.com/watch?v=ee5FgIJu26l Nov 12, 2020	experience, Ship Finance Consultant), Puneet Ojha(27 Years, Klaveness Asia-Director, Alok Shrivastava(20+ years commercial), Priyabrat Parida (Chartering-Iron ore, Coal), Capt. Govind Gautam(30+ years Diverse Experience), Capt. Rahul Bhargava(35+ years, Shipowner, Broker, Charterer), Alejandro Gutierrez(10+ years Commercial), Capt. Gotham Ramaswamy(30+ year, Ship Arbitration, Insurer)	
V4	72:50	Digitalisation in commodities trade: The steps you should be taking now https://www.youtube.com/watch?v=Gvo_DuwiYsk Nov 12, 2020	Munir Al Sharif(36 Years experience, metal trade), Sandeep Jain(Director, Bombay Middle Exchange Ltd.; 26 years experience), Aprameya Saxena(Director-exports, Hindustan Zinc Ltd., 12 years experience), Dhiraj Khandelwal(Chartered Accountant, 20 years' experience in commodity trading)	English

4.4 Research Ethics

Following the research ethics is a very important element of any research project. General ethical principles such as honesty, objectivity, integrity, openness, intellectual property, confidentiality, legality, etc. were followed while conducting this project. This thesis contains two different research methods, there are different requirements for them.

First of the methods employed was SLR. For this all the research work conducted by the other authors has been cited using the academic standards. Also, the studies filtered during the SLR process were relevant to the topic of the thesis.

Second method employed was Interview & Webinar analysis. For a thorough analysis interviews were to be recorded. Interviews are considered as personal data. Hence, prior approval from Norwegian Centre for Research Data (NSD) was sought. It was ensured that the personal data was processed as per the GDPR regulations and

guidelines from NSD. Before participating in the interviews, the participants were familiarized by means of an information letter/consent form, making them understand their rights as a participant and that the data will only be used for academic purposes with anonymity and confidentiality. Thereafter, they were sent the non-Disclosure agreement to ensure them that their data is legally protected. They were also advised that on or before 31st dec 2021, all the collected personal data will be anonymized and all video/audio recordings will be deleted.

4.5 Research Limitation

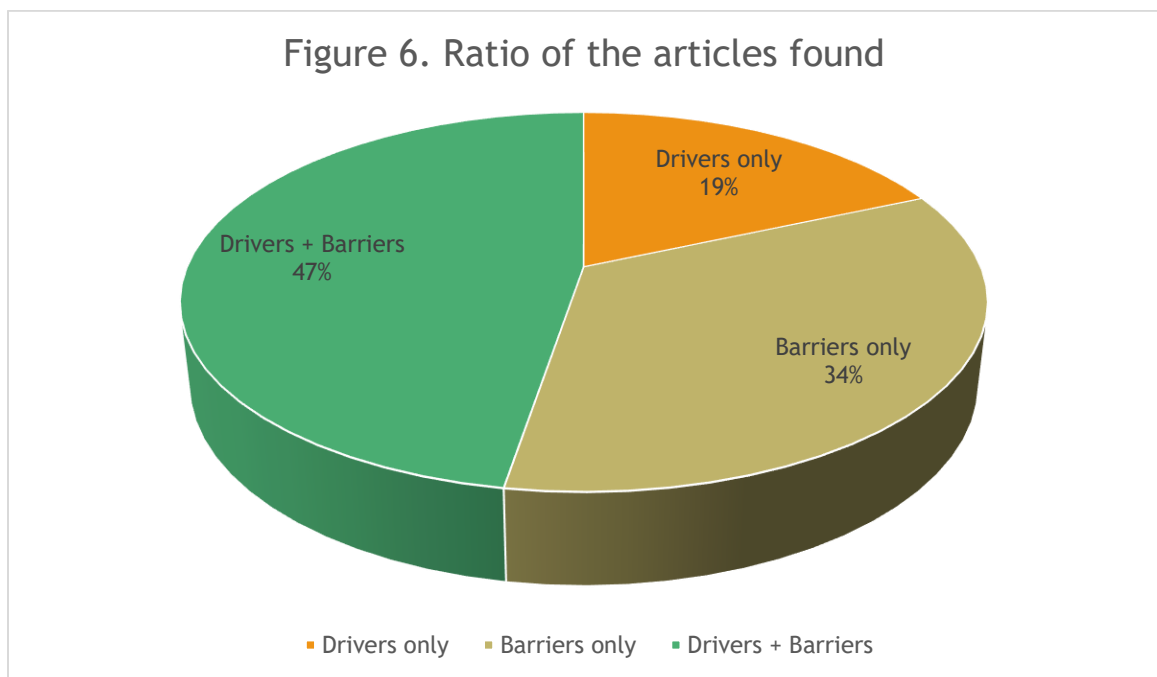
The limitations of this study might stem from primarily two factors: the chosen method and the study population and data source. Apart from SLR, qualitative study was employed. Since, there is no similar study within the domain of this thesis, mixed method research would have been a better option. Even though being aware of this limitation the present qualitative method was selected due to the time and resource related issues. Regardless of this issue measures were put in place to maximize the credibility of the findings. The limitation also exists with SLR. The limitation is in terms of the availability of the academic articles which are commercial shipping domain specific. Talking about the second limitation the study population was five participants and four webinars. All of the five participants have significant commercial shipping experience some as ship brokers and other both as ship charterer and ship broker. None of the participant had any specific experience in the IT industry. Their experiences were based on their interaction with the technology without specifically knowing how that technology works. This was one of the most significant limitation of the study. Another was that all the interview participants and the webinar participants were males. It was ensured that the interview participants were geographically dispersed. But the webinar participants were mostly of Indian origin, which could give a region-specific bias to the study. Each limitation must be considered, many elements of the study design were included to ascertain that this thesis is not weakened by these issues. Careful documentation of each data collection and analysis phase was employed. Data quality and richness was ensured by the carefully curated questionnaire. Though peer review was not employed but the consistency of the findings of SLR and QDA ensured that the researchers conclusions are grounded in the data.

Chapter 5 Results

This chapter presents the drivers and barriers towards adoption of digitalization in ship chartering and shipbroking industry that have been identified from the two of the following adopted research methods. Firstly, the review of the findings from the Systematic Literature Review (SLR) are discussed, then the analyzed information from the interviews will be presented.

5.1 Systematic Literature review Results

Majority of the selected articles do not directly identify the drivers or the barriers towards adoption of digitalization. On closer scrutiny of the text of the articles the drivers and barriers have been identified. Most of the article were from maritime industry, yet they did not focus specifically on the digitalization aspect in the Ship Chartering or shipbroking. In fact, none of the articles (open access) found in the repositories specifically focus on the Commercial aspect of shipping. The common pattern of the articles identifies the drivers and barriers into the organizational factors, the technological factors, and the external factors(Tijan et al., 2021) which the industry faces. Below Figure x represents the ration of all found articles along with the drivers and the barriers.



Below *Table 5*. represents summary of all the articles including backgrounds of the authors, research method employed for the study, and the key highlights of the findings which relate to the research questions of this thesis.

Table 5. Synthesis of Systematic Literature Review Findings

	Article Number	Author	Drivers/Barriers	Specialty	Method	Key Findings
Stage 1	1	Alcaide & Llave, 2020	Barriers	Cybersecurity, Logistics, Maritime security and safety	Bibliographic review, Qualitative study	The paper addresses the issue of maritime cybersecurity in today's ever-increasing adoption of digital solutions. The paper frays into the level of knowledge of the industry and the further training that is required on the issue.
	2	Alop A., 2019	Drivers & Barriers	E-Learning, ICT, Pedagogy	SWOT Analysis	The author tries to identify the risk factors and obstacles in the adoption of smart and digital solutions in the maritime industry. The paper also tries to establish if the non-trivial approaches of the industry can lead to the acceptable results in the area or not?
	3	Balan, 2020	Drivers & Barriers	Supply Chain & Logistics, CRM, Marketing management	Systematic Literature Review	The review tries to identify the factors and components of the mechanism that lead to the disruptions in the impact of different types advanced ICT inventions on maritime transport.
	4	Dede et al, 2021	Drivers & Barriers	Maritime Psychology, sustainability	Systematic review, case study	Brings forward the views, approaches, and results about blockchain adoption in supply chain industry.
	5	Feibert et al, 2017	Drivers & Barriers	Healthcare logistics, Business Process management	Literature review	The study identifies and categorizes the major themes in literature according to digitalization/BPM and efficiency/responsiveness. The main BPM and digitalization enablers or drivers of shipping SC performance have been identified.
	6	Gonzalez-Cancelas et al., 2020	Drivers & Barriers	Coastal and offshore, sustainability	SWOT	To understand the scope of effects of digitalization in ports using the SWOT methodology and measures to address the issues.
	7	Gruchmann et al., 2020	Drivers	Digital Business Models, 3PL/4PL, Sea freight logistics	Systematic Literature Review	This article qualitatively analyzed FreightHub, a 4PL online business model with the tradition 3PL industry. The paper presents the extended framework for digital freight business model while applying the digital business model conceptualization. In addition to the above the paper provides the managerial

					implications about the opportunities and threats of digital transition in the industry.
8	Harris et al., 2015	Barriers	Technological trends and ICT applications in Logistics, Network design for traditional and green logistics	qualitative and explorative	Explores the potential reasons for slow adoption of ICTs in the European Union specifically in the field of Multimodal freight transport industry. The article also explores how these barriers can be overcome. The author classifies the barriers in three categories: the user related, technology related, and policy related.
9	Irannezhad, 2020	Drivers & Barriers	Blockchain and Logistics, E-logistics platforms, Supply chain and freight transport	Literature review, Value proposition	The article clarifies the opportunities and challenges of Blockchain in logistics and transportation industry. The paper however concludes that the industry is widely fragmented and no single player can dictate the blockchain technology market.
10	Jahani et al., 2021	Drivers & Barriers	Supply Chain Management, Industry 4.0 applications	Systematic Literature Review (SLR)	The paper tries to identify the digital technologies applicable to the procurement processes of the supply chains and also tries to understand how the managers can play an important role in the digital transformation of their organizations.
11	Philipp et al., 2019	Drivers	Blockchain, smart contracts	Qualitative, quantitative	The paper discusses the ways in which the smart contracts powered by blockchain technology can facilitate the ease of transactions between various players in the industry. The paper is based on the interviews of subject matter experts and also employs the case studies to demonstrate the usefulness of blockchain technology.
12	Pu and Lam, 2020	Drivers	Blockchain, Maritime technology adoption	Content Analysis	The paper analyses in detail the current and emerging uses of Blockchain applications in maritime industry. In addition to the above, the paper tries to build conceptual framework to layout the ways of adoption of Blockchain in the industry and also to

						guide the future research.
	13	Sarkar & Shankar, 2021	Barriers	Port management	Literature review, TISM, MICMAC analysis	The paper identifies key barriers which affect the optimum operation of port logistics in Industry 4.0 era.
	14	Sullivan et al., 2021	Drivers & Barriers	Industry 4.0, Digital solutions	Qualitative study	The article establishes an organized set of technologies and characteristics related to digitalization. The paper also endeavors to establish a set of practical definitions.
	15	Tan and Sundarakani, 2021	Drivers & Barriers	Freight Booking, Blockchain	Explorative case study	The article evaluates the challenges faced by the global shipping companies in freight consolidation business and explores the case of blockchain use in enhancement of competitiveness and sustainability of freight booking activity.
	16	Tijan et al. 2021	Drivers & Barriers	maritime transport digital transformation	Comprehensive literature review	The article identifies the drivers, barriers, and success factors for the maritime sector's digital transformation, using a number of cases
	17	Zaman et al. 2017	Barriers	Big Data Analytics	Discussion	The paper primarily shows how big data analytics can create an impact in the shipping industry. It also illustrates the applications and obstacle in the implementation of big data in the industry.

	Article Number	Author	Drivers/Barriers	Specialty	Method	Key Findings
Stage 2	18	Bui & Nguyen 2021	Barriers	Big Data analytics	Review	The article identifies the challenges of big data application in maritime industry and comprehensively suggests its applications in the wider maritime transport.
	19	Grover et al. 2020	Barriers	Artificial Intelligence	Systematic literature review	The article explores the feasibility of Artificial intelligence within an organization and provides guidelines to the managers for AI application in varied areas of operations management.
	20	Jabbar et al. 2021	Barriers	Blockchain	Survey	The article makes a comprehensive overview of the digitalization of supply chain, points out the

						challenges and how these challenges can be addressed. The article critically analyzes the technological and non-technological challenges in adoption of Blockchain in the supply chain industry.
	21	Khan et al. 2021	Barriers	Blockchain, Smart contracts	Systematic Literature review	The article discusses the present smart contract studies done by other authors. It identifies challenges and open issues that need to be addressed in the industry to adopt smart contracts in the future.
	22	Lambrou et al. 2019	Drivers & Barriers	Shipping digitalization, AI, Blockchain, innovation	Multi-Case study, Qualitative research	The article illustrates an overarching theoretical model which systematizes the technological components, present day management rationales, and determinant factors i.e., the practices of shipping digitalization.
	23	Mrakovic & Vojinovic 2019	Barriers	Maritime Cyber-Security	Case Study	The paper highlights key problems in maritime industry with the perspective of cyber security and proposes the solutions to eliminate or minimize them.
	Article Number	Author	Drivers/Barriers	Specialty	Method	Key Findings
Backward search	24	Gausdal et al. 2018	Drivers & Barriers	Blockchain	Literature review, case study	The paper aims to set a theoretical framework for Blockchain and operations. The paper identifies the drivers and barriers of digital innovation and explores the avenues in maritime industry where the blockchain technology can be implemented. The Article primarily considers the Norwegian offshore industry as a case.
	25	Liu et al, 2021	Barriers	Blockchain	Case study	The article tries to identify the pain points of maritime supply chain industry and based on those suggests the application for blockchain in supply chain wide perspective.
	26	Popoutsidaki s et al. 2019	Drivers	Digital platforms & ERP Systems	Case studies	The article tries to illustrate and establish the need for the use of ERP systems in the shipping industry and for that purpose the Authors employ case study methodology. The authors identify the advantages and disadvantages of use of ERP systems in various sub segments of shipping companies.

27	Chang et al, 2020	Drivers and Barriers	Blockchain	Critical literature synthesis	The article gives a complete bird eye's view of the applicability of Blockchain technology and its challenges, opportunities, and gaps in the global supply chain industry.
28	Osmundsen et al. 2018	Drivers	Digital Transformation	Systematic Literature review	The article endeavors to identify the drivers of digital transformation, identify success factors and forays into the implications.
Article Number	Author	Drivers/ Barriers	Specialty	Method	Key Findings
29	Shen, Cong 2013	Drivers & Barriers	Electronic Intermediaries in Shipping Business	Mixed method	The main findings show that the e-intermediaries can rely on the broadened searching scope or perhaps cooperate with the existing intermediaries i.e., the Brokers to offset their weaknesses. The thesis also recommends the strategy advise to electronic intermediaries.
30	Svarstad et al, 2018	Barriers & Drivers	Digitalization in shipbroking	Case study	The key finding of this thesis is that in some of the functions of shipbroking the traditional brokers are better than the digital shipbrokers, such as in providing additional services, network formation, and total performance.
31	Tebni, Dhia 2019	Barriers	Digital Platforms	Case study	The thesis aims to qualitatively explore the digital development platforms 'Veracity' of DNV & 'Kognifai' of Kongsberg Digital. The thesis compares the platforms and identifies the challenges of both the platforms.
32	Wan Yuqian, 2021	Barriers	Information flow, Business Process	Case study	The thesis summarizes the influence of digitalization on the maritime logistical process, information flow, and business processes.
33	Korres Stefanos, 2020	Drivers and Barriers	Digitalization, Digital Platforms and Transformation	Case Study	The thesis illustrates various technologies which are available for adoption in shipping. It also highlights the key challenges and main drivers of digitalization in maritime industry.
34	Number & Batrinca 2007	Drivers	Digital Platforms, E-chartering	Case study	The paper tried to evaluate the reasons as of why the multiple chartering platforms built during the dot com era failed to capture the market. In addition to the

						above the paper also suggests the requirements of the chartering platforms which would make the e-chartering web platforms successful.
35	Prasad, 2020	Drivers	Technology adoption, shipbroking	Case study		The paper forays into the modern tools which are being offered to the shipbrokers. The paper also tries to assess the impact of the technology adoption in the shipbroking industry.
36	Prasad	Drivers & Barriers	Communication systems in Shipbroking	Discussion		The article tries to identify the impact of modern-day communication methods in the traditional ship broking industry.
37	Lloyd's List	Drivers & Barriers	Digital Transformation	Survey		The report highlights the drivers and barriers in deployment of digital technologies in the maritime industry with a perspective of ship owners and managers.
38	Fitzgerald et al. 2013	Barriers	Digital Transformation	Research Report		The report tries to better understand why some businesses fail to improve their business performance while using the latest digital technologies.

5.1.1 Summary review of driver and barriers in adoption of digitalization.

5.1.1.1 Drivers

Drivers can be defined as external or internal triggers that cause organizations to engage in Digital transformation (Osmundsen et al., 2018). In this thesis the drivers of digitalization are sub-categorized in three ways: Organizational drivers, technological drivers, and external drivers. (Tijan et al., 2021).

Based on the thorough SLR, 15 organizational, 12 technological, and 13 external drivers were identified.

One of the most vital organizational driver identified is reduction in operational costs (Bălan, 2020; Dede et al., 2021; Gonzalez-Cancelas et al., 2020; Irannezhad, 2020; Jahani et al., 2021; Philipp, 2020; Tan & Sundarakani, 2021). Operational cost remains the primary concern of any organization. OPEX cost directly impacts the profitability of any firm. Digitalization has been positively identified as the single largest factor which can help the charterers and shipbrokers in reducing the operational costs directly and indirectly. Second most prominent driver of digitalization from organizational perspective was identified to be competitive advantage (Bălan, 2020; Feibert et al., 2018; Gruchmann et al., 2020; Lambrou et al., 2019; Number & G Batrinca, 2007; Tijan et al., 2021). This driver is very understandable any company would want to have an advantageous position in comparison with its rival. Though there is an inherent bias in this finding, and it is that adoption of digitalization or digital transformation requires substantial CAPEX costs. The shipbroking companies and the large chartering majors only have access to that extensive financing. So, to summarize this driver specifically focus on the larger companies while omitting this with the perspectives of SMEs. Other prominently featuring organizational drivers are: increase in organizational productivity, decision support systems, meeting customer requirement, increased trust, wider market access, etc.

Technological drivers are the features offered by digital systems which resound to the management as assuring about the wider adoption of digitalization in the industry. Prominent Technological drivers which were identified are:

Immutability (Dede et al., 2021; Gausdal et al., 2018; Irannezhad, 2020; Pu &

Lam, 2020); security, efficiency, and confidentiality(C.-H. Chang et al., n.d.; Dede et al., 2021; Gausdal et al., 2018; Irannezhad, 2020; Number & G Batrinca, 2007; Pu & Lam, n.d.; Sullivan et al., 2021; Tan & Sundarakani, 2021; Wan, 2021); Process digitalization; seamless flow of information(Gruchmann et al., 2020; Jahani et al., 2021; Pu & Lam, 2020.; Shen, 2013; Tan & Sundarakani, 2021; Wan, 2021). From technological point of view, security, efficiency and confidentiality is identified as single largest driver.

External drivers are the effects of external influences which prompt the maritime industry to adopt digital technologies. Most prominent external drivers identified in the SLR are: Cargo visibility & Traceability(Bălan, 2020; Chang et al., 2020.; Dede et al., 2021; Jahani et al., 2021; Liu et al., 2018), Customer management(Bălan, 2020; Y. Chang et al., 2020; Dede et al., 2021; Jahani et al., 2021; Prasad, n.d., 2020; Svarstad et al., 2018), Documentation(Dede et al., 2021; Gausdal et al., 2018; Gruchmann et al., 2020; Irannezhad, 2020; Lambrou et al., 2019; Liu et al., 2018; Philipp, 2020; Pu & Lam, 2020; Tan & Sundarakani, 2021), risk mitigation, Legal and policy requirements. These are the factors which effect the decisions of the organizations to adopt digital systems.

Below in *table 6*. the other oraganizational, technological, and external drivers towards adoption of digitalization are summarized in an elaborate manner.

Table 6. Drivers of Digitalization identified by SLR

	Types	Main Findings	Article
Organizational Drivers	Increase in organizational productivity	-Productivity Increase -Increased Operational Efficiency & responsiveness -Cost Optimization	[3], [7], [26], [33], [37]
	Reduction in operational costs	-Cost savings on operations as a result of optimization of processes and manpower -Reduction in fuel costs -Reduction in costs associated with breakdowns such as in Demurrage -Reduction in costs associated with procedural delays	[3], [4], [6], [9], [10], [11], [15], [16], [22], [24], [29], [33], [37]
	Improvement in service quality	-Quality improvement -Extended services via extension of established business -Service integrity	[3], [7], [9]
	Streamlined Operations/ Efficiency	-Optimized operational scheduling thus minimize fuel consumption -Prediction of vessel performance -Streamlined operations	[2], [3], [5], [16]
	Cargo Management Efficiency	-minimization of cargo storage costs -Estimation of cargo damage and theft via data driven analytics	[2], [3],
	Competitive Advantage	-Improved competitiveness -Benchmarking & performance measurement -CA by connecting and integrating actors in the value chain -Managing market pressure	[3], [5], [7], [9], [16], [22], [33], [28]
	Data Analytics for management	-capability to focus on own core business strategies -Better asset management insights	[3], [8], [37]
	Speedier decisions via Decision Support systems	-Easier and shorter decision-making process -Decision about the vessel speed for lower fuel consumption -Real-Time access to shipping data, making faster decision making possible. -Faster calculations such as laytime, demurrage, etc. and post-fixture support tools.	[3], [9], [13], [14], [22], [33], [34], [37]
	Human error elimination	-Correction of errors of human operators -Role of big data in removal of human error -Error elimination by removal of repetitive humanistic processes	[3], [17], [32]
	Impact on human resources	-ICTs have Positive and significant impact of productivity(Cardona et al., 2013)	[3], [17], [33],

Technological Drivers		<ul style="list-style-type: none"> -Increased capability of performance monitoring and increase interdependencies of components. -Boosting personnel training -reducing the qualified manpower shortages 	
	Increased trust	<ul style="list-style-type: none"> -Increased trust due to Blockchain's ability to remove untrusted parties -Impossible to counterfeit transactions since they are marked with a timestamp 	[4], [9], [12], [25], [27], [29], [32]
	Wider market Accessibility	<ul style="list-style-type: none"> -reduced Geographical locations -Transparency in the international market leads to trustworthy customers -Mass emailing systems and Mass Messaging systems disseminate information to hundreds of stakeholders 	[4], [5], [17], [29], [34], [35]
	Cross Border Payments	<ul style="list-style-type: none"> -Safer transactions by blockchain powered Escrow accounts -Fulfillment of international transactions without the help of intermediaries such as banks -Transaction information traceability 	[12], [25], [29], [32]
	Meeting customer requirements	<ul style="list-style-type: none"> -Deeper understanding of changing customer behaviors and expectations -Customers can track their goods and services -Blockchain keeps the customers in the loop by allowing them to review the chain of custody of their cargo. 	[16], [22], [24], [28], [33], [35]
	Better Internal and external communications	<ul style="list-style-type: none"> -Connectivity of the branch offices -Multiple and cheaper communication channels -Stored information can be reviewed and analyzed for deeper understanding -24X7 connectivity -Online virtual conferences and meetings 	[26], [33], [35], [36], [37]
	Better insights of the Business processes	<ul style="list-style-type: none"> -Immediate data to Vessel charters to allow them to hedge the Risks -Big data analysis platforms for the transport processes -Harnessing the big data to provide performance monitoring -Understanding and benchmarking of the assets 	[3], [4], [17], [37]
	Interoperability and Collaboration	<ul style="list-style-type: none"> -Interoperability and collaboration between multiple actors in the shipping process 	[3], [25], [28]
	Immutability	<ul style="list-style-type: none"> -Cryptographic security, impossible to change the data -Prevents counterfeiting, thus increasing trust -Transactions marked with timestamp 	[4], [9], [12], [32], [24]
	Security, Efficiency, Confidentiality	<ul style="list-style-type: none"> -Only access possible if the partners have permission 	[4], [9], [12], [14], [15],

External		<ul style="list-style-type: none"> -Simplification of the traditional processes and workflows -All information in the blockchain is encrypted thus preventing fraudulent activities, manipulations, and questions about the chain of custody 	[24], [25], [27], [32], [33],
	Process Digitalization & Improvement	<ul style="list-style-type: none"> -reduces risk of errors -removes geographic boundaries -easier access from around the world -removal of redundant processes, such as setting up of various groups and giving permission to see open cargoes and open positions 	[4], [5], [10], [12], [22], [25], [26] [32], [34],
	Seamless flow of Information	<ul style="list-style-type: none"> -data sharing management -Information authentication and validation is developed(Apte & Petrovsky, 2016) -lean process -reduction in the customs processing time -lesser market friction and more efficiency -better connectivity of the branch offices 	[7], [10], [12], [15], [26], [29], [32]
	Cyber-Security	<ul style="list-style-type: none"> -Data security improvement -immutability and traceability of information are the features of blockchain -enhanced digital risk awareness 	[10], [12], [33]
	Fraud reduction, under writing, Claims Management	<ul style="list-style-type: none"> -marine insurance management -Impossible to counterfeit transactions, since all of them marked with timestamp(Gausdal et al., 2018) -Establishing authenticity of contacts with whom shipbrokers deal with. -Anti-counterfeiting traceability 	[12], [24], [25], [36]
	Data Transparency	<ul style="list-style-type: none"> -More confidence in online trading environment -Development of trust mechanism in stakeholders 	[16], [25], [33], [34]
	Ship Intelligence	<ul style="list-style-type: none"> -Enables the usage of large volume of shipping data being generated -Optimization of fuel consumption and transparency -Difficult to hide performance shortcomings, hence higher charter hire or easy claim for the same 	[17], [22], [37]
	Cloud ERP	<ul style="list-style-type: none"> -Feasible solution for small charterers and shipbrokers -Improved performance and communications 	[26], [37]
	Impact of AI/ML/DL/Computing Power	<ul style="list-style-type: none"> -Matching algorithms for cargoes with the ships -Highly accurate email management -Voyage estimates, laytime calculations -Recap of main terms -Charter party preparations 	[35]
	Environmental Concern/Sustainability	<ul style="list-style-type: none"> -Minimizing environmental change -Lesser fuel consumption and GHG emissions -Sustainable operations 	[2], [3], [10], [14], [37]

	-Compliance with environmental policies	
Efficient Voyage Planning & Optimization	-effective planning and control of shipping process -Shorter time delays	[3], [16]
Cargo Visibility & Traceability	-Logistic flow traceability -Transparency and traceability to shipowners, brokers, etc. -Better management of cargo, risks, etc.	[3], [4], [9], [12], [15], [25], [27], [33],
Customer Management/ Customer Network	-better integration with the customers -reduction in direct contacts and formal information meetings -Customer business benchmarking allowing focus on important customers -No longer entry barrier to shipbroking business	[3], [4], [10], [27], [30], [33], [35], [36], [37]
Elimination of Intermediaries	-Disintermediation -online services for preparation of smart contracts -Blockchain promises elimination of banking service intermediaries.	[4], [9], [11], [24], [29], [30]
Documentation	-Lesser time spent on customs clearance -reduced paperwork increases efficiency and the response times -Smart contracts enable more efficient business arrangements -Real-time availability of documents for clearance and review -Reduced transaction and enforcement costs -e-Certificates and e-Doc sending	[4], [7], [9], [11], [12], [15], [22], [24], [25], [32], [35], [37]
Risk Mitigation	-Mitigation of counterparty risk in shipping contracts -Minimization of performance related claims (leeway, weather, currents, speed, etc.) in contractual performances. -Reduction in insurance premiums	[4], [6], [9], [30], [37]
Legal, Regulatory, & Policy requirements	-Managing dynamic policies -Regulations relying on ships data (EU MRV) to quantify CO2 emissions -E-Customs	[14], [16], [17], [24], [27], [28], [32], [33],
Shipbroking and chartering specific drivers	-Undertake legal advisory -Fixtures through electronic negotiations -Algorithmic matching of cargoes and vessels -Equal opportunity trade without the bias of the shipbroker	[27], [29], [30], [31], [34]
Advanced Searching Capabilities	-Large searching scope -Mathematically complex searching criterias -Performance evaluation of the other party for contract performance -Reduced search costs	[30], [31], [34]

Negotiation Process Change	-Negotiation process has changed with times. Earlier Shipowners and charterers followed “first come first serve”. Now, both the parties look at profitability. Negotiation processes stretch just until signing of Charter Parties.	[36]
Ease of doing Business as a Shipbroker	-Lowered entry barriers into ship broking profession due to cheaper communication and availability of professional contacts for cheaper price.	[35], [36]
Effect of other Stakeholders	-Market pressure from the other stakeholders to keep up the pace w.r.t. digitalization -Blockchain's success depends on all the stakeholders to adopt the technology	[3], [15], [16], [22], [28]

5.1.1.2 Barriers

Barriers to adoption of digitalization are the collective challenges which prohibit the firms in taking up or inhibiting them in adoption of digital transformation. Tijan et al.(2021) asserts that challenges may arise collectively and form barriers that substantially hinder the progress of Digital transformation. Such barriers require explicit and extensive coping actions that go beyond the mitigation of individual issues(Fuchs & Hess, 2018).

In total 26 barriers in adoption of digitalization were identified in the SLR. In the similar fashion as was done in section 5.1.1.1 drivers, the barriers are also categorized in three sub-categories: Organizational barriers, technological barriers, and external barriers.

In the SLR, 6 organizational barriers, 10 technological barriers, and 10 external barriers.

In organizational barrier sub category prominent barriers such as Costs, lack of human resources, and management related barriers are identified.

In technological barrier sub category barriers such as Concerns about cyber-attacks/Data safety/ Trust, Lack of uniform technological standards throughout the industry, Scalability, and data related constraints appear in prominence.

In external barriers category, barriers such as Legal, Legislative, and regulatory concerns; Wait and watch attitude of the industry; and Differences among stakeholders are the major identified barriers.

Below Table 7, represents a comprehensive summary of all the barriers identified in the SLR.

Table 7. Barriers in adoption of digitalization identified by SLR

	Types	Main Findings	Article
Organizational Barriers	Increasing competition in shipping business environment	-Ease of doing business as a shipbroker is putting market pressure on established broking firms and reducing the profit margins and thus leaving lesser capital for the technology adoption -Threat of aggressive response is a significant strategical entry barrier making the adoption of digital chartering platforms difficult	[3], [5], [30], [33]
	Costs	-High operational expenses such as fluctuating fuel prices and low freight -Early adoption of technology is costly and risky -Large investments to enter a blockchain consortium or develop it is a great barrier especially in the industry with low-cost focus -High running/maintenance costs of technology is ranked among top two barrier in adoption of ICTs(Evangelista & Sweeney, 2006, pp. 55–74) -Low ROI	[3], [4], [5], [6], [8], [9], [10], [13], [14], [15], [16], [17], [22], [24], [25], [26], [30], [32], [37]
	Lack of human resources	-Lack of ICT specialists in Maritime industry -Technically unsophisticated users -Lack of training and domain expertise	[3], [6], [8], [9], [13], [14], [16], [31], [32], [33], [37]
	Fear of job loss	-Functions no longer required to be performed by humans -Worker community less open to experimentation	[6], [19], [38]
	User related barriers	-Resistance to change -Reluctance to try something new -Lack of motivation in the employees and the managers	[8], [16], [24]
	Management related barriers	-Reluctance in adoption of high-risk innovations -Management's ability to understand the implications of the technology adoption in the organizations -Lack of strategic planning, vision, and direction -Failure to implement Technology-oriented culture -Hesitation to invest money -Old-fashioned, non-pioneering culture and conservative senior decision-makers -Digital immaturity of the leadership -Industry has faced a debacle once when there was an initiative to digitalize the freight markets	[2], [3], [4], [6], [9], [10], [15], [16], [20], [24], [27], [29], [30], [32], [33], [37], [38]
	Tech nolo	Concerns about cyber-attacks/Data safety/ Trust	- Concerns about cybernetic incidents -Cybercrime and cyberterrorism -Lack of trust in online transactions

	<ul style="list-style-type: none"> -Multiple cyber attacks on shipping related organizations -Information security and privacy protection -Technologies such as blockchain require absolute trust of the partners, serial numbers can be easily copied and transferred without the knowledge of the blockchain itself making the system unreliable. -Unanticipated bugs -Risks from third party and fourth party service providers 	[15], [16], [17], [21], [23], [24], [25], [27], [31], [32], [33], [37], [38]
Risk of errors in the digital systems/algorithms	<ul style="list-style-type: none"> -Risk of AI systemic errors -extreme difficulty in creating reliable and flexible algorithms -System collapses due to external factors -Disappearance of human control -High degree of system instability -Vulnerabilities of regression errors -Reliance on 'off-chain' resources introduced 'point of failure' 	[2], [7], [9], [20], [21]
Complexity of digital systems	<ul style="list-style-type: none"> -Unpredicted integration obstacles when inserting new technology -High implementation risk of new technologies 	[2], [15], [16]
Human factors/interference	<ul style="list-style-type: none"> -Issue of correctness of entered data -Issue of unwelcome events such as those related to the human operator's mental model of automation 	[3], [20], [21], [26], [37]
Lack of uniform technological standards throughout the industry	<ul style="list-style-type: none"> - Common standards of the distributed ledger system -heterogeneity and compatibility of the ICT applications -Constraints of the human operators -Problems in integration of the partner and customer applications -Lack of industry specific guidelines -Most of the ERP systems used in shipping industry are legacy systems making it extremely difficult to integrate Blockchain and AI/ML capabilities 	[3], [4], [6], [8], [9], [13], [14], [15], [16], [17], [20], [27], [32], [37], [38]
Scalability	<ul style="list-style-type: none"> -Amount of time spent in data handling and verifying is not yet acceptable for the timing sensitive operations. -Low dataset scalability of present day blockchain systems -Limited transaction capability of blockchains inhibits its ability to put in wider operations, hence its adoption by the industry. 	[4], [9], [15], [17], [20], [21], [25], [27]
Time duration for	<ul style="list-style-type: none"> -Long time requirements for the full implementation 	[3], [8], [37]

	digital transformation	of the ICTs meanwhile the technology becomes obsolete	
	Constraints of Data	<ul style="list-style-type: none"> -Poor data quality -Concerns about data integration and Ownership -Large costs associated with handling Big Data -Poor information or data management levies increased expenses -Large amount of unutilized data inhibiting the proper analysis of the operations 	[17], [18], [24], [31], [33],
	Lack of Human Like features	-Commercial shipping is human intelligence intensive, featuring trust, negotiation, follow-up, interpersonal relationship and pedigree. No digital technology at present can match these all features.	[29]
	New technologies- new claims	-Industry faces innovation fatigue i.e. people are tired of the innovation ideas especially with very high failure rates.	[33], [38]
External Barriers	Legal, Legislative, and regulatory concerns	<ul style="list-style-type: none"> -Concerns about legal liabilities of the cargo carrier. -Inconsistencies in the international, national, and regional policy regulations -Non supportive policy ecosystem; regulation development and approval is lengthy process while the technologies are being developed at exponential pace -Concerns about acceptance of smart contracts in the courts of law -Blockchain data is immutable, while the GDPR necessitates that the people have the “right to be forgotten” -Lack of policy formulation by the authorities -Authorities are devoid of the robust infrastructure to overcome the threats -Who is the regulatory authority to set the regulations pertaining to the digitalization in maritime industry is still unclear 	[1], [2], [3], [4], [6], [8], [13], [14], [15], [16], [21], [25], [27], [31], [33]
	Effects of Unforeseen events	-effect of natural forces such as cosmic impacts	[2]
	Lack of ideal reference case	<ul style="list-style-type: none"> -Very few real-world examples of Blockchain technology(cryptocurrencies) -Unclear when blockchain would have real-world applications and commercial viability. -Most systems have been developed for internal uses and hence the real-world feasibility has not been tested 	[3], [9], [12], [24], [25], [37]
	Wait and watch attitude of the industry	<ul style="list-style-type: none"> -Many players prefer to wait and observe the current practices before making investments -Players like following the big companies 	[4], [8], [13], [14], [15], [16], [20],

	-Unwillingness of the industry to be in the forefront -Senior legacy minded executives like to wait for wider adoption before committing to the investments	[24], [32], [33], [37], [38]
Complexity of shipping business	-Limited applications of blockchain in the shipping business due to immense complexity of the industry	[12]
Lack of research and funding	-Lack of public research is a reason for slow adoption -Lack of research initiative in the commercial shipping domain	[13], [15], [22], [30]
Differences among stakeholders	-International applications of blockchain is restricted because many countries do not recognize it. -Low adoption rate in the supply chain industry	[3], [15], [24], [38]
Personalized nature of business handling	-Shipbrokers have extensive information of at least one party, which not obtainable without personal relationship -Shipbrokers get customers exclusive deals -Personal information processing with discretion -Legal advisory and mediation in case of dispute -Multiple incentives offered by traditional shipbrokers which lead to make platforms undesirable	[29], [30], [36]
Unsubstantiated information	-There are too many over the internet information sources. Unsubstantiated rumors can vitiate the decision making of the shipbrokers	[35], [36]
Business decision privacy of the Charterers and the shipowners	-Shipowners and charterers show the availability of their assets as per their strategy, platforms and visibility enhancing technology rob their strategy -Complete transparency is not a desirable trait for any setup	[4], [30]

5.2 Exploratory Qualitative study results-Interview and webinar analysis

Data collection was primarily conducted by interviewing the industry professionals. In addition to the interviews the webinars on YouTube were also employed since it recognized as alternative of data sourcing method that enables wider scope of research sampling and area and access to experts' opinion and collaboration.(Tiong & Sim, 2020)

Table 8. Drivers in adoption of Digitalization as identified by Qualitative Data Analysis of interviews and webinars.

Types		Main Findings	Qualitative Data Ref
Organizational Drivers	Increase in organizational productivity	<ul style="list-style-type: none"> -Business transactions are high-speed, more frequent, and more accurate -As a result of digitalization human operators' capacity to work increases, thus increasing overall organizational productivity -Digitalization has a capacity to automate the tasks undertaken by human operators, who have limited capacity to work -Increases the accuracy of data and thus creating more business opportunities from the received information 	[P1], [P2], [P3], [P5], [V3], [V4]
	Reduction in operational costs	<ul style="list-style-type: none"> -Digitalization makes the organizations more cost-efficient by eliminating unnecessary expenditures -Charterers lose a lot of money on demurrages and waiting charges of the ship due to opaque decisions of authorities in ports -Digitalization can reduce the operational costs of the organization such as the travelling costs, which were required to conduct face-to-face meeting. 	[P1], [P2], [V3], [V4]
	Improvement in service quality	<ul style="list-style-type: none"> -People can now process a large amount of data in minutes to give faster service to the clients -The information needed by customers of shipbrokers used to be dispatched in matter of days. Now the same information is disseminated in matter of minutes thus speeding up the service cycle. 	[P1], [P2], [P5], [V1], [V3], [V4]
	Data analytics for management	<ul style="list-style-type: none"> -With the customized dashboards managers can keep a keen eye on the key indicators of the business -AI based systems allow the managers to make 	[P1], [P2], [P5], [V3],

	more sense of the data generated by their firms	
Decision support systems	<ul style="list-style-type: none"> -Managers are more informed today than they were before the era of digitalization began -Managers are able to take more informed and quicker decision as a result of digital tools -The data from the various sources, commodity prices, futures markets, etc. can be crunched to help the managers take better decisions in the market where even slightest variation in the freight prices can cause loss of thousands of dollars -For shipbrokers the data can give an unbiased view about the customers and their businesses 	[P1], [P3], [P5], [V1], [V2], [V3]
Human error elimination	<ul style="list-style-type: none"> -Proper technology application can make the systems fool proof, thus reducing the human errors 	[P1], [P3], [V4]
Impact on human resources	<ul style="list-style-type: none"> -Digitalization can capacity of human operators to be more productive in their present jobs -Adoption of auction based digital platforms has made chartering operations very less complicated -Shipbrokers can be more efficient in their jobs by reaching countless customers with single click email dispatch 	[P1], [P2], [P5], [V3], [V4]
Increased trust	<ul style="list-style-type: none"> -It is believed that Blockchain technology will provide single source of truth to the people, hence increasing their trust -Digitalization increases the level of confidence among different stakeholders -Fair freight rate is ensured by the enhanced visibility on digital platforms thus increasing the level of trust between the parties 	[P1], [P3], [P5], [V1], [V4]
Wider market accessibility	<ul style="list-style-type: none"> -As a result of digitalized marketing the companies can become more visible thus increasing their market presence, and access to previously unknown markets -Digitalized communications can break the language and cultural barriers, thus, giving access to previously restricted markets -Commodity traders and charterers have wider contacts of trading community thus increasing their business 	[P1], [P4], [P5], [V2], [V4]
Cross border payments	<ul style="list-style-type: none"> -Banks as intermediary of payment system create many problems for the trading community, moreover, charging them heftily. Technologies such as blockchain can ease the payments process 	[V4]
Meeting customer	<ul style="list-style-type: none"> -Integration of data gives better insight to the 	[P1], [P2],

	requirements	customers and increasing the collaboration with them -Customers mostly have concerns about the biased pricing strategies, but digitalization can allay those apprehensions -Shipbrokers try to find to be more helpful to their customers with help of newer digital tools	[P3], [V1], [V4]
	Better internal and external communication	-Digitalization opens new communication channels for internal as well as external players -Better external communication has made contacting the clients very easy -Reasonable and cheap cost communication has helped shipbrokers use the saved money in bettering their services	[P1], [P3], [P4], [V1], [V3], [V4]
Technological Drivers	Effect of other stakeholders	-Data is disintegrated amongst various players, the big players are trying to go for integrated approach, thus, forcing the smaller stakeholders to digitalize their business models For providing better services to the customers and having better communication with the other party business are forced to digitalize	[P5], [V1], [V2]
	Better insight of the business process	-Back looking of the information becomes very easy with the database management systems -Data can help organizations look into their future by helping them formulate long term strategies	[P3], [P5], [V2], [V3], [V4]
	Interoperability and collaboration	-Bigger companies are opening up their data so that the shippers can collaborate and identify where there are the breakdowns in the chains -All the parties benefit from the data and information which is readily accessible -Data exchanges can increase collaboration and minimize manual processes such as manual email based systems, which are still susceptible to not being read	[P2], [V1], [V2]
	Process digitalization & improvement	-Ship chartering and shipbroking processes are labor intensive. Many of the jobs are human intensive such as laytime and demurrage calculations. Digitalizing the ship call process can allow for auto calculations and thus free up the human resources -Blockchain can use many of the processes such as document verification, making the ships nomination process much easier	[P1], [P2], [P3], [V2], [V3], [V4]
	Seamless flow of information	-Most of the information from the charterers to the shipowners flows via shipbrokers, digitalization can manage transfer of information from one party to another very easily	[P1], [P2], [V1], [V2], [V3]

		-Digital tools can help keep all the stakeholders updated allowing all the parties to be updated and plan accordingly	
	Fraud reduction, under writing, claims management	-Technologies such as blockchain can help avoid forgery of documents -Multiple BLs can be taken to multiple banks to issue LOCs, and banks can be duped of a lot of money. Digitalization can solve this issue -In the name of governance Port authority officials resort to preferential berthing orders for ships causing huge loss to the other parties. Technology adoption can increase visibility and reduce such practices	[P3], [V2], [V3], [V4]
	Data transparency/ ownership	-Data must be kept open for use by everyone and must not be owned by anyone, then only its complete use is possible -With online auction based chartering platforms charterers own and control the data and they are able to generate more competition for themselves but curtail competition for other players in the chain	[P1], [P3], [P5], [V2], [V3], [V4]
	Impact of AI/ML/DL/Computing power	-All shipbrokers basically have access to same information and data, but how they make use of that information makes all the difference -AI can allow the players to choose among the best suited alternatives -Commodity traders and charterers can crunch through a lot of data from various sources to predict the future market and act in best interest of their companies	[P1], [P2], [P3], [P4], [P5], [V2], [V3], [V4]
External Drivers	Cargo management efficiency	-Digitalization can allow better visibility to shippers so that they can take better decisions to minimize the losses due to damage to the perishable cargo/spoilable goods -Digital platforms are facilitating loading, unloading, and other cargo management operations. Thus, providing more standardized solutions for cargo management	[V1], [V2], [V3]
	Cargo/vessel visibility and traceability	-All the players in the shipping industry want more visibility of the cargo/vessel -Port authorities and governments can have better idea about what all products and goods are entering their territories	[V1], [V2], [V3]
	Documentation	-Every shipment of cargo has great deal of paperwork. Digitalization of the process can reduce a lot of time in the shipping process	[P1], [P2], [P3], [P5], [V1], [V2],

	<ul style="list-style-type: none"> -Online verification and e-Certificates can make the vessel's nomination process by charterers much easier -Digitalization of the documentation and verification process, SOFs and Charter parties can allow for faster transaction time -Blockchain technology can provide verified source of documents hence increasing trust in digital documentation 	[V3], [V4]
Risk mitigation	<ul style="list-style-type: none"> -Digitalization and timely information dissemination can allow shipping industry to carry out agile risk management for their supply chain planning -Digital platforms powered by AI, ML can allow for better hedging of risks by charterers/ commodity traders 	[V1], [V4]
Shipbroking & chartering specific drivers	<ul style="list-style-type: none"> -With digitalization of many shipping processes a lot of time and money associated with dispute resolution can be reduced -Carrying out mediation by shipbrokers has become more convenient since they can bring the opposing parties face to face -With the ground information such as port congestion readily available to the charterers, a lot of cost such as demurrage and claims can be reduced 	[P1], [P5], [V3]
Advanced searching capabilities	<ul style="list-style-type: none"> -Now AIS data readily and publicly available shipbrokers can easily find vessels. -Advanced platforms can even leverage API data to find if the vessel has been fixed or open for negotiations -Advanced platforms can convert the data and vessel information received via email into meaningful visualization for use by charterers and shipbrokers 	[P3], [P5], [V3]
Negotiation process change	<ul style="list-style-type: none"> -With online based auction platforms, the bidding process is now conducted online and in an anonymous way. Thus, leaving no room for negotiations in the freight rates -Market data is now more readily available to all the parties thus the charterers and shipowners do not have to rely on the words of the shipbrokers 	[P1], [P2]
Easy setup of shipbroking business	<ul style="list-style-type: none"> -Digitalization has enabled the professionals to easily setup their shipbroking firms due to low cost of communication and personalized relationships 	[P1], [P2], [P4]
Problem solving attitude of younger generation	<ul style="list-style-type: none"> -Newer startups with younger generation in the lead has been very proactive in identifying the problems in the industry and developing the solutions for the same 	[P5], [V1]

-Younger generation in the shipping industry is more digitally inclined and adept to using digital solutions instead of manual processes

Table 9: **Barriers in adoption of Digitalization as identified by Qualitative Data Analysis of Interviews and webinars**

	Types	Main Findings	Qualitative Data Ref.
Organizational Barriers	Increasing Competition in Shipping Business environment	-Many companies are creating platforms for their internal use. This creates a limitation for adoption of general use platforms and wider usability of market data analysis.	[P1]
	Costs	-Big investment for small players -Company specific platforms introduce high costs for smaller operators for acquiring new technologies -Third party digitalized service charge exorbitantly -High costs are associated with developing and managing digital platforms -High costs for API solutions, and interoperability of data.	[V1], [P2], [P3], [P4], [P5], [V2],
	Lack of Human Resources	-Improperly trained commercial shipping professionals who exuberate poor judgement over digital platforms. -Difficult to learn shell programs create shortage of qualified professionals	[P2], [P4], [P5]
	User Related Barrier	-Insecurity among present staff regarding digital solutions taking their jobs prompts them to cooperate in ongoing digitalization efforts -People don't want to learn new things or sometimes they are just complacent, though with adoption of new technologies this will be important	[V3], [P1], [P2]
	Management related barriers	-Understanding of management about usability of technology pertaining to individual businesses. -Managers are reluctant about how they will justify the huge investments in the boardrooms. -Managers remain confused which systems are better for them, since there are multiple software in the market. -Charterers are not open to change and want to continue as they are continuing their businesses. After many chartering platforms of the industry have failed, the commercial shipping industry has lost confidence in such platforms	[V1], [P1], [P2], [P3], [P4], [P5], [V2], [V3]
	Effect of organization size	-Smaller firms do not have adequate capital to undertake digitalization. -Major shipping companies are investing huge portion of their revenue in digitalization	[P1], [P2], [P3], [P4], [P5]

		-Bigger companies which trade large amounts of cargo and have good market position have resorted to online auction-based system.	
Technological Barriers	Concerns about Cyber-attacks/Data safety/Trust	-Professionals lack trust in Digital systems due to data safety concerns -Newer digital platforms have not been able to garner trust of professionals -Issues of trust in the other party and its commitment to the deal and -Information and data is very valuable in today's world. Many platforms use the data from their clients to commercially profit from the ventures. -As the businesses are developing solutions, the cyber criminals are developing new ways to hack them.	[P1], [P2], [P3], [P4], [V2], [V3], [V4]
	Risks of errors in digital systems/algorithms	-Risk of Machine learning algorithm trained in an improper way	[V2]
	Human factors/interference	-Human errors and inputs often remain unchecked and can cause hindrances in proper functioning of the digital systems -Humans are slow in learning the full functionality of technological applications	[P2], [P3], [P4], [V2]
	Lack of uniform technological standards throughout the industry	-Incompatible industry tools cause the free flow of information one system to the other. -Data is bound in the silos and stays there without the systems talking to each other efficiently	[P1], [P2], [V2]
	Technology devoid of human like features	-Shipbroking and chartering industry are human intelligence intensive -Technology is devoid of prompt action and dynamic decision making -Technology cannot take into account the industry specific practical problems -Humans are required for settling disputes. A person who understands and evaluates the market position and problem of both the parties can only mediate or arbitrate.	[P2], [P3], [P4], [P5], [V2]
	Legal, Legislative, and Regulatory Concerns	-There are no streamlined directives from the promotional bodies -Most of the governments do not have the guidelines for the applicability of the technology in shipping as well as in general -Concerns about data monetization and data ownership -Lack of standardization of the crucial regulations	[V1], [V2], [P3], [P5]
External Barriers			

	<p>regarding documentation like eBLs.</p> <p>-Policy formulation of the international authorities is very slow while technological innovation has been very fast</p>	
Lack of an Ideal reference case	-No case has been reported till date about the end-to-end application of technologies such as blockchain	[P1], [V2], [V3]
Wait and watch attitude of the industry/resistance to change/Laggard	<p>-The shipbroking and chartering industry at present do their business via email and they don't feel the need to invest in the expensive technologies</p> <p>-Majority of the commercial shipping industry has been laggard in the technology adoption</p> <p>-Some companies are trying to adopt the technologies such as blockchain but are restricted due to lack of cooperation from the industry in general</p>	[P1], [P3], [P4], [P5], [V3]
Complexity of shipping business	<p>-Multiple variables in the commercial shipping industry are making the digitalization adoption difficult</p> <p>-In dry bulk trade there are many probabilities of cargo to ship matching, many traders, multiple shippers, hundreds of cargo types and thousands of ships. With so many of the players in the supply chain the adoption of digitalization becomes very difficult</p>	[P1], [P3], [V1], [V2], [V3], [V4]
Differences among stakeholders	-Cultural differences among the different stakeholders are hindrances in the common technological standard adoption	[P2], [V3]
Personalized nature of business handling	<p>-Chartering business needs very on-to-one approach</p> <p>-The business leverages personal contacts of trust which is not present in the digitalized platforms</p>	[P3], [P4]
Unwarranted Information	<p>-Shipbrokers and charterers receive a lot of information for the areas they are not operating in, this creates a lot of efforts from them to filter lot of information</p> <p>-Stakeholders might rely on the unreliable information from other sources and create hindrance for the business</p>	[P3], [V3]
Business decision Privacy of Charterers and shipowners	<p>-Charterers and shipowners like to keep their strategies a secret. With the digitalization they loose their business secrecy</p> <p>-Charterers and shipowners take bold decisions to go on ballast for longer distances, while the chartering platforms show region specific availability of the ships and cargo</p>	[V1], [P1], [P3], [P4], [P5], [V3]

-Commercial shipping professionals are reluctant in conducting business with unknown people
-Charterers are reluctant that their trade secrets would become public and they will lose their market position

Chapter 6 Discussion

This chapter contains a discussion on the comparison and analysis of the research questions posed in the thesis previously i.e. the drivers and barriers identified in SLR and the qualitative analysis of the qualitative data(interviews and webinars)

6.1 Comparison of identified Drivers

For better visualization and understanding of all drivers identified in the thesis are presented in the table below.

Table 10. Comparison of the findings on drivers

No	Drivers	Systematic Literature Review	Code Frequency / Groundedness	Qualitative	Code Frequency / Groundedness
1	Increase in organizational productivity	X	8	X	14
2	Reduction in operational costs	X	23	X	7
3	Improvement in service quality	X	4	X	12
4	Streamlined Operations/ Efficiency	X	9		
5	Cargo Management Efficiency	X	5		
6	Competitive Advantage	X	15		
7	Data Analytics for management	X	3	X	6
8	Speedier decisions via Decision Support systems	X	10	X	16
9	Human error elimination	X	3	X	3
10	Impact on human resources	X	4	X	6
11	Increased trust	X	7	X	5
12	Wider market Accessibility	X	6	X	5
13	Cross Border Payments	X	5	X	1
14	Meeting customer requirements	X	8	X	8
15	Better Internal and external communications	X	6	X	7

16	Better insights of the Business processes	X	5	X	9
17	Interoperability and Collaboration	X	3	X	6
18	Immutability	X	6		
19	Security, Efficiency, Confidentiality	X	11		
20	Process Digitalization & Improvement	X	13	X	17
21	Seamless flow of Information	X	10	X	12
22	Cyber-Security	X	4		
23	Fraud reduction, under writing, Claims Management	X	5	X	7
24	Data Transparency/ Data ownership	X	4	X	11
25	Ship Intelligence	X	3		
26	Cloud ERP	X	2		
27	Impact of AI/ML/DL/Computing Power	X	1	X	15
28	Environmental Concern/Sustainability	X	6		
29	Efficient Voyage Planning & Optimization	X	3		
30	Cargo Management Efficiency			X	4
31	Cargo Visibility & Traceability	X	10	X	4
32	Customer Management/ Customer Network	X	12		
33	Elimination of Intermediaries	X	7		
34	Documentation	X	22	X	15
35	Risk Mitigation	X	6	X	2
36	Legal, Regulatory, & Policy requirements	X	10		
37	Shipbroking and chartering specific drivers	X	15	X	4
38	Advanced Searching Capabilities	X	4	X	5
39	Negotiation Process	X	2	X	3

	Change				
40	Ease of doing Business as a Shipbroker	X	2	X	4
41	Effect of other Stakeholders	X	5	X	4
42	Problem Solving attitude of younger generation			X	2

At the first glance Table 10 shows some points which need to be discussed:

- It can be seen from the code frequencies that the findings between the SLR and Interview/webinar analysis are consistent in nature.
- Driver 2 Reduction in operational cost appears in high frequency in both the methods
- Driver 30 and 42 are not identified in the SLR. These drivers were however identified in the Interview analysis.
- Drivers 4, 5, 6, 28, 29, 32, 33 are not identified in the interview analysis but in the SLR.

6.2 Comparison of identified Barriers

Comparison between the barriers is as shown in the Table 11.

Table 11. Comparison of the findings on Barriers

No	Barriers	Systematic Literature Review	Code Frequency / Groundedness	Qualitative	Code Frequency / Groundedness
1	Increasing competition in shipping business environment	X	6	X	1
2	Costs	X	27	X	10
3	Lack of human resources	X	12	X	3
4	Fear of job loss	X	4	X	1
5	User related barriers	X	6		2
6	Management related barriers	X	35	X	18
7	Effect of Organization Size			X	9
8	Concerns about cyber-attacks/Data safety/ Trust	X	40	X	12
9	Risk of errors in the digital systems/algorithms	X	11	X	2
10	Complexity of digital systems	X	4		
11	Human factors/ interference	X	5	X	5
12	Lack of uniform technological standards throughout the industry	X	26	X	7
13	Scalability	X	9		
14	Time duration for digital transformation	X	3		
15	Constraints of Data	X	15		
16	Technology devoid of Human Like features	X	1	X	8
17	New technologies- new claims	X	2		
18	Legal, Legislative, and regulatory concerns	X	18	X	10

19	Effects of Unforeseen events	X	1		
20	Lack of ideal reference case	X	6	X	4
21	Wait and watch attitude of the industry/ Resistance to change	X	15	X	8
22	Complexity of shipping business	X	1	X	9
23	Lack of research and funding	X	4		
24	Differences among stakeholders	X	4	X	2
25	Personalized nature of business handling	X	6	X	3
26	Unsubstantiated / unwarranted information	X	2	X	2
27	Business decision privacy of the Charterers and the shipowners	X	2	X	12

6.3 How can the barriers be overcome?

The world has entered a new decade in the information age. The shipping industry has never been very data inclined. Almost all the shipping operations have been very manual in nature even today. Some of the segments within the shipping industry started digitalization efforts and have made the most use of the recent technological developments and devised newer ways to generate the data. Today's technological capabilities can only work with digitized data. Some players have started to digitize previously analogue processes. Even though the efforts to digitalize are becoming speedier there still is some hesitation to digitize the current processes. This hesitation is itself a barrier and is quite understandable because shipping is part of a very huge business environment i.e., complex logistics chain involving many steps and players across the world. To reap the maximum benefits of digitalization each and every link in the shipping chain and more specifically the entire logistics chain must digitize at least to a minimum base level. This can be a very daunting and challenging task since it can possibly disrupt the business models, both in-house and on the high seas.

Apart from this there are multiple other barriers which hinder the adoption of digitalization in commercial shipping or at some level negatively affect it. These barriers must be removed or overcome so that the industry reaps the benefits of digitalization. Some of the barriers are very difficult to overcome while the others can be removed by little collective efforts.

The overcoming of the barriers can also be termed as the Success Factors for achieving Digitalization in commercial shipping. Success factors can be defined as the elements required for achieving desired goals(Tijan et al., 2021). The success factors were identified by carrying out coding from the articles which were identified for SLR.

Success factors for Organizational barriers-

- **Costs:** - Costs associated with the digitalization of commercial shipping is identified in this thesis as one of the most significant barriers. Costs associated with acquiring the services of digital platforms can be substantial. Findings indicate that high OMC costs of the digital technologies are significant as is the high CAPEX. CAPEX for larger Charterers and shipbrokers is not a concern but for SMEs it is not possible to invest that kind of fortune.
- **Lack of human resources:** - Lack of properly trained human capital is also a significant barrier in digitalization efforts. This is one barrier which can easily be removed. Alcaide and Llave (2020) suggest that strengthening the training levels of the human resources is a solution to overcome this barrier.
- **User Related barriers:** - User Related barriers are mostly associated with the attitude of the users with respect to the digital technologies. The attitude includes their resistance to change, lack of motivation, resistance from the long-term employees who do not have adequate skills for the future. Such barriers could be overcome by the collective efforts of both the management and the employees themselves. The employees must adapt to the ensuing change and the management must provide the training opportunities to the existing staff rather than employing newer younger generation employees.
- **Management related barriers:** - These are one of the largest and most varied group of barriers. Also, these are perhaps one of the most difficult to remove. These include the biases against technology, perception about negative impact of the technology, lack of technology-oriented organizational culture, lack of vision, lack of knowledge about how

the technology can be beneficial for the organization, etc. These barriers form one of the largest group of barriers. Some of these problems can be answered but the others would require just some time. But the key to overcome these barriers is that the organizations must adapt the change in the business environment. Creation of new leadership roles such as Chief Digital Officers might be a way to fill the perception and understanding related barriers(Tijan et al., 2021). To answer the cultural barriers the organization must become agile and develop new and dynamic capabilities. This might not be enough and thus the organizations must also become more adept to taking risk and tolerating failures.(Tijan et al., 2021)

Success factors for Technological barriers-

- Concerns about Cyber-attacks: -This was identified in the SLR as the single largest barrier which prohibits the industry to digitalize. Shipping is very critical leg of entire supply chain. It becomes even more critical due to the fact that the vessel is virtually invisible while at sea, with limited communication. There are many facets of technology and the darkest of them is cyber-attacks. People have devised new ways to harm the property and life with the technological advancement. Cyber crimes have increasingly become very common. They have now pervaded the maritime industry too. On June 27, 2017, the largest shipping company A.P. Møller-Maersk fell prey to cyber attack NotPetya. This was not the single case all of the largest four shipping companies Maersk, MSC, COSCO, CMA CGM have fallen prey to cyber-attacks(Cimpanu, 2020). Events of such scale and the targets of such scale deter other players in the industry. People believe when such big companies with highly sophisticated security structure can be hacked then what about the smaller companies. People even have a reason to believe that the immutable technologies such as Blockchain are not safe too. Gonzalez-Cancelas (2020) argues that the Blockchain data is lodged in the intangible cloud in the air and is available to all the inhabitants of the world. Tan & Sundarakani(2021) assert that the digitalization of the industry exposes to the threat of cyber-crime and cyber-theft. Moreover, in the recent past there have been multiple thefts of crypto currencies

which are blockchain based.(Tidy, 2021). These incidents reinforce low trust of professional in the technology. This is one of the hardest barrier to be removed. But, strengthening the cyber security infrastructure can be a key to removing this barrier.

- Risk of errors in digital systems/Algorithms: - These barriers are related to technological difficulties of the digital systems. Chartering decisions pertain to a lot of capital. A slight variation in the freight rate can surmount to thousands of dollars. Risk of errors in digital systems can thus cost a lot to a firm, than assist it earn money. These is always a factor of lack of trust in the digital systems. Slight variation in the AI algorithms can cause loss of human control on the systems and that can be a big hassle of the organization. In the large and complex systems errors are self-introduced by default(Gonzalez-Cancelas et al., 2020). The strategy to overcome such a barrier is to design robust systems, although it means that the CAPEX will be substantially more.
- Lack of uniform technological standards throughout the industry: - Due to this factor many industry players are reluctant.(Dede et al., 2021). There is a widespread heterogeneity in the maritime industry. All the industry players adopt different applications, and those applications are based of different standards. This is a problem because due to this the systems are basically not talking to each other or simply to say they are incompatible. This brings in a major problem where the integration of the partner and customer applications becomes a key issue(Harris et al., 2015). The resolution of this barrier is only possible when the industry wide standards are enforced on the industry via some regulatory body such as IMO, or UNCTAD, etc.
- Constraints of data: - This is another key issue. Even though the maritime industry is now generating huge amount of data, the data remains virtually unusable due to the following issues: Data quality, data reliability, Data management, data ownership etc. The constraints of data is a barrier because if the data is unusable it is basically a waste of resources for the company. Poor information management leads to increased expenses and can account up to 20% of the operational budget(Gausdal et al., 2018). This is a barrier which can be overcome relatively in a simple way albeit at some cost. New technologies such a big data management technology can allow the organizations to refine their data and thus make more sense out of it. Thus, overcoming this barrier.

Success factors for External barriers-

- Legal, Legislative, and regulatory concerns: - This is another significant barrier in adoption of digitalization in commercial shipping industry. They include different legal requirements and customs regulations in different countries.(Harris et al., 2015). Another barrier is the legal issues, concerns about acceptance of smart contracts in the courts of law(Jabbar et al., 2021). These concerns can only be enforced by the regulatory body such as IMO. The IMO must take timely action regarding this issue so that the digitalization in maritime industry can go on unabated and wider adoption becomes speedier.
- Wait and watch attitude of the industry and resistance to change: - This is one of the barriers which is costing the maritime industry the most. Maritime players want to be cautious regarding their investments. They want higher ROI on their investments. They will only invest in the technologies which are proven. So, to summarize they are happy to be laggards, they are not proactive, they are followers of “old ways” i.e. the way they have always done things. This in turn creates lack of investments and initiatives(Tijan et al., 2021). Managements wait for wider adoption before committing to the initiatives(Jabbar et al., 2021). They remain unwilling to be in the forefront(Gausdal et al., 2018). To overcome this barrier everyone, all the stakeholders in the supply chain including managers, charterers, shipbrokers, agents, shipowners need to be convinced of the benefits of digitalization. Stakeholders must be made to fully understand the end-to-end adoption procedure and advantages of complete digital transformation.
- Personalized nature of business handling: - Talking about the commercial shipping industry, specifically the shipbroking market, the industry is very protective of its business. Commercial chartering platforms have since a long time tried to enter the market but have failed time and again. The reason for this has been identified as very personalized nature of business handling done by the shipbrokers. In addition to their main business i.e. the negotiations, shipbrokers also assist the Charterers and the shipowners with several other value added services such as giving them exclusive deals, legal advisory, personal information processing with discretion, domain specific

expertise, mediation in case of discrepancies. Digital chartering platforms face barriers such as access to the network of established client(Svarstad et al., 2018). To overcome this barrier Svarstad et al. (2018) suggest three ways to overcome this i.e. by acquisition, by alliance, and by accumulation. Acquisition mean the digital platform buy out the existing brokerage house thus gaining access to the established client network. Alliance means that the digital platform come is strategic alliance with the shipbroking firm and thus gain access to its client network. Third, by accumulation. This method is time and cost consuming. This can be done by using incentives, complementary services and big data. This remains the most preferred strategy of the present players(Svarstad et al., 2018)

- Business decision Privacy of Charterers and shipowners: - Complete transparency is not a desirable feature in many sectors. Charterers and shipowners care about the privacy of their business because loss of privacy of their decisions can affect their leverage on the market. This was a barrier due to which shipbroking is still one-to-one business. Regardless of the claims from the platforms that they maintain utmost privacy of their clients, shipowners and charterers do not have confidence in them due to sporadic incidents in which they received calls regarding cargo from untrusted sources. Trading off privacy with the wider market accessibility will remain a decision of shipowners and charterers and can only be overcome with time.

Chapter 7 Conclusion

In the light of the previous chapters, this section will review the key findings and the discussion of this thesis. This thesis has tried to identify the drivers and barriers in adoption of drivers and barriers in commercial shipping (Ship chartering and ship broking). In the initial chapters the three research questions were posed. All the three of these questions were asked systematically by employing two research methods: Systematic Literature Review and exploratory qualitative study.

The first research question (RQ1): *What are the drivers in adoption of digitalization in Ship Chartering and Shipbroking?*

Findings suggest three main groups of drivers i.e. organizational, technological, and external drivers. The findings of the SLR and interview analysis were done qualitatively and are consistent with each other barring few.

The second research question (RQ2) *What are the barriers in adoption of digitalization in Ship Chartering and Shipbroking?*

Findings suggest three main groups of barriers i.e. organizational, technological, and external barriers. The findings of the SLR and interview analysis were done qualitatively and are consistent with each other barring few.

The third research question (RQ3) *How can the barriers be overcome?*

In the discussions section this research question has been discussed and some of the barriers are difficult to overcome but some of the barriers can be overcome with the collective efforts of the maritime industry, authorities such as IMO, UNCTAD and IT industry.

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Appendix 1 : interview questions

Questionnaire Design

First, I will give a brief explanation of the thesis and the purpose of why I am interviewing the Commercial shipping professionals. During the research I want to uncover what the executives consider as the impact of digitalization on their business model, what they have done so far to digitalize their companies, what they find as barriers or facilitators for this change and what their forecast the future of the maritime industry. Then we will clarify what we define as digitalization and which components that we will include in our understanding of business model. Since, the thesis tries to identify the drivers and barriers, the questionnaire is semi-structured and the participants will be probed for information.

Before starting the interview

1. Is it okay that we use direct quotes in the thesis?
2. Can we record the interview?

Opening Question

3. Can you please tell us about yourself, such as your role in the company and how long you have been there?

Focus point Digitalization:

4. How has and will your company's services change as a result of digitalization?
 - a. What have been applied so far (as is)?
 - Why you have applied this?
 - b. What will be applied in the future (plan, to be)?
 - Why you will apply this?
5. How has the role of the customer and the interaction with these customers changed as a result of technology?
6. How does new technology affect the value delivery for the customer? a. New partnerships? b. New distribution channels?
7. How has new technology changed how you capture value of the services you deliver?
 - a. Data Analytics, Blockchain, IOT, and artificial intelligence?
 - b. Reduction of employees or new competencies?

Barriers and facilitators:

8. How does your company organize changes as a result of new technology within the organization?
 - a. An own department that experiment or within existing business model?
 - b. Who keep track of new technology?

c. Entire organization included or just a limited amount?

9. Are there changes the maritime companies do or have done to adapt to new technology?

a. New structure, tasks, IT- systems?

b. Changes in management?

c. Specific challenges because of the changes?

10. Do you think your company experience other challenges as a result of digitalization? a. Any benefits?

11. How has your role changed over the years with the adoption of new technology?

Closing Question

12. Is there anything you want to add that we have not asked you about?