Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Social and Educational Sciences
Department of Geography

Mari Wardeberg

The drivers and barriers of environmental upgrading in Norwegian short-sea shipping

Master's thesis in Globalisation and Sustainable Development
Supervisor: Markus Steen
May 2021

NTNU
Kunnskap for en bedre verden

Mari Wardeberg

The drivers and barriers of environmental upgrading in Norwegian short-sea shipping

Master's thesis in Globalisation and Sustainable Development
Supervisor: Markus Steen
May 2021

Norwegian University of Science and Technology
Faculty of Social and Educational Sciences
Department of Geography

NTNU
Norwegian University of
Science and Technology

Abstract

The shipping industry is under considerable pressure to reduce its environmental impacts and reduce its emissions. Shipping is a hard-to-adapt industry and issues of environmental upgrading are under-investigated, despite recent emerging literature.

This thesis aims to contribute to the growing literature by furthering environmental upgrading perspectives in global industries. The purpose of this thesis is to examine and understand the main drivers and barriers for environmental upgrading in global value chains, conceptualized through Norwegian short-sea shipping. By employing global value chain perspectives to issues of environmental upgrading, this thesis understands the interconnected nature of the problem, thus emphasising the importance of developing the whole value chain simultaneously. It has examined environmental upgrading in Norwegian short-sea shipping through a qualitative case study consisting of nine semi-structured interviews triangulated with secondary data. This thesis has identified the main drivers and barriers for environmental upgrading in Norwegian short-sea shipping, categorized into the dimensions of; politics and regulations; the market and societal pressure; and innovation, technology, and adaptability.

I argue that environmental upgrading is likely to happen when these dimensions facilitate fair and just development across the industry, allowing deep value chain collaborations and where market structures do not hinder sustainable development. Furthermore, I will make the case that national and international governance structures are essential for environmental upgrading and that Norway is characterized by multiple and interacting governance structures, which have changed and evolved as the industry has matured. Moreover, I will also highlight the importance of looking at environmental upgrading as an innovation process involving vertical interaction and cooperation.

Acknowledgement

The process of writing this thesis has provided me with so much life knowledge, giving me the possibility to deepen my interest in a topic that is close to my heart – sustainable development. Doing this in the middle of a worldwide pandemic has been challenging, but also rewarding and provided a necessary structure for my day-to-day life.

First, I would like to express my gratitude to my supervisor Markus Steen. Thank you for all the inspirational and encouraging conversations, good advises and constructive criticism, and for supporting me throughout this process.

I also want to express my deep gratefulness to all the participants of this study. Without your expertise and willingness to participate, this thesis would not have happened. Your input into this thesis has been invaluable.

There are many people who have filled my life with love, laughter, and joy in these last months, making the process of writing this thesis much easier.

To my family, thank you for the unconditional love and support, and for always believing in me and my life choices.

To my friends, thank you for always being there for me, providing support, a hand to hold and the most beautiful hugs. A special thanks to Thea, for motivating me through these past two years and bringing so much joy to the office at Dragvoll.

To my roommates, thank you for dragging me out running, climbing and for late wine nights.

To Spotify, thank you for all the beautiful music you provide.

Mari Wardeberg

Trondheim, 17.05.2021

List of content

List of Figures

List of Tables

List of Abbreviations

CO_2	Carbon Dioxide
EEDI	Energy Efficiency Design Index
EnvU	Environmental Upgrading
EU	European Union
GCC	Global Commodity Chains
GPN	Global Production Networks
GVC	Global Value Chain
GSP	Green Shipping Program (Grønt Skipsfartsprogram)
GHG	Greenhouse Gasses
SOLAS	International Convention for Safety of Life At Sea
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships
IMO	International Maritime Organization
LNG	Liquefied Natural Gas
MPEC	Maritime Environmental Protection Committee
MBM	Marked Based Measures
NO_x	Nitrogen Oxide
NSD	Norwegian Centre for Researched Data
PM	Particular Matter
R&D	Research and Development
SEEMP	Ship Energy Efficiency Management Plan
SO_x	Sulphur Oxides
SDG	Sustainable Development Goals
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development

Chapter 1: Introduction

1.1: Introduction to the field

In recent years, the importance of environmental implications from industries has risen. Within the scientific world, there is a clear consensus on the correlation between human activity and climate change, highlighting human activities as a dominant factor for increased atmospheric concentrations of greenhouse gasses (GHG) (Dicken, 2015, p.258). As this correlation has become more apparent, the world has moved towards a higher focus on sustainable development, defined as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, p.24). This increased emphasis on sustainable development can be seen in the United Nations' Sustainability Goals (SGDs) and the development of the 2015 Paris Agreement on climate change, which 186 countries have ratified (U.N, 2019).

The contemporary world is becoming more and more interconnected, where two of the most significant features of the world economy are globalization of production and global trade (Gereffi et al., 2005). The world is entirely reliant on trade and global economic activities; however, there is a strong correlation between increasing GHG levels and global economic activity growth (Dicken, 2015, p.360). A dominant feature of global trade has been, and still is, international shipping – the movement of goods, material, and people - carried onboard vessels over geographical areas (IMO, 2013; Wan et al., 2018). Maritime transportation act as the backbone of globalization and global trade, accounting for approximately 80 % of total global trade volume (UNCTAD, 2019, p.89). Compared to other transportation modes, shipping is the most energy-efficient and environmentally friendly; however, this industry is heavily dependent on fossil fuels, contributing to increased GHG emission.

International shipping accounts for approximately 3% of global carbon dioxide (CO_2) emissions. With the expected growth in the global economy and global freight volume, the International Maritime Organization (IMO) has predicted that emissions from the industry could increase between 50 % and 250 % in the next 30 years (Mitsubishi heavy industries group, n.d; IMO, 2020a; Wan et al., 2018). In addition, the shipping industry is also accountable for approximately 10-15% of sulphur oxides (SO_X) and nitrogen oxides (NO_X) emissions (Bjerkan & Seter, 2019), as well as a considerable amount of particular matter (PM) emissions. These emissions bring substantial concerns regarding the planter, climate change and global human health (Mitsubishi heavy industries group, n.d; Poulsen et al., 2016).

The shipping industry is under considerable pressure to reduce its environmental impacts, thus contribute to sustainable development. However, shipping faces significant and complex challenges to reduce emissions, such as transitioning from fossil fuels to more sustainable energy sources, requiring substantial technological and political changes. To the understand development trajectories of the shipping industry, it is not sufficient to focus on one single firm. The integration of global trade characterizing the global economy calls for a global value chain (GVC) perspective (De Marchi et al., 2013a; Poulsen et al., 2016).

1.2: Research challenge

The shipping industry is faced with extensive challenges to reduce its environmental impacts. The whole industry and its value chain must become more sustainable to tackle these challenges, both developing and introducing low-and zero-emission solutions and implementing these solutions in its operations. In addition to emission reduction, the industry also needs to change its operations to facilitate better marine life; however, this thesis conceptualizes emissions reduction issues in the shipping industry by looking at Norwegian short-sea shipping through a theoretical framework of GVC and its analysis of environmental upgrading (EnvU) processes. First, Norwegian short-sea shipping is here defined as sea-going transport between ports in Norway and Europe. Moreover, GVC refers to "the full range of activates that firms, farmers and workers carry out to bring a product or service from its conception to its end-user, recycling or reuse" (Ponte et al., 2019, p.1). Lastly, EnvU refers to "the process of improving the environmental impacts of value chain operation (including production, processing, distribution, consumption and disposal or recycling" (Poulsen et al., 2016, p.60). While analysing EnvU processes of global industries, such as shipping, from a GVC perspective is still in its infancy (Poulsen et al., 2016), this thesis will highlight the paths in which Norwegian short-sea shipping can utilize to reduce its emissions and lower its environmental impacts.

Having this in mind, this thesis aims at investigating the following research problems:

> *Which significant drivers and barriers for environmental upgrading can be identified in Norwegian short-sea shipping?*
>
> *How is environmental upgrading connected to GVC governance?*

This thesis aims to interpret and understand the complex processes involved in EnvU in general shipping. By focusing on Norwegian short-sea shipping, this thesis contributes to a more in-depth understanding of the industry and its upgrading processes. The purpose is to understand the conditions of EnvU in the context of Norwegian short-sea shipping, thus better understand the development trajectories of the industry.

Norway presents an interesting case for EnvU in shipping. First, as IMO, the Norwegian Government and The Norwegian Shipowners' Association have goals for emissions reductions, this case can provide useful insight into how the industry can achieve these goals. IMO aims to reduce international shipping emissions by 50% by 2050, compared to 2008 levels (Joung et al., 2020). The Norwegian Government ambition is to reduce domestic emission from shipping and fisheries by 50 % by 2030 compared to 2008 levels (Norwegian Government, 2019; Meld. St. 10 (2020 – 2021)), which is also the goals for The Norwegian Shipowners' Association and their members, aiming at a 50 % reduction per unit transported by 2030 (Norwegian Shipowners' Association, 2021). Second, Norway holds a leading role in green shipping practices (Norwegian Shipowners' Association, 2019), and maritime industries contribute to significant Norwegian value creation (Norwegian Government, 2019). Lastly, shipping represents the most energy-efficient way to transport goods and passengers between ports in Norway and between Norway and Europe. Looking closer at the case of Norwegian short-sea shipping contributes to essential aspects for the industry's green transitions and is relevant regarding how solutions can be utilized within a broader global perspective.

1.2.1: Previous research

Studies of greening processes of industries through an EnvU analysis is still in its infancy, and there is a lack of literature connecting EnvU, GVC and global industries.

Poulsen et al. (2016; 2018b) have made significant contributions to the analysis of shipping through GVC and EnvU perspectives. Poulsen et al. (2016) focus on buyer-driven greening of shipping, and especially deep-sea shipping, examining the relations between chain governance and EnvU. They argue that EnvU is more likely to occur in GVCs characterized by unipolar governance and where the firms are customer-faced and influenced by reputational risks. Furthermore, they argue that EnvU is complex due to its issues of environmental regulations and being commercially and politically sensitive. Poulsen et al. (2018b) highlight EnvU in GVCs in the greening of ports. Here, it is argued that ports have two main ways to improve the

environmental performance of shipping by lowering tool implementation complexity through more vital collaboration within the GVCs and by enhancing emissions visibility through alliances with cargo-owners and regulators.

Numerous studies have been conducted analysing other global industries, which can connect to shipping. De Marchi & Di Maria (2019) focus on EnvU in leather GVCs and highlights the limits of green transitions when buyers and suppliers do not share the same visions of sustainability. De Marchi et al. (2013b) applies GVC and EnvU analysis to examine the greening processes of the furniture industry, highlighting the differences in standard-driven and mentoring-driven greening processes. Furthermore, Khattak et al. (2015) address the gap in EnvU literature by examining the conditions and drivers for EnvU in apparel firms. Their study argues that the primary incentive for upgrading is to maintain environmental performance and reduce operational costs. Khan et al. (2020) provide further valuable contributions on EnvU in GVCs by examining the EnvU processes of Pakistani apparel firms. They argue that one needs to include the perspective of EnvU as a process, disentangled from the traditional perspective of economic outcomes of upgrading.

There is a rich amount of literature on the greening of industries regarding technical and operational solutions, which is helpful in this thesis (see Bach et al., 2020; Balcombe et al., 2019; Bouman et al., 2017; Cariou et al., 2019; Di Vaio et al., 2020; Mäkitie et al., 2020; Pettit et al., 2018; Steen et al., 2019). Moreover, it has also been conducted substantial research into the technical solutions the shipping industry can utilize to become more sustainable, and there is a rich amount of literature on the regulatory frameworks surrounding shipping, which provide essential insight into the processes of EnvU (see Čampara et al., 2018; Joung et al., 2020; Lee & Nam, 2017; Serra & Fancello, 2020; Wan et al., 2018). This thesis draws on the literature above and more and tries to broaden the perspectives of previous research by conceptualizing sustainable transitions through EnvU of Norwegian short-sea shipping by looking further into the drivers and barriers of EnvU. By doing so, this thesis sets out to fill gaps in the existing literature and contributes to a broader understanding by using the GVC framework in the context of short-sea shipping.

1.3: Justification and significance of the study

New technologies and new ways of thinking are required to decrease human implications on the planet and its climate. At the same time, increased globalization of production and global

interconnectedness depends on transportation modes, which is where shipping becomes relevant. Shipping provides the most energy-efficient and environmentally friendly way of transporting large volumes over geographical areas, and the so-called Global North is entirely dependent on shipping to maintain its lifestyle. However, shipping is a hard-to-adapt industry, where change is slow. Significant challenges of emission reduction, new technologies and innovations, alternative fuels, economic incentives and governance and political structures need to be addressed (Balcombe et al., 2019; Pettit et al., 2018). It is crucial to understand how the industry can encourage and facilitate measures to reduce the environmental impacts of the industry.

1.4: Thesis outline

This thesis proceeds as follows. Following the introduction, chapter 2 will present relevant background of the shipping industry, including international shipping and its regulatory framework, shipping segments, Norwegian shipping and sustainability aspects of Norwegian short-sea shipping. Chapter 3 will cover the theoretical framework used in this thesis, elaborating on GVC and EnvU theory and provide a theoretical proposition. Chapter 4 presents the employed research methodology, discussing the research strategy, data collection, analysis method, and associated limitation. Here, some ethical considerations will also be presented and discussed. Chapter 5 will present the main findings derived from the triangulated data collection, organized into the dimensions of; Norwegian short-sea shipping; politics and regulations; market and societal pressure; and innovation, technology and adaptability. Chapter 6 will discuss the analysis prested in chapter 5, linking the findings to the theoretical framework presented in chapter 2. In the final chapter, I will conclude the research by summarizing the main findings in relation to a broader EnvU perspective. Lastly, some possible topics for future research will be proposed.

Chapter 2: The shipping industry

The oceans have played a significant role in developing our contemporary world, from fishing, energy through oil and gas extraction to trade routes transporting people and goods between continents. Likewise, new industries are emerging, ranging from extracting valuable minerals from the seabed to cultivating and harvesting marine plants for human consumption. As the world becomes increasingly interconnected and globalized in terms of production and economy, international shipping has exploded in volume and scale (Pettit et al., 2018; UNCTAD, 2020). The following chapter will begin by looking at international shipping, followed by an overview of the international regulatory framework and the shipping segments relevant to this thesis. Lastly, this chapter will look at Norwegian shipping and sustainability within Norwegian shipping.

2.1: International shipping

The overall volume of international shipping has increased dramatically since the 1970s (Figure 1). The United Nations Conference on Trade and Development (UNCTAD) estimates a total volume of 11.08 billion tons in 2019 (UNCTAD, 2020). International shipping now accounts for approximately 80% of global trade volume and is characterized as the lifeline for global trade and global economy (UNCTAD, 2019). International shipping growth declined in 2019, reaching its lowest level since the global financial crisis of 2008-2009, which can be attributed to trade tensions and policy uncertainty (UNCTAD, 2020).

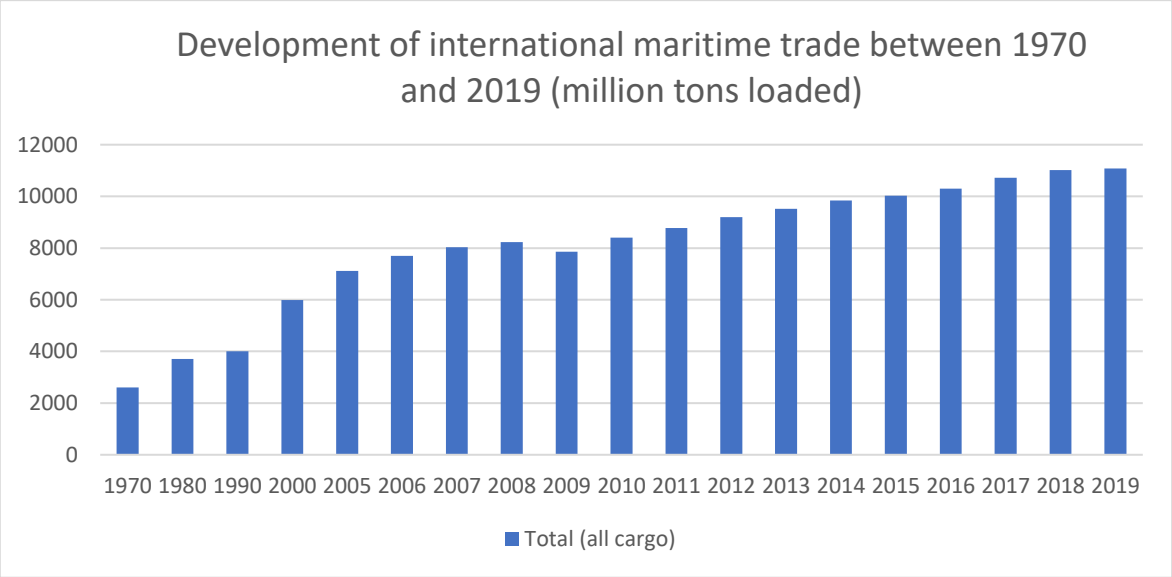


Figure 1: Development of international maritime trade between 1970 and 2019. Source: UNCTAD, 2020, p.4

Historically, international shipping has undergone five innovation waves, identified by several technological innovations and paradigm shifts (Table 1). These innovation waves are essential in understanding the future of shipping, as some now argue that shipping is currently entering a sixth innovation wave focusing on socio-technical transitions towards more sustainable solutions (Pettit et al., 2018). The industry may be at the beginning of a sixth innovation wave where technological solutions have a higher emphasis on reducing/eliminating the emissions from the industry.

Innovation wave	Important elements of the innovation wave
1789 – 1845	Sail to steam. Technological innovations in ship design and shipbuilding improved reliability. Stronger institutions emerged. Improved communication. Reduced cost of production and transportation.
1845 – 1900	Coal. Improvements in steam power. Larger steamships improved effectiveness and enhanced global trade.
1900 – 1950	Electricity. Development of internal combustion engines. Improved efficiency. Establishment of the United Nations.
1950 – 1990	The establishment of the General Agreement on Tariffs and Trade (GATT) stimulated the development of a global trade economy. Specialized shipping operations. Containerisation. Advanced technology.
1990 – Today	Digital Networks and software. Better communication and information systems. Globalization. Larger vessels. Significant reduction in transportation costs.

Table 1: Five historical innovation waves and important elements. Developed from: Pettit et al., 2018.

International shipping is the characteristic paradigm of a globalized industry that operates under a continuously changing business environment (Di Vaio et al., 2020). In today's climate, the shipping industry is under increased sustainability pressure, which, together with changing business environment, can create instability and uncertainty regarding future operations. Globalization poses significant challenges for shipping firms that aim to reduce their

environmental impacts, adding to the complexity of coordination due to increased distances and differences in business habits and environmental legislations (De Marchi et al., 2013a).

The introduction of radical technological and operational solutions and measures is a crucial challenge for worldwide transport sectors (DNV GL, 2019). Here, the international shipping industry can play an essential role in contributing and introducing new environmentally friendly solutions across global transport sectors and industries. New regulations, technical solutions and operational measures can accommodate these new challenges and make the industry greener and cleaner. However, no single measure can alone be sufficient to reach considerable reductions in GHG emissions – there is a need for a combination of individual and independent actions. Further, the success of environmental regulations, policies and measures is dependent on the growth rate of maritime transport (Bouman et al., 2017).

The shipping industry is under considerable pressure to act upon the Paris Agreement and reduce its GHG emissions (DNV GL, 2019). However, the shipping industry was not included in the global emission reductions targets laid out by the Paris Agreement, nor mentioned in the agreement. This left the discussions regarding shipping to IMO, who was expected to develop regulations, set emissions limits, and ensure practices to facilitate implementations of these regulations and limits (Wan et al., 2018).

2.1.1: International regulatory framework

The International Maritime Organization (IMO) is the UNs regulatory agency responsible for international shipping's security and environmental impacts. IMO acts as the main international regulatory body to ensure a regulatory framework for the shipping industry that is fair and effective and can be universally adopted and implemented (IMO, 2018).

Through developing a roadmap for national governments and implementing international mandatory environmental regulations, IMO can steer the direction of EnvU. IMO work as a technical organization where most of the work carried out is done through several committees and sub-committees composed of IMOs Member states. As well as Member States, IMO also includes several inter-governmental and non-governmental organizations, representing a vast number of maritime, legal, and environmental interests and contribute by providing information and expertise. Through this, IMO has promoted the adoption and implementation of approximately 50 Conventions and protocols and over 1000 codes and recommendations regarding maritime safety, security, and pollution prevention (IMO, 2013). Most of the

recommendations and codes are not binding on national Governments but provides guidelines that contribute to framing national regulation and maritime requirements. However, some have become internationally mandatory under Conventions such as SOLAS (International Convention for Safety of Life At Sea) and MARPOL 73/78 (International Convention for the Prevention of Pollution from Ships) (IMO, 2013). MARPOL 73/78 provides in the context of this thesis an understanding of the regulatory framework at the core of EnvU as it provides comprehension of how the maritime regulatory framework works related to pollution.

MARPOL 73/78 (Table 2) is an environmental convention to prevent marine water and air pollution from occurring because of ships (Lee and Nam, 2017). This Convention is one of the most important international conventions for the maritime environment and consists of regulations aimed at preventing and minimizing pollution from ships, during operations and due to accidental causes. This Convention consists of six annexes, where Annex VI is most relevant in this context.

Annex	**Regulation**
Annex I	Regulations for the Prevention of Pollution by OIL
Annex II	Regulation for the control of pollution by Noxious Liquid Substance in Bulk
Annex III	Regulations for Prevention of pollution by harmful substance carried at sea by packages form
Annex IV	Regulations for the Prevention of Pollution by Sewage from Ships
Annex V	Regulations for the Prevention of Pollution by Garbage from Ships
Annex VI	Regulations of Air Pollution from Ships

Table 2: Overview of MARPOL 73/78 Annexes. Source: IMO, 2020b

MARPOL 73/78 Annex VI was adopted in September 1997 and entered into force in May 2005. The development of this Annex due to increased international awareness of global air pollution and GHGs (Čampara et al., 2018). Here, IMO sets limitations on $S0_x$, NO_x and PM emissions from ships and prohibits deliberate emissions of substances depleting the ozone layer, organized into five chapters. Chapter 1 refers to the definitions and the final applications of the rules; chapter 2 provides guidelines for necessary surveys, certifications and means of control. Chapter 3 lays out the requirements on limits and control mechanisms for all emissions from ships, except CO_2 covered in chapter 4, and chapter 5 outlines verifications of compliance (Čampara et al., 2018).

Chapter 4 of the Annex was adopted in 2011 and sets mandatory technical and operational energy-efficiency measures to reduce GHG emissions from shipping (IMO, 2020b). This crucial step toward reducing GHG emissions laid out the groundwork for developing EEDI (Energy Efficiency Design Index) and SEEMP (Ship Energy Efficiency Management Plan). EEDI is the main technical measure for compliance with the regulations (Čampara et al., 2018) and requires all new ships to comply with a minimum mandatory energy-efficiency performance level and defines vessel conditions to reduce CO_2 emissions (Poulsen et al., 2016). The introduction of EEDI for newly built ships stimulates technological and engineering innovations, ranging from optimized hull and propellers, and improves engine performance to better waste heat-recovery systems in vessels (Wan et al., 2018). SEEMP is a mandatory plan for all ships, aimed at reducing fuel consumption in the daily operations of ships (Poulsen et al., 2016). SEEMP establishes a mechanism for shipowners to improve energy-efficiency in both new and existing vessels, using operational measures such as routing, trim and drought optimization, speed optimization and just-in-time-arrival in ports (IMO, 2020a). The development of energy-efficient measures, such as EEDI and SEEMP, are important but are not sufficient, as fossil fuels need to be replaced by low-and zero-emission fuels. IMO has also set in place Market-Based-Measures (MBMs), considering the carbon market and the global emission trading systems in technical and operational measures (Lee & Nam, 2017).

IMO placed climate impacts of shipping on the agenda in 2003, and on December 5th the same year, IMO adopted A.963 (23), requiring the Marine Environmental Protection Committee (MPEC) to regulate shipping CO_2 emissions through technical, operational, and market-based mechanisms (Wan et al., 2018). This, as well as a response to the 2015 Paris Agreement, led to the adoption of IMOs Initial Strategy for Reducing GHGs caused by ships in April 2018 (Joung et al., 2020). This Strategy is under MARPOL Annex VI, and the overall goal of this Strategy is to reduce the total CO_2 emissions by at least 50 % by 2050, compares to 2008 levels (Cariou et al., 2019; Joung et al., 2020), and represent IMOs initial contributions to the global climate goals presented in the Paris Agreement (Serra & Fancello, 2020).

During the 70th MEPC meeting in London in 2016, IMO took a landmark decision which laid out the new Sulphur regulations mandatory from January 1st, 2020 (referred to as IMO 2020). This regulation states that ships need to reduce sulphur emissions (SO_X) from 3.5 % to 0.5 % by switching to low- sulphur fuels, which will significantly reduce SO_x emissions from ships and improve air quality in places such as port cities and coastal areas (UNCTAD, 2019, p.44). Today, the primary type of fuel for the shipping industry is based on heavy fuel oil, which is

derived as a residue from crude oil distillation. This crude oil contains sulphur which ends up in the ship's general emissions. SO_x are known and scientifically proven to be harmful to human health, causing respiratory symptoms and lung diseases. Further, from a global environmental perspective, SO_x in the atmosphere causes acid rain, which is harmful to agriculture and forests and contributes to acidification (IMO, 2020c). IMO 2020 and its cap on SO_X emissions are among the first examples of establishing a mechanism for pricing negative effects on the environment. However, IMO 2020 bring fresh challenge due to increased operational fuel costs and price instability, reduction in supply capacity and vessel availability and require radical changes in and by the shipping industry (UNCTAD, 2019). Nevertheless, SO_X reductions contribute to cleaner air by reducing air pollution and reducing PM emissions. This will also bring about higher-quality fuels for ships, which positively impact human health (IMO, 2020c). Both IMO 2020 and IMO strategies for reducing GHG emissions have the potential to become game-changers in the industry (DNV GL, 2019).

2.2: Shipping segments

Shipping can be classified into short-sea and deep-sea shipping (examples of typical deep-sea and short-sea vessels shown in Figure 2 and 3). Short-sea shipping refers to vessels typically operating in limited geographical areas in relatively short routes with frequent port calls. This type of shipping is ideal for testing new fuels and technological solutions due to a lower degree of energy demand than deep-sea shipping (DNV GL, 2019). In contrast to short-sea shipping, deep-sea shipping includes larger, ocean-going vessels covering longer routes. Deep-sea involves different challenges compared to short-sea, as deep-sea shipping requires globally available fuels and depends on energy sources that have a sufficient high-energy density to maximise the available cargo space (DNV GL, 2019). This type of shipping usually consists of container ships, tankers, dry-bulk vessels, and so on, which sails intercontinental and facilitates the development of global trade. Short-sea shipping consist of the same types of vessels; however, the ships in short-sea shipping are smaller compared to deep-sea. Deep-sea shipping is estimated to account for more than 80 % of the world fleet CO_2 emissions (Serra & Fancello, 2020).

Figure 3: Example of short-sea vessel. Source: VARD in Stensvold, 2021a

Figure 2: Example of deep-sea vessel. Source: NYK in Stensvold, 2015

Short-sea shipping has more options for new solutions, for example, electrification of vessels. The use of batteries and the development of fully electric ships represent a leap forward regarding power system design; however, these solutions are only feasible on shipping segments such as ferries operating on short routes (DNV GL, 2019). Short-sea shipping is more embedded within the region in which they are operating. This is reflected by the use of short-sea shipping in the European region. Here, short-sea shipping has been a significant mode of transportation for centuries and contributed to the fast economic development of the European continent. It has facilitated this by transporting goods and people, being a source of economic growth, providing jobs, and contributing to value creation (ECSA, 2016).

Shipping segments operating in short-sea and deep-sea shipping can be categorized into two main categories: liner shipping and tramp shipping. The main difference between these two is that liner shipping operates on fixed routes and port calls, while tramp shipping operates without a fixed schedule and port calls (Munari, 2012). Figure 2 show some of the segments operating in deep-sea and short-sea shipping.

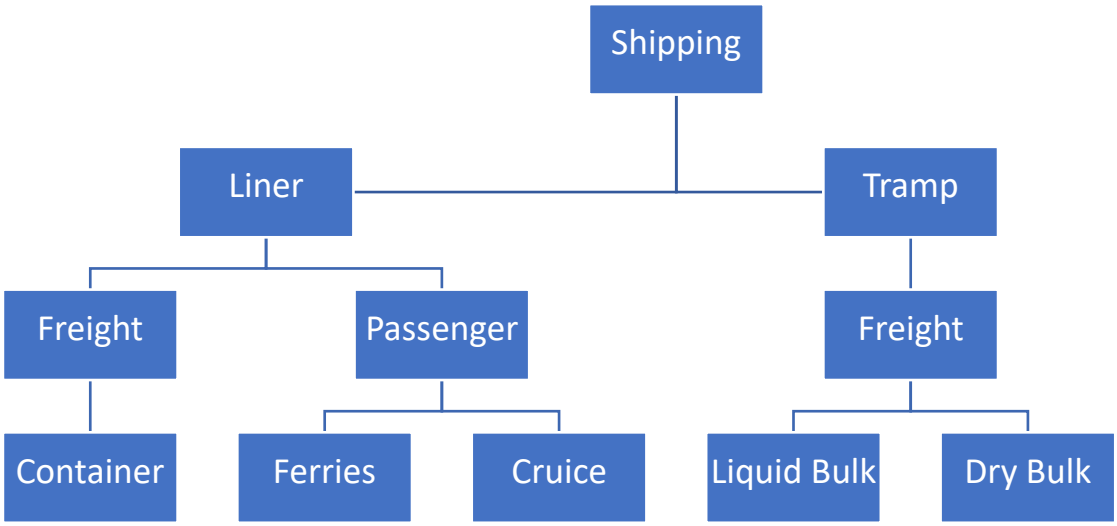


Figure 4: Overview of shipping segments

Container shipping operates on fixed routes, transporting different kinds of cargo for different cargo-owners on the same voyage. This segment usually transports cargo of high value per weight, including consumer goods and semi-manufactured products. A large proportion of the transported cargo is ready for distribution and retain when they arrive at the end destination. In general, this segment is closer to the end-user and tends to be more engaged with environmental initiatives than bulk shipping (Poulsen et al., 2016; Stalmokaite & Hassler, 2020). Examples of Norwegian companies operating in the container segment are Awilco Container, MPC Container Ships ASA and Sogna Container.

The passenger segment also operates on fixed routes, consisting of ferries and cruise vessels. Cruise vessels are, in this context, defined as passenger vessels connecting Norway to the rest of Europe. Cruise vessels usually stay longer in ports due to passengers embarking or disembarking, attracting attention to their operational effects on the environment and port-cities (De Vaio et al., 2020). Examples of Norwegian companies operating in the passenger segment are Color Line, Hurtigruten and FjordLine.

Dry-bulk and liquid-bulk vessels (hereafter referred to as bulk vessels) are first and foremost focused on transporting one type of cargo for one cargo-owner per voyage with low value per weight. This segment usually carries coal, iron ore, aluminium, different rock products and various timber and woods, and liquid cargo, which need considerable processing before reaching the end consumer (Poulsen et al., 2016). Norwegian shipping companies operating in

the bulk segment are Hagland, Arriva, Egil Ulvans Shipping Company, Misje Shipping Company and Sea-Cargo.

2.3: Norwegian shipping

Shipping has been and still is an essential feature of Norwegian society and economy. Since the Viking Age, Norway has been a maritime nation, and shipping, ship design and fishing are arguably Norway's oldest businesses (Reve & Sasson, 2012, p.84). At the beginning of the 20th century, Norway had a significant position in international shipping, reflecting the prominent role shipping played in the Norwegian economy (Tenold, 2019). This strong international position was based on favourable geographical circumstances, historical legacy, and a strong maritime culture. Throughout the next 100 years, these factors still played an important role; however, the nature of their importance has changed. Norway's shipping history began to include the exploitation of petroleum resources, which laid the foundation for new maritime activity. New technologies and knowledge enabled Norway to use these new resources, which has dramatic impacts on Norway's economy, politics, and culture (Tenold, 2019). Throughout Norwegian maritime history, this industry has played a critical role in settlement, value creation and employment in Norway, especially in the rural parts (Norwegian Government, 2019). This is also the case today. In 2018, the Norwegian maritime industry created value for approximately 89 billion NOK and employed 84,000 people throughout the country (Meld. St 10 (2020-2021)). Today, the Norwegian shipping industry represents a knowledge-intensive, thoroughly globalized industry (Norwegian Shipowner's Association, 2019).

The Norwegian Government has signed and committed to the 2015 Paris Agreement to reduce emissions. The Norwegian Government highlighted in 2019 that Norway is determined to reduce its overall emissions by at least 40 % by 2030 compared to 1990 levels (Norwegian Government, 2019). The Norwegian Government also wants to reduce emissions from domestic shipping and fishing by 50 % within 2030 compared to 2008, presented in the latest White Paper on Norway's maritime industry (Meld St. 10 (2020-2021)). This White Paper lays out a direction for the Norwegian shipping industry to maintain its international competitiveness and ability for value and job creation. For the Norwegian Government, cooperation with the sector has been vital in developing green shipping policies. By facilitating close collaboration, the Government aims to speed up change in the maritime sector (Norwegian Government, 2019).

The Norwegian short-sea shipping industry can be distinguished into two categories: those who sail within the Norwegian border (coastal shipping) and those who sail between Norwegian and European ports (Fjose et al., 2020). This thesis will use short-sea shipping for the latter and coastal shipping for shipping operating within the Norwegian border.

There is uncertainty regarding the actual level of GHG emissions from domestic shipping in Norway, partly because the estimate of emissions is based on registered sales of fuel in Norway only. This leaves out vessels that bunker fuels abroad (Norwegian Government, 2019) but contribute to domestic emissions. This uncertainty further complicates the emissions reduction strategies of the Norwegian Government, as the numbers describing the actual domestic emissions are questionable. Norway needs to achieve substantial emission reduction in non-quota sectors, including transportation and shipping (Meld St. 10 (2020-2021)).

Today, Norway has the world's most complete maritime cluster (Norwegian Shipowners' Association, 2019; Meld. St. 10 (2020-2021)), which covers all parts of the value chain, from research institutes and technology development; shipbuilders; operations and safety; to shipowners and finance (Reve & Sasson, 2012). Having a robust maritime cluster, which involves all parts of the value chain, has been critical in developing the industry. The Norwegian maritime cluster has been pointed to as the strongest and most dynamic business cluster in Norway, and the maritime industry has been described as Norway's only global competence industry (Reve & Sasson, 2012). Across the different shipping segment, Norway has an internationally leading maritime industry, including shipping companies, maritime services, shipyard, and equipment suppliers (Norwegian Government, 2019).

International regulations and policies are essential for developing a more sustainable Norwegian shipping (Norwegian Shipowner's Association, 2019). Furthermore, Norway plays an important role in developing IMOs international environmental protection regulations and holds a leading role in green transitions in international shipping. Moreover, The Norwegian Government wants Norway to be a driving force in strengthening IMOs regulations and will promote "the adoption of Norwegian innovations as the international standard" (Norwegian Government, 2019, p.13).

2.4: Sustainability in Norwegian shipping

All industries, including Norwegian short-sea shipping, must become more sustainable and strive towards accomplishing the SDGs. Maritime transport touches upon several of the SDGs;

however, this thesis will focus mainly on SDG 13: Take immediate action to combat climate change and its impacts (U.N, n.d). Norwegian short-sea shipping can contribute to this through developing and implementing low-and zero-emission solutions, such as batteries, hydrogen, biofuels and so on, which is essential to reduce GHG emissions and meet the demand of the future.

Using batteries as a power source for vessels can directly store electrical energy for propulsion, generating opportunities to optimize the power system. Recent improvements in battery technologies and reduced costs have made batteries attractive as energy sources in shipping (DNV GL, 2019). In the last years, the market for batteries and electrification in maritime transport have increased. Today approximately 40 % of global maritime battery installations are on Norwegian vessels, which can be explained by increased capability and reduced costs for batteries (Bach et al., 2020) and governmental financial support. The use of batteries represents a transformation in the way energy is used and stored on vessels and represents a lead forward in the design of power systems. With the technological capability today, the use of batteries is only feasible for short routes in shipping, such as ferries (DNV GL, 2019). By 2022, Norway aims at having 60 battery-powered ferries along the coast (Norwegian Shipowner's Association, 2019).

The use of hydrogen is also important in developing a more sustainable Norwegian short-sea shipping industry. However, today approximately 95 % of hydrogen is produced from fossil fuels, mainly natural gas, oil, and coal. When hydrogen is produced from renewable sources and using an efficient supply chain, this fuel has the potential for becoming a viable low-emissions alternative for shipping (DNV GL, 2019). The hydrogen knowledge base is limited, which indicates a need for substantial research and technology development; however, hydrogen is a promising fuel for several segments within the industry, especially for vessels operating on longer routes. Furthermore, the Norwegian market of hydrogen is still small, especially for fossil-free hydrogen (Bach et al., 2020), and there is a need for infrastructure covering the whole coast.

Biofuels are also a promising solution to reduce GHG emissions. Biofuels are usually derived from primary biomass or biomass residues which are transformed into liquids or gas. Concerning shipping, biofuels such as biodiesel and LBG (liquid biogas) are the most promising solutions, are currently the only biofuels commercially available (Bach et al., 2021; DNV GL, 2019). Biofuels can reduce emissions from the shipping industry and have the advantage of being rapidly biodegradable. This is a flexible fuel alternative, which means that it can be mixed

and blended with more conventional fuels (Bach et al., 2021; Serra & Fancello, 2020). Increased use of biofuels may be important for the achievements of national and international ambitions of emission reductions (Norwegian Government, 2019).

However, there are other suitable fuel solutions in which the industry can use to become more sustainable and reduce emissions. Table 3 shows some fuel alternatives, their reductions in SO_x, No_x and GHG emissions, their investment cost, fuel cost and availability.

	Biogas	**Biodiesel**	**Electric (full)**	**Electric (hybrid)**	**Hydrogen**
Reductions of GHGs	High	High	Very high	Moderate-high	Very high
Reductions of NO_x	High	Low	Very high	Moderate	Very high
Reductions of SO_x	Very high	Very high	Very high	Moderate	Very high
Investment cost (on vessels)	Low	Low	High	Moderate–high	High
Fuel cost	High	High	Low	Moderate	High
Availability (including infrastructure	Low	Low	Moderate	Moderate	Low

Table 3: Alternative fuel evaluation. Source: Steen et al., 2019

The most suitable fuel depends on the type of shipping segment. The choice of technology depends particularly on vessel size and operation patterns (Norwegian Government, 2019). The benefits and challenges of the solutions above, and more, differ depending on the specific segment (Bach et al., 2020). The development and implementation of low-and zero-emission solutions require extensive research, willingness and capital, and as Bouman et al. (2017, p.418) argues, “no single measure is sufficient by itself to reach considerable sector-wide reduction”. Moreover, the different segments will need different measures to encourage the phase-in of more sustainable solutions and technologies (Norwegian Government, 2019).

Chapter 3: Theoretical framework

The following chapter will set the theoretical framework on which this thesis is based. Research on GVCs has been present in the scientific world for many years; this chapter will draw on the most relevant GVC literature, highlighting GVC dimensions essential for understanding the greening processes of industries. Moreover, the following chapter will provide a more in-depth literature review into the un-investigated area of EnvU in global industries, providing an overview of identified EnvU drivers. Lastly, this chapter will present a theoretical proposition of critical theoretical concepts used as an analytical framework.

3.1: Global Value Chain

Economies worldwide have become increasingly interconnected and interdependent, and world trade and production are progressively structured around global value chains (GVC) (De Backer & Miroudot, 2013). GVC refers to the "full range of activities that firms and workers perform to bring a product from its conception to end user and beyond" (Gereffi & Fernandez-Stark, 2016, p.7), presented in Figure 5. The concept includes the composition of several coordinated activities; hence design, production, marketing, distribution, retail and disposal or recycling, split among and between firms on a global geographical scale (Poulsen et al., 2016).

Figure 5: Global Value Chain. Source: De Backer & Miroudut, 2013; Poulsen et al., 2016

Today, GVCs act as the dominant feature of the global political economy and the world's economic backbone and central nervous system. The emergence of GVC has been a significant driver of global economic change at global, regional, national and local levels (Neilson et al., 2014). Historically, it has captured some of the main characteristics of the world economy; the increased fragmentation of production across countries, the interconnectedness of economies, the increased global specialization, and the role of networks and global suppliers (De Backer & Miroudot, 2013). Today, GVC described the global economy as a part of a complex economic network made up of inter-firm (between different firms) and infra-firm (within the same firm) relationships. Due to the frameworks ability to understand developmental trajectories of different industries, it has been recognized as a valuable tool to understand internationalization of industries (De Marchi & Di Maria, 2019).

The concept of GVC was introduced in early 2000. Throughout the literature, the GVC framework is used to explore and examine different ways in which global production, distribution systems and infrastructure are integrated (Gereffi et al., 2005). This framework can be traced back to the 1970s with the concept of commodity chains (De Backer & Miroudot, 2013). The term commodity chains were developed by Hopkins and Wallerstein in 1977, who sought to take an ultimate consumable item and trace this back to the inputs which lead up to this item (Bair, 2009). Gereffi later introduced the concept of Global Commodity Chains (GCC) in 1994. This was inspired by significant shifts in the organization and governance of global industries in the 1980s, which was characterized by the emergence of buyer-driven and producer-driven commodity chains (Gereffi, 2014). In the 2000s, GCC transformed into GVC, which introduced the analysis of trade and added value in a chain. The concept of value chains is not highly differentiated from commodity chains, but it tries to "capture the determinants of the organization of global industries" (De Backer & Miroudot, 2013, p.8). GVC has further extended into highlighting the importance of networks in global industries, which is referred to as Global Production Networks (GPN)

> "The core of a GPN is the circuit of interconnected functions, operations and transactions which a specific commodity, good or service is produced, distributed and consumed" (Dicken, 2015, p.86).

GCC, GVC and GPN are all valuable tools when analysing global industries, and they all characterize the global economy consisting of complex networks of inter-firm and intra-firm relationships (Gereffi, 2014). However, this thesis will use the concept of GVC as it offers essential aspects which can enrich a firm's strategic approach to environmental management by analysing upgrading processes within a value chain (De Marchi et al., 2013a). The framework explains the global expansion of supply chains and the geographical patterns of value creation and value capture within a global economy by conceptualizing the construction of chain governance and networks (Neilson et al., 2014; Gereffi, 2014). Moreover, GVC is also an important tool in understanding how global industries, such as shipping, are organized by "examining the structures and dynamics of the different actors involved" (Gereffi & Fernandez-Stark, 2016, p.6). In relation to sustainability, the GVC framework proves useful in understanding how traditional industries can transform to meet sustainability issues (Navarrete et al., 2020) through upgrading.

There are six basic dimensions explored by the GVC framework, divided into global (top-down) and local (bottom-up) elements, presented in Figure 6. These two contrasting elements provide a holistic view of global industries (Gereffi, 2014).

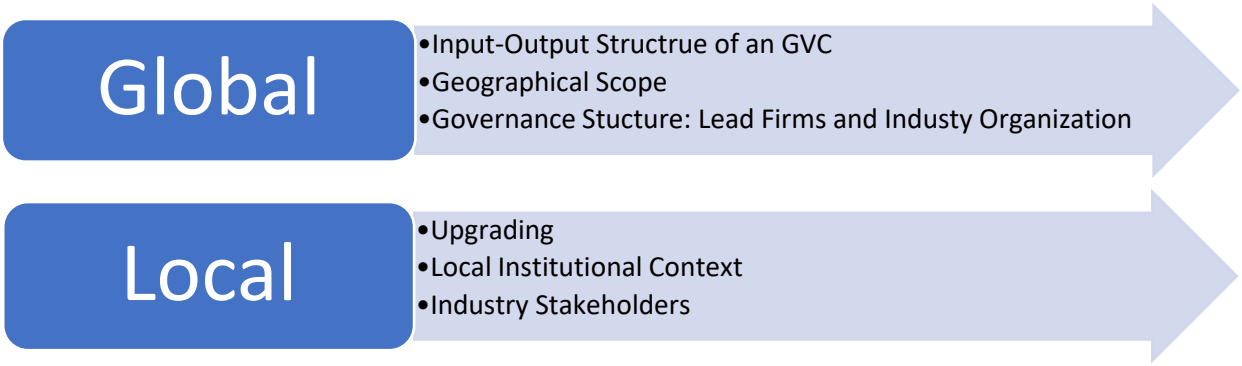


Figure 6: Dimensions of GVC analysis. Source Gereffi & Fernandez-Stark, 2016

The globalization of industries has been facilitated by the improvements in transportation and communication infrastructure (Gereffi & Fernandez-Stark, 2016). Shipping has been crucial for establishing GVCs and especially for retail trade. Deep-sea and short-sea enable GVCs by transporting goods, raw materials, and people effectively and cheaply (Norwegian Shipowners' Association, 2019). Today, approximately 70 % of international trade can be linked to GVCs (UNCTAD, 2020).

3.1.1: Governance in GVC

One of the critical concepts of the top-down perspective is governance, focusing on lead firms within the GVC and the organization of international industries (Gereffi, 2014). Governance analysis of GVCs provides an understanding of how GVC is governed, controlled, and coordinated (Gereffi & Fernandez-Stark, 2016).

Literature on GVC governance emphasizes an essential difference in buyer-driven and producer-driven chains (Poulsen et al., 2016; De Backer & Miroudot, 2013; Gereffi & Fernandez-Stark, 2016). Producer-driven GVCs are found in high-technological sectors which rely on technology and R&D. Here, the lead firm controls the design of various activities used to develop products, as well as the assembly and construction of the products, which often take place in different countries (De Backer & Miroudot, 2013). Buyer-driven GVC highlights the influential role of the retailers. Here, the retailers dictate how the chain operates by requiring suppliers to meet specific standards or policies (Gereffi & Fernandez-Stark, 2016). GVC

governance is driven by the strategies and decisions made by specific actors within the value chain (Poulsen et al., 2016). Final-product manufacturers exert power in producer-driven chains, common in capital-, technology-, or skill-intensive industries. On the other hand, in buyer-driven chains, retailers and marketers of final goods wield the most leverage due to their ability to influence mass consumption through dominant market shares and influential brand names (Gereffi, 2014).

Furthermore, GVC governance can be classified into five typologies: *markets*, *modular*, *relational*, *captive* and *hierarchy*, shown in table 4.

Type of governance	**Characteristics**
Market	Involve relatively simple transactions. Information is easily transmitted. Buyers can develop products with minimal input from buyers. Require little to no formal cooperation between actors. The central governance mechanism is price rather than powerful lead firm.
Modular	Occur when complex transactions are relatively easy to codify. Suppliers make products to customer's specifications. Suppliers take full responsibility for competence and use generic machinery that spread investments across a wide base. Relationships are more substantial, due to the high volume of information flow across inter-firm linkages. Information technology and standards for information exchange are key.
Relational	Occurs when buyers and sellers rely on complex information, which is not easily learned or transmitted. Frequent interactions and knowledge sharing. Require trust and mutual reliance. Lead firms will specify what is needed and thus have some level of control over suppliers. Relational linkage takes time.
Captive	Small suppliers are dependent on one or a few buyers, which often hold a great deal of power. Involve a high degree of monitoring and control by the lead firm. Suppliers face significant switching costs and are, therefore "captive".
Hierarchy	Involve vertical integration and managerial control within lead firms, which develop and manufacture products in-house.

Table 4: Governance structures of GVCs. Developed from: Gereffi et al., 2005; Gereffi & Fernandez-Stark, 2016

Three variables determine these governance typologies; (1) the complexity of information shared between actors; (2) how the information can be codified; and (3) the level of supplier competence. The form of governance can change over time, as the industry evolves and matures or from one level of the chain to another (Gereffi et al., 2005; Gereffi & Fernandez-Stark, 2016). Furthermore, recent literature shows that GVCs can be characterized by multiple and interacting governance structures, which will affect upgrading opportunities and challenges (Gereffi & Fernandez-Stark, 2016).

Governance is at the heart of GVC analysis. It demonstrates how corporate power efficiently can influence the distribution of profits and risk within a market and identify the main power-players in a value chain (Gereffi, 2014). From an international perspective of GVC governance, regional and national structures and institutions matters (Gereffi et al., 2005), meaning that regional and national structures influence the leading power players within a GVC due to the geographical embeddedness of those actors.

3.1.2: Upgrading in GVCs

As one of the main concepts in the bottom-up perspective presented in Figure 6, upgrading highlights the different strategies used to maintain or improve the position of a firm/country/stakeholder within the global economy (Gereffi & Fernandez-Stark, 2016; Gereffi, 2014). In GVC analysis, the term upgrading has been used to highlight paths for value chain actors to move up the value chain for economic gain and increase the value already achieved (De Marchi & Di Maria, 2019). Upgrading has traditionally been used to emphasise the relationship between GVC actors and economic development. It has contributed to new opportunities for developing countries to participate in the global economy by accessing new markets and competence (Ponte et al., 2019). The upgrading processes of GVC is usually examined through the lenses of how knowledge and information flow within the value chain, from the lead firm to their suppliers and clients (Poulsen et al., 2016). Upgrading processes depend on the type of governance implemented by the lead firm of the chain. The lead firm is the driver for upgrading, transferring knowledge, and sustaining the capable growth of suppliers (De Marchi & Di Maria, 2019).

Within the GVC literature, upgrading can be classified as economic upgrading, social upgrading, and environmental upgrading (Navarrete et al., 2020). Economic upgrading has had the most focus in the literature and is defined as the processes by which economic actors move

from low-value to high-value activities in GVCs (De Marchi et al., 2013a). Economic upgrading consists of four types of upgrading*; product upgrading* (or moving into more sophisticated product lines); *process upgrading* (transforming inputs into outputs more effectively, reorganizing the production system or introducing new technologies); *functional upgrading* (acquiring new functions which increase the overall skill of the activities); and *chain upgrading* (where firms move into new but often related industries) (Gereffi, 2014; Poulsen et al., 2016; Khan et al., 2020; Khattak et al., 2015; Navarrete et al., 2020). The main argument is that upgrading, in any form, will be stimulated by vertical interaction with lead firms rather than horizontal interaction with firms in the same place in the value chain (De Marchi et al., 2013a). Social upgrading refers to "the processes of improvement in the right and entitlements of workers as social actors, which enhances the quality of their employment" (Barrientos et al., 2011, p.324, cited in Khan et al., 2020, p. 770). Research on upgrading processes in GVCs has now moved from its economic and social elements to include environmental dimensions (Khan et al., 2020). Traditional perspectives on upgrading have been criticized for their linear (upward) nature of upgrading, as to whether upgrading contributes to better returns (Khattak et al., 2015), and if upgrading leads to increased competitiveness and higher value captured in the GVC (Goger, 2013).

Understanding sustainable development trajectories and the greening of industries, it is not sufficient to limit the scope on one single firm. The de-integration of production and the integration of trade characterizing the global economy call for value chain perspectives (De Marchi et al., 2013a). By analysing upgrading processes, such as EnvU, through the lens of GVCs, one can enrich the analysis of upgrading in industries. Furthermore, the GVC perspective is useful in understanding EnvU due to its focus on activities across international borders yet recognizing the importance of national institution and geographically based competitive advantage (De Marchi et al., 2013a). This type of upgrading will be at the core of this thesis and will be more thoroughly examined in section 3.2.

3.2: Environmental upgrading

EnvU is an essential tool for analysing how industries can improve their environmental impacts and further GVC analysis by including environmental dimensions (De Marchi et al., 2013a). A common way of conceptualizing EnvU is by defining it as the "process of improving the environmental impacts of value chain operation (including production, processing, distribution,

consumption and disposal or recycling)" (Poulsen et al., 2016, p.60). EnvU emphasise the processes in which different actors in a value chain move towards more sustainable production systems and practices to improve environmental impacts, avoiding or reducing environmental damage from the processes or products within the value chain (De Marchi & Di Maria, 2019; Khan et al., 2020).

EnvU differs from traditional GVC analysis on upgrading. While economic upgrading focuses on shifting to a higher economic position within the value chain, EnvU address reducing environmental effects and impacts throughout the value chain. There is a lack of differentiation between upgrading as a process and an outcome within the existing literature. Upgrading as a process emphasise the strategies and choices made by firms, industries, or countries to add and capture more value within the GVC, while upgrading as an outcome focus on the actual achievements of better profitability, value-added or reduction of costs (Khan et al., 2020). For EnvU, it is important to understand the trajectories leading to better environmental outcomes while also reducing environmental impacts.

EnvU literature is under-investigated, but some promising approaches are emerging. One interesting approach links GVC governance and upgrading (also EnvU) by examining drivers and distinguishing between standards-driven and mentoring-driven greening processes (Poulsen et al., 2016; D Marchi et al., 2013b). Furthermore, lead firms can also engage in greening processes through deep and shallow strategies (Khan et al., 2020). Standard-driven greening emphasizes the lead-buyers in unipolar and highly driven chains. These lead-buyers identify the main environmental impact to be reduced within the value chain and decide how to do this. Information is then embedded into standards that suppliers need to comply with (Poulsen et al., 2016). These greening processes work best for environmental improvements of eco-efficiency or other impacts related to production processes (De Marchi et al., 2013b). Eco-efficiency refers to operational and technical innovations contributing to emission reductions (Pettit et al., 2018). Standard-driven greening can also be linked to shallow engagement of lead firms. This takes place when suppliers can meet standards through certificates provided by third parties and where they can comply with protocols. This strategy is best suited to drive environmental improvements linked to production systems and eco-efficiency and where the lead firm seeks to identify the main environmental impacts to be reduced (Khan et al., 2020). Mentoring-driven greening focus on personal interactions between lead-buyers and suppliers and governance are often characterized as being bipolar or multipolar. In this type of greening, actors tend to be mutually dependent on knowledge and skills (Poulsen et al., 2016; Khan et al.,

2020). Here, the lead firm usually expresses leadership in environmental knowledge, while the suppliers usually hold the technical knowledge (Poulsen et al., 2016). The primary tool used by the lead firm in the value chain is design and product specifications, enabling their suppliers to improve their environmental performance and thus reduce their environmental impacts (De Marchi et al., 2013b). Mentoring-driven greening processes can be linked to deep engagement. Deep engagement happens when buyers provide technical support and engagement with their suppliers to reduce the environmental impacts of a final product, when standards are not available or when the suppliers do not have the capacity to comply with them (Khan et al., 2020).

3.2.1 Drivers and barriers of EnvU

Previous literature on GVC and EnvU identify several external and internal drivers. External drivers of EnvU are associated with market demands, stakeholder requests, regulations, collaboration with value chain partners, buyer-demand, the institutional context in which firms are embedded, pressure for social society and technologies (De Marchi & Di Maria, 2019; Poulsen et al., 2016; Khan et al., 2020). While external drivers focus on the dimensions outside the GVC actors, internal drivers emphasise the forces from within GVC actors. Internal drivers of EnvU relates to proactive leadership, corporate culture and values, reputation, new market opportunities, operational improvements, and cost-optimizing measures (De Marchi & Di Maria, 2019; Poulsen et al., 2016). These are factors lead firms and suppliers grasp to meet their strategic choices, including increased efficiency and reducing energy consumption (Khan et al., 2020). For the shipping industry, the literature identifies fuels savings and energy prices as important internal drivers for EnvU (Poulsen et al., 2018b; Khan et al., 2020). Linking drivers of EnvU and governance, existing research suggests that EnvU are more likely to occur in GVCs with unipolar governance (the lead firm play a dominant role in shaping the GVC), where the lead firm is customer-facing with a high level of reputational risk (Khan et al., 2020; Poulsen et al., 2016).

The external and internal forces of EnvU are in the context of this thesis organized into the dimensions of; politics and regulations; market and societal pressure; and innovation, technology and adaptability.

3.2.1.1 Politics and regulations

Politics and regulations are essential external drivers for EnvU. Here, politics refer to activities associated with a country or region's government, including governmental decisions and how these decisions are made (Heywood, 2004). For green transitions to happen, it is important that governments and governing institutions emphasise long-term perspectives and regulations, as this provides actors important guidance (Rogge & Reichardt, 2016). Furthermore, environmental regulations are essential in this context, which is understood as governmental legislation (laws, acts) and standards focusing on reducing environmental impacts from an industry (Rennings & Rammer, 2011).

Global regulations are essential for shaping and directing innovation and change within GVCs (Gereffi et al., 2005). Innovation processes in GVC contributing to EnvU require multi-faced policy interventions and a policy mix. Policy-mix refers to using a combination of political instruments and the processes in which these instruments emerge and interact (Rogge & Reichardt, 2016). Regulatory instruments in a policy-mix facilitating sustainable transitions refer to concrete tools or technique of governance to achieve objectives introduced by a governing body (Rogge & Reichardt, 2016). Governments and organizations may approve stronger regulations to push firms and industries to adopt environmentally friendly processes and products. Regulations can also influence sustainability investments by adopting MBMs (De Marchi & Di Maria, 2019). In shipping, MBMs relate to taxes, incentives, and green shipping practices and is based on economic incentives to achieve more sustainable pollution control. MBMs works in two ways, to discourage the use of high-emission fuels and encourage the adoption of low-emissions activities (Serra & Fancello, 2020). For shipping, international regulatory instruments from IMO on GHG, SO_x, NO_x and other emissions are means of achieving EnvU in the industry (Poulsen et al., 2016). Moreover, regulatory instruments can also be used in combination, distinguishing between core instruments and complementary instruments (Rogge & Reichardt, 2016). For example, in shipping, MARPOL 73/78 act as core instruments, supplemented by complementary instruments. Regulatory instruments steering the shipping industry can also act as a barrier for EnvU when being too fragmented and uncertain (Poulsen et al., 2016).

3.2.1.2: Market and societal pressure

In addition to politics and regulations, market and societal pressure are important external drivers of EnvU. Market and societal pressure contribute to firms producing more sustainable

products or processes, and the societal pressure increases the demand for greener products. This opens up new market opportunities for firms to modify their current operations or develop new greener products or processes (De Marchi & Di Maria, 2019). EnvU does not only open up new market opportunities for firms in GVC, but it can also transform the market in which firms compete (De Marchi et al., 2013a).

Cooperation in GVCs is important in developing green practices, innovation and EnvU (De Marchi et al., 2013b). Cooperation act as an essential external driver for EnvU, as cooperation is vital to ensure the input of eco-friendly components, which may not be available on the market. Cooperation with external partners is important in R&D sectors and for radical innovations and environmental knowledge (De Marchi, 2012). By facilitating collaborative fora, actors within the value chain can educate and encourage each other towards more environmentally friendly solutions and improvements (Poulsen et al., 2016). Literature on EnvU also suggests that early movers (those who are first in implementing EnvU strategies, new technologies etc.) can have a competitive advantage and benefit from EnvU. However, when most or all firms do the same, competitive pressure will not have financial benefits for suppliers. When EnvU becomes more widespread, the early movers or front runners lose their competitive advantage (Khan et al., 2020).

EnvU trends have increased simultaneously with increased consumer awareness and the power of civil society to push the processes of more sustainable industries and highlight the implications of production and transportation of goods (Poulsen et al., 2018b). Moreover, increased consumer awareness of the environmental impacts of production and transportation forces corporate actors within a value chain to assess and address the environmental impacts of their activities. The pressure of doing this usually comes from campaigns, actions by NGOs (Non-governmental organizations) and other civil society groups. The increasing fragmentation of production poses specific challenges to actors within the value chain seeking to reduce their environmental footprint (Poulsen et al., 2016). When including EnvU and sustainability into the value chain of shipping, it can transform the business of operation, and provide new opportunities, value creation and competitiveness for shipping companies (Poulsen et al., 2016).

3.2.1.3: Innovation, technology and adaptability

Innovation, technological development and adaptability (firms' ability to adapt to EnvU processes) are essential for EnvU. Innovation can be perceived as a learning process (Dicken,

2015, p.106) and putting ideas into practice (Lema et al., 2019). Technological innovations refer to new solutions or process improvements and new materials that improve environmental impacts (De Marchi & Di Maria, 2019).

Innovation is not a linear process but involves continuity requiring investments into capital assets, new technologies, certification system and human resources, which can be challenging for some firms in GVCs (Lema et al., 2019; Khan et al., 2020). In relation to upgrading trajectories in GVCs, Lema et al. (2019, p.5) argue that there is no overlap between upgrading and innovation, but that these concepts are distinct, originated in different analytical contexts. The processes of environmental upgrading can be perceived as an innovation process, where new technologies or organizational knowledge are produced or applied by a firm to achieve environmental goals. To achieve these environmentally friendly improvements, a strong collaboration is necessary between and with the actors of the respective value chain (De Marchi & Di Maria, 2019). Technologies and innovation processes need to be adapted by local conditions, which can only be done through local expertise (Khattak et al., 2015). Here, mutual learning and knowledge sharing is essential for innovation (Lema et al., 2019).

Upgrading, in its traditional forms, in GVCs happens as a result of learning and innovation, resulting from firm interactions and influenced by GVC governance structures (Khattak et al., 2015). For GVCs aiming to EnvU, national governance structures matter. Innovation and technology development requires the presence of environmental regulations and policies, which are properly enforced (Glachant et al., 2013). Examples of this can be carbon-taxes, emissions standards, and international cap of emissions. Furthermore, "creating demand for green technologies via environmental policies inducing pollution abatement and environmental protection is a prerequisite for green innovation and technology diffusion" (Glachant et al., 2013, p.7), which show the importance of politics and regulations facilitating green transitions in GVCs. GVC literature further assumes that innovation cycles can create competitive advantage and drive national development (Goger, 2013) and EnvU. Moreover, supplier in GVC often engages in EnvU and its innovation processes to "remain in the game" (Khan et al., 2020, p.773).

For adaptability, firms in GVCs differ in terms of their ability to absorb, master and adapt to innovation and technology development (Lema et al., 2019). Furthermore, the level of adaptability of firms in GVCs depends on financial support. EnvU cannot be achieved without considering the need to make sure of financial viability (Khan et al., 2020).

3.3: Theoretical proposition

I now turn to present a proposition of critical theoretical concepts used as an analytical framework for analysing and discussing the proposed research challenge. The following theoretical proposition is derived from the theory presented in chapter 3 and the literature review and background on shipping presented in chapter 2. While this thesis' analysis and discussion draw on all the proposed theoretical framework above, some elements of GVC and EnvU are of higher importance.

I will first turn to the identified internal and external drivers for EnvU, presented in the subchapters of 3.2.1. The analytical framework will draw on concepts such as value chain cooperation, external societal pressure, and market demand to show the positive implications this has on learning and knowledge sharing within the value chain. It is expected that this thesis will show that EnvU is likely to happen in value chains characterised by strong collaboration, where the market facilitates adaptability and long-term investments in green technologies and where societal pressure act as an essential incentive to go green. Moreover, the analytical framework will also draw on the presented theory on politics and regulations, connected to section 2.1.1, to show the importance of this on EnvU in GVCs. It is expected to show that international regulatory structures act as essential for EnvU and that regulatory instruments used in a policy-mix will drive emissions reduction and facilitate innovation. Due to the complexity of the shipping industry, it is also expected that for regulatory instruments to work as means to archive EnvU, they must emphasise long-term perspectives and "hit" the whole industry fairly, leaving out regional regulatory patchwork. Theory on innovation, technology and adaptability will also highlight some of the most pressing issues in which the shipping industry must face. Theory on innovation and technology will highlight the importance of "front-runners" in EnvU processes while also emphasise the challenges related to this. It is expected that this thesis will show innovation not as a linear process but as a continuous process involving vertical interactions.

Lastly, GVC governance structures will be expanded to emphasise the importance of national and international bodies in stimulating innovation and EnvU within shipping. It is expected that shipping involved several governance typologies (presented in Table 4), characterized by interactions between these governance structures. Highlighting national embedded structures

of governance on EnvU in GVCs, this thesis is expected to show the importance of these structures on cooperation, knowledge transfer and innovation.

Chapter 4: Research methodology

The following chapter aims to describe and discuss the chosen research methodology applied in the context of this thesis. First, this chapter will present and discuss the chosen research approach and its appropriateness. Thereafter, the data collection methods will be presented, followed by the analysis method. From there on, the quality of the research design will be discussed, followed by limitations. Lastly, ethical considerations will be presented and discussed.

During my time at NTNU, I got the opportunity to conduct an internship at SINTEF Digital in the fall of 2020, connected to their GREENFLEET project. This provided me with an excellent opportunity to learn and discuss the greening processes within the shipping industry, and my interest in green transitions in global industries started. During my internship, I got the opportunity to attend meetings and seminars and while the internship provided immense knowledge, I also understood the complexities involved in greening processes. I started to ask how EnvU can occur in this industry, thus becoming more sustainable, which brought me to dig deeper into Norwegian short-sea shipping. This master thesis is done as a part of a SINTEF-led project, submitted and approved by NSD (Norwegian Centre for Researched Data).

4.1: Research approach

There are multiple appropriate research methodologies available when researching how value chains can improve their environmental footprints and reduce GHG emissions. Concerning the specific research question of this thesis, a qualitative case study with a triangulated data collection is chosen as the most appropriate research design.

Qualitative research allows for a deep understanding of a topic or a phenomenon. It recognizes parts of the world as they are being experienced and understood (Crang & Cook, 2007), which provides an inductive approach to linking theory and data together (Bryman, 2012). However, qualitative research also involves specific issues. According to Bryman (2012, p.405), it can be perceived as more subjective due to personal involvement, affecting the subjectiveness of interpretations and analysis. I have, during this process, been observant of this and have tried to be as objective as possible. Furthermore, qualitative research tends to be more challenging to replicate and involve a lower degree of transparency (Bryman, 2012). The difficulties replicating qualitative studies, especially related to this thesis, can be linked to the shifting nature of the researched phenomena. When studying global industries, such as shipping, one

needs to consider the shifting nature when doing the research, and this is also why qualitative research is essential. The world is constantly shifting and changing, the global economy changes, global issues change, and some issues are becoming more pressing. One such issue is the environment.

This thesis is based on a case study, defined as an "empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." (Yin, 2003, p.13). This involves intensive research into a single to comprehend and transfer the understanding of a larger class of related units (Gerring, 2004, p.342, in Hay, 2016, p.130). Generally, case studies investigate the "how", "why", and "what" of complex phenomena (Yin, 2003). Compared to qualitative studies, where statistical generalization is important, qualitative case studies aim to analyse a phenomenon or to develop theory (Hay, 2016). In this thesis, case study is the most appropriate research strategy due to its qualities of investigating complex phenomena and its explanatory nature. By looking at Norwegian short-sea shipping as a case, one can gain a broader understanding of the complexities of EnvU and how the industry works towards sustainability issues. The process of EnvU in Norwegian short-sea shipping contributes to the understanding of how the industry can tackle environmental issues and how this affects this industry in the present and future.

Furthermore, researching this case can further explain how the whole shipping industry can develop in terms of new technologies and solutions. Hay (2016, p.141) highlights how a phenomenon may differ from one case to the next due to its geographical placement. This is also the case for environmental upgrading in short-sea shipping due to the importance of national climate policies, regulations, and visions. The national policies, goals and regulations change from country to country. Even though the shipping industry are under international regulations from IMO, the specific countries have different targets regarding sustainability.

Moreover, this thesis is based on triangulation, which refers to using more than one data collection method or source of data to develop a comprehensive understanding of a complex phenomenon (Serra & Fancello, 2020; Bryman, 2012). Examining collected information through different methods can reduce potential biases, which can occur when using one method (Bowen, 2009). This thesis has used semi-structured interviews triangulated with secondary data sources. Doing so allows for an improved validity of the research (Yin, 2003). Furthermore, triangulations allow for more in-depth research into the complex and versatile nature of EnvU in Norwegian short-sea shipping and provides a more thorough understanding of the phenomenon and dimensions of EnvU.

4.2: Data collection

This thesis employs both primary and secondary sources of data collection. The primary data was collected through nine semi-structured interviews between January and Mach 2021 with representatives from the Norwegian short-sea shipping industry, including governmental, private-public organizations and shipping companies. Due to COVID-19, all the interviews were conducted over digital platforms, such as Microsoft Teams, due to travel and meeting restrictions. The secondary data was collected through a diverse collection of published sources, such as several reports, Governmental White Paper, news articles, and scientific papers.

4.2.1: Semi-structured interviews

When studying complex topics, semi-structured interviews provide a lot of possibilities (Galletta, 2013). These interviews allow the opportunity to ask specific questions related to the studied phenomenon while also leaving space for new perspectives. They include some degree of a predetermined order for the questions, and flexibility regarding time and the order, while also providing the possibility to ask additional questions (Hay, 2016; Bryman, 2012; Galletta, 2013). Semi-structured interviews allow more in-depth questions throughout the interviews and are not strictly dependent on a detailed interview guide that allows flexibility. The semi-structured interviews have been used in this thesis to gain a more comprehensive understanding of the Norwegian short-sea shipping industry and have been especially important to the understanding of the complexity of the case. Furthermore, the semi-structured interviews have provided an insight into contrasting individual interpretations of the drivers and barriers for environmental change within this industry, significant for the analysis.

According to Hay (2016, p.150), interviews are used for four primary purposes; to fill gaps in knowledge: to investigate complex motivations or behaviours, to collect a diversity of meaning, options or experiences, and show respect and empowerment to the people who are being studied. Here, semi-structured interviews were primarily used to fill gaps in knowledge, to collect a diversity of meanings and opinions and to gain an in-depth understanding of the phenomenon of EnvU and short-sea shipping. By interviewing some key actors within the industry, the collected data have provided a deeper insight into the processes of EnvU in Norwegian short-sea shipping. This can be transferred into other parts of the shipping industry and other industries that need to reduce their environmental footprint to meet the demands of the future.

4.2.1.1: Participants and sampling

The sampling of the participants makes up the building block of the research, and some factors are determining the sampling design: time, cost and other practicalities (Galletta, 2013). For this thesis, nine participants were interviewed, representing key actors within Norwegian short-sea shipping. Some hold essential expertise in the field, contributing to a broader understanding of the industry and its value chain, and some represent short-sea shipping companies, contributing to an insight into the complex operations and issues regarding sustainability. Furthermore, these participants understand how the industry is governed and regulated, both internationally and nationally, which is essential for EnvU of the industry. Moreover, the participants represent diversity through the different companies they represent, which provides interesting perspectives regarding the possibilities within Norwegian short-sea shipping and how the future might look like. Table 5 shows an overview of the participants sampled for this these, what kind of actor they represent and how they are coded in the analysis.

Actor	Coded in analysis
Government Ministry	Respondent A
International certification and classification company	Respondent B
Government enterprise	Respondent C
Governmental agency	Respondent D
International certification and classification company	Respondent E
Shipping company, passenger segment	Respondent F
Trade and employment organization	Respondent G
Shipping company, bulk segment	Respondent H
Shipping company, bulk segment	Respondent I

Table 5: Overview of respondents

The participants were sampled through snowball sampling, which in qualitative research refers to accessing participants through contact information provided or identified by others (Hay, 2016; Noy, 2008). By using snowball sampling, I have identified some experts in the field. However, representativeness is not promised, which is critical to have in mind during the sampling. As a preparation for the sampling of participants, I had in mind which actors I was interested in talking to. By having this, I could ensure some degree of representativeness within the industry. In qualitative research, snowball sampling is used to get access to "hidden populations" (Noy, 2008, p.330); however, this is not the case for this thesis. Here, snowball sampling has been used to get access to participants with expert knowledge on the field.

Furthermore, I experienced a higher degree of willingness for participation when contracting participants with a recommendation from other participants.

During the sampling process, I encountered some issues. First, it showed a laborious and time-consuming process to contact possible participants, and because of this, there is a limited sample size. However, the participants hold such knowledge in their field, which minimizes the risks of limited sample size. Second, COVID-19 have had severe implications on companies, which contributed to some actors not having the time or resources to participate in this thesis. However, the pandemic has required interviewing participants over "Microsoft Teams". The effect of being unable to interview the respondents face-to-face is deemed insignificant.

4.2.1.2: Conduction and transcribing the interviews

In preparation for the interviews, an extensive amount of time was used to analyse and study existing literature, news articles and reports on Norwegians short-sea shipping, and knowledge from the SINTEF internship. The gained insight was used as an inspiration for developing the interview guide (Appendix A), and six steering themes for the interviews emerged:

1. The regulatory framework (IMO, international, regional and national regulations)
2. External and internal drivers for EnvU
3. External and internal barriers for EnvU
4. Current EnvU activities within Norwegian short-sea shipping
5. The future for Norwegian short-sea shipping
6. The value chain shipping companies are operating within.

The interview guide was used as a tool for steering the conversation and organized around ordered but flexible questions, in line with semi-structured interviews. Accordingly, this provided the possibility to ask further in-depth questions, which contributed to more profound information on specific emerging themes. However, limited knowledge on the topic can exclude relevant questions, but extensive research done in the preparation process decreases this risk.

Through semi-structured interviews, the information provided by the participants contributed to rich and in-depth information on the phenomenon studied. Due to COVID-19, the interviews were conducted over Microsoft Teams, which were discussed in front of the interviews. This does not take away face-to-face interactions with the participants, which is vital in the relationship between the researcher and the participants. By doing the interviews this way, the

interviewing process did not participate in further spreading the virus, which was important to me during this process. Furthermore, this also allowed me to interview participants in other geographical areas, which contributed to a better representation of participants. I also got the opportunity to talk to participants, which would be harder to talk to in more traditional interviewing methods. Many of the participants are busy people and doing the interviews over Teams allowed for a flexible way of talking to the participants.

Due to the flexible nature of semi-structured interviews, the interviews took on average between 45 minutes and one hour and thirty minutes. During the interviews, I took notes on interesting themes and perspectives for two reasons. First, these notes allowed me to pick up on specific aspects and then further dig into these aspects or perspectives. Second, these notes were also useful in analysing the findings from the interviews, as they provided an overview of relevant themes that the different interviews and participants were focused on. This type of interview also allows the participants to express their views and knowledge more freely. Throughout the interviews, it was important to encourage a free conversation allowing the participants to express their knowledge and options. However, during interviews, one cannot ensure a fully honest conversation, but the risk gets minimized by ensuring anonymity. I also conducted the interviews in Norwegian, which was easier for the participants and contributed to a freer conversation. However, by doing this, coding the interviews became more complicated due to translation errors.

All interviews were transcribed to sort, organize and code the collected data. Transcribing the interviews provides a more thorough examination of the content of the interviews and helps identify possible biases of the researcher (Bryman, 2012). Transcribing the interviews brought me closer to the data and through this allowed for a higher awareness of the similarities and differences between the participants and it was therefore easier to detect key themes. However, the process of transcribing is a time-consuming process, and took far more time than anticipated. As Bryman (2012, p.484) points out, transcribing interviews generate vast amounts of material to be analysed and dealing with this large amount of material it is advised to conduct the process of transcribing simultaneously with the analysis. This was done during the work with this thesis, allowing for a higher degree of awareness of emerging and interesting themes. The generated amount of material to be analysed posed a challenge, as it became easy to "get lost" in the collected data.

During transcribing, I encountered a few problems besides the amount of time and material generated. By doing the interviews over Microsoft Teams due to the ongoing pandemic, I

encountered some technical issues during transcribing. Some interviews were harder and more complicated to transcribe due to unfortunate sound quality such as lack of microphone and background sounds. This shows the importance of good technical equipment during these types of interviews.

4.2.2: Document analysis

This thesis is, as introduced above, based on a triangulated research approach consisting of both interviews and analysis of primary sources retrieved from semi-structured interviews, and the use of secondary data, such as reports, government documents and scientific practices undergird the primary sources. Using document analysis helps to uncover meaning, understandings, and insights into the research question (Bowen, 2009). Furthermore, the selected documents have a high degree of authenticity and credibility, which is essential in assessing the quality of documents (Bryman, 2012) and which increase the credibility of the analysis of this thesis.

Several documents have been selected, such as Governmental papers, White Papers, several reports, new articles, and scientific articles, supporting the primary data. A complete list of the selected documents can be found in Appendix C. These selected documents contribute to furthering the analysis by supporting and validating findings from the primary data and providing additional perspectives that did not occur during the interview.

4.3: Analysis method

Thematic analysis has been chosen as the most appropriate analysis method. This is a common approach when analysing documents, including interview transcripts (Bryman, 2012). Analysing the collected data through thematic analysis provided the opportunity to analyse all the collected data in the same manner, making it easier to detect emerging themes, core aspects and connect the data.

Thematic analysis examines the collected data to extract core themes using coding, which beak the data into parts that are given labels (Bryman, 2012). Making sense of the data, this thesis has primarily used the six steering themes presented in section 4.2.1.2, which have been furthered developed into four analysis dimensions; The Norwegian short-sea shipping industry; politics and regulatory framework; market and societal pressure; and innovation, technology and adaptability. These four dimensions were developed to summarize the overall themes from

the six steering themes and provide helpful insight into the structures influencing EnvU of Norwegian short-sea shipping. Furthermore, these four dimensions also identify and map the main drivers and barriers for EnvU while also understanding the complex nature of their interconnectedness. By organizing the analysis into the four dimensions above, I have identified some of the most urgent issues the industry must tackle to become more sustainable and the main drivers pushing the industry. Furthermore, they also correlated to the presented theoretical framework, providing useful when analysing upgrading trajectories and processes of Norwegian short-sea shipping.

4.4: Quality of the research design

For ant research, it is relevant to discuss the level of validity and reliability. For this specific research design, three conditions are considered to ensure its quality: internal validity, external validity and reliability (Yin, 2003; Bryman, 2012).

Validity is concerned with the integrity of the conclusion generated from a study (Bryman, 2012). Internal validity is concerned with causality (Bryman, 2012, p.47), meaning that the research has managed to make a causal connection from the collected data. The triangulated nature of this thesis increases the internal validity. External validity refers to the level of generalization within the findings (Yin, 2003). This thesis' conclusions can be drawn to generalize how short-sea shipping in other countries, and shipping in general, can achieve EnvU. However, the processes of EnvU are also emphasised out of one specific country conditions.

Reliability, or the degree to which a study can be replicated, is generally rugged in qualitative research (Bryman, 2012), which applies to this study. First, the changing nature of the concepts on which this thesis is built, hence regulation, globalization, climate change and trade, are making replication of this study hard. Second, the shipping companies and their view on environmental upgrading can also change, affecting the external reliability. However, this represents the changing nature of which the world is changing and the shifting paradigms we are experiencing, and therefore it is important to research these topics. Conducting research that contributes to a deeper understanding of precisely the changing paradigm of our contemporary world is important to understand both the present and the future.

4.5: Limitations

The chosen data research approach includes some limitations. Due to this thesis time limits and scope, I have not been able to interview as many participants as I initially wanted. Interviews including more parts of the value chain of Norwegian short-sea shipping would be highly relevant; however, this also requires interviewing more than just one or two additional actors in the value chain, which would require more time. Furthermore, interviewing more shipping companies could have contributed to a higher representation and included important aspects found in other shipping segments.

The document analysis also brings some limitations and weaknesses. First, some documents are not retrievable, which complicates access to information (Bowen, 2009). Here, the selected documents have been retrieved from open sources, but there is always a chance of not including vital information due to limited access to documents or that the documents have been blocked for the public. Second, one can experience some degree of biased selectivity through an incomplete collection of data (Bowen, 2009). By using documents to support findings from the primary data, I have reduced the risk of this. The triangulated nature of this thesis provides a higher degree of robustness to the analysis. Third, there is a lack of research in the field of EnvU in short-sea shipping; however, there is an extensive amount of literature focusing on other development theories that can be connected to EnvU.

4.6: Ethical considerations

When conducting qualitative research, it is essential to include and discuss ethical considerations. Understanding ethical issues and highlighting these issues are important and increase the credibility of the research. For this specific thesis, ethical considerations are mainly concerned with anonymity, consent, harm and COVID-19.

For qualitative research, it is essential to ensure anonymity and be aware of related issues. The anonymity and privacy of the participants need to be respected, and all personal information need to be kept confidential (Bryman, 2012). Ensuring anonymity and privacy to the participants allows a higher degree of a free and honest conversation, which have been vital to me during this process. Due to conducting the interviews over digital platforms, there is a chance that people outside this project could view the recordings. To minimize this risk, I have not transcribed the interviews in public areas, or shared any information, recordings or personal correspondence with anyone outside this project. I have also coded the respondents for the use

of the analysis; however, there is a chance of tracing the participants. This has been discussed with the participants, and I have done all in my power to minimize this risk.

Considerations concerning informed consent have been thoroughly respected. Informed consent is concerned with the principle that the participants have been given as much information as needed about the project, which makes them adequate to decide whether to participate (Bryman, 2012). The participants in this thesis have been informed through a formal consent form (Appendix B) with additional information about the project, the project's aim, what the data will be used for and why. Furthermore, through this consent form, the participants were informed of the possibilities to withdraw their consent to participate in this project, which they could do at any time without justification. Due to the ongoing pandemic, the participant gave oral consent in front of the interviews, which was discussed and agreed with the participants. Doing this allows for and consider that the participants could be sitting in home-office without the possibility to print out, sign and scan a consent form. The formal consent form was submitted and approved by NSD.

Chapter 5: Analysis

The following chapter will present the findings from the nine semi-structured interviews and associated secondary literature. These findings will be presented within the four dimensions presented in section 4.3; Norwegian short-sea shipping; politics and regulatory framework; market and societal pressure; and innovation, technology and adaptability. However, distinguishing between these aspects is challenging, as they affect each other to a great extent, which this analysis will show. This highlights the complexity of achieving EnvU in Norwegian short-sea shipping.

Remembering the definition of EnvU from chapter 3, the following analysis focuses on identifying some of the main drivers and barriers associated with EnvU in the industry. By doing so, this analysis provides an overview of the main challenges Norwegian short-sea shipping needs to tackle to become more sustainable. Furthermore, this analysis provides important insight into the power and governance dimensions of the value chain of Norwegian short-sea shipping, which further can contribute to examining how this industry is organized and how it can meet and tackle sustainability issues.

5.1: Norwegian short-sea shipping

Conceptualizing EnvU processes, it is important to take some steps back to Norwegian short-sea shipping. Due to Norwegian short-sea shipping's complexity and international nature, it became evident that there are a number of different drivers and barriers influencing EnvU of this industry. These drivers and barriers push (or pull) the industry into developing and implementing solutions reducing GHG emissions, thus contributing or delaying EnvU.

GVCs enables Norwegian short-sea shipping to happen. Short-sea shipping has been and still is important in meeting the commercial transportation needs in Norway and Europe, and for the competitiveness of Norwegian industries (Norwegian Shipowners' Association, 2019). Norwegian short-sea shipping is a part of a larger maritime sector, where ships are produced, for example, in South-East Asia, used for their purpose in Norway, and then sold out into other maritime markets, ending up in recycling facilities. The lifespan of shipping vessels shows us that Norwegian short-sea shipping contributes to value creation in a far bigger perspective than Norwegian short-sea shipping alone.

5.1.1: The value chain and value chain cooperation

Norway has a complete maritime cluster, representing all parts of the value chain (Meld. St. 10 (2020 – 2021)). My findings suggest that this has been especially important and will be essential for future development of Norwegian short-sea shipping. Through a strong maritime cluster involving actors from all parts of the value chain, the prerequisites for innovation and collaboration are good. The value chain of the Norwegian maritime sector can be divided into six main categories, highlighted in Figure 8:

Figure 7 The Norwegian maritime value chain. Source: Mäkitie et al., 2020:

Traditionally, the Norwegian maritime cluster has been characterized by strong interdependencies between value chain actors, emphasising innovation and entrepreneurship (Benito et al., 2003). Cooperation has been and still is important to increase the competitive advantage for Norwegian actors. Respondent G argues in this regard that Norway would not have had such a strong international maritime position if not for a flat hierarchical system, interdependency, and short distances between actors in the value chain. Respondent G further argues:

> "I think it is the clusters that have made us successful. The number of clusters and that they also have talked to each other, have made something completely ground-breaking and unique in Norway".

Respondent B support this by arguing that cooperation within the value chain has led to a high degree of learning related to technologies and environmental issues. This will also be important in the future as "if everyone has to invent the gun-powder themselves, things will take a long time" (respondent B). Respondent C highlights this:

> "The actors collaborate when they can, and compete when they have to, so that you have good clusters and arenas to use the competence that is developed".

My findings suggest that many different types of actors along the entire value chain are essential for EnvU, such as governments, financial institutions, technology developers, cargo-owners,

shipping companies and customers. These actors play an important role in the development of the industry, but they also involve different degrees of importance. This will be further discussed in section 6.2. However, my findings also suggest that when these actors cooperate, they facilitate and drive EnvU. For EnvU, it is important to see the totality in development projects, thus simultaneously develop the whole value chain (respondent C). Looking at isolated actors playing a role to develop the industry exclude important aspects and leave may out significant information related to EnvU.

5.1.2: Segmental differences

My findings suggest that several EnvU aspects are general for the whole industry. However, it is also evident that segments such as bulk and passenger, into which this thesis provides a more detailed insight, involve specific challenges and opportunities connected to EnvU dimensions. Generally, the industry faces challenges related to regulations on emission reduction, availability and price of alternative fuel, access to capital and fleet renewal.

The different segments are characterized by their room of manoeuvrability and level of adaptability. This is linked primarily to the profitability and predictability of the segment, which is highly dependent on the market in which the segment is operating (Meld. St. 10 (2020-2021)). My findings suggest that the bulk segment is characterized by low profitability, high competition, and low predictability, which in many cases are due to short-term contracts (DNV GL, 2018; Meld. St. 10 (2020-20201)). Furthermore, Norwegian short-sea shipping is also characterized by strong competition, both from Norwegian and European actors. The industry also meets competition from road and transport (Meld. St. 10 (2020-2021)), and the passenger segment is under considerable competition from air transport.

5.2: Politics and regulatory framework

The political and regulatory framework constituting the basis for Norwegian short-sea shipping is essential for developing a more sustainable industry. The impacts on EnvU from politics and regulations will be further discussed in section 6.1.1. During my data collection, interesting perspective emerged, categorized into “policies and regulations on emissions reduction” and “politics and regulations supporting innovation”. By distinguishing between the two, this analysis emphasises their particular importance on EnvU.

5.2.1: Policies and regulations on emission reduction

Policies and regulations governing emissions in Norwegian short-sea shipping are established by either the Norwegian Government (national level), the EU (regional level) or IMO (international level).

Norwegian short-sea shipping is under increasing pressure to reduce its GHG emission, and one way to facilitate this is through regulatory instruments. IMO has put emissions regulations on the shipping industry through MARPOL 73/78, including IMOs Initial Strategy for Reducing GHG Emissions and IMO 2020 (IMO, 2013). Furthermore, IMO have set limitations on SO_x, NO_x and PM emissions and developed indexes for energy-efficiency (EEDI and SEEMP) (Čampara et al., 2018; IMO, 2020b). My findings suggest that indexes set by IMO, such as EEDI and SEEMP, pose a challenge for segments lacking reference data. Respondent I argues:

> "It is a challenge that they do not know which indexes they want to benchmark […] There is no one in short-sea shipping that has statistics from 2008, how are you going to have a benchmark and make accounts for emission reduction and an improvement when you do not have references in the first place?"

At a national level, the Norwegian Government has developed a national CO_2 taxing system to make less energy-efficient solutions more expensive, thus steering the industry in a sustainable direction (Helseth et al., 2021). Domestic shipping was estimated to contribute to 2.95 million tonnes equivalents (CO_2-eq) in 2017 (Norwegian Government, 2019), but there is a great deal of uncertainty linked to these numbers. This uncertainly is linked to ships bunkering abroad due to lower tax levels (respondent G). Emissions from domestic emissions are calculated from the sale of fuels registered in Norway (Helseth et al., 2021). These vessels will to a small extent, be affected by the Norwegian CO_2 tax. Respondent I, representing the bulk segment, argues that higher costs through taxes can kill the Norwegian districts and industries along the coast due to higher costs for the shipping companies. A CO_2 tax that only hit the Norwegian market can decrease the international competitiveness of Norwegian shipping companies and contribute to international competition taking over the market (respondent G). Respondent G further argues:

> "We as a union are eager for an international CO_2 tax, because we see that it is the way to go to get more parts of the industry into new technologies and also the way to go to make them more energy-efficient".

Several of my respondents and associated literature (DNV GL, 2018) argues that a solution could be developing a CO_2 fund, through IMO, which could be channelled back into the industry, encouraging R&D and thus contributing to EnvU. This has been done, on a national level, with the NO_x-fund. The model of the Norwegian NO_x-fund involves companies paying per kilo NO_x emitted, in turn funding the industry and projects aiming at reducing the NO_x emissions (respondent H and G). According to my data, this model can be applied to a CO_2-fund, which is the desirable way to go. Such a CO_2-fund needs to involve all transportation, such as cars, trucks, busses, shipping, and air transportation (DNV GL, 2018), stimulating EnvU across transportation sectors.

5.2.1.1: Common and fair regulations

My findings clearly show a need for common, fair, and just international emission regulations, initiated and followed up by IMO. National regulations on emissions reduction can reduce the competitiveness for Norwegian short-sea shipping companies (DNV GL, 2018), create suboptimal solutions for shipping operations (respondent F) and move industries and production out of Norway (respondent I). Therefore, such regulations should be developed internationally. However, my findings also show that this is a challenging task. Respondent B argues that fair regulations which treat everyone equally are essential, but that the decision-making processes of IMO complicate the development of this. IMO consist of 174 Member States and as respondent A argues:

> "Those countries will agree on something. It is also clear that in some areas, progress is fast and other times, progress is slower. It is quite simply the case that the countries have different starting points, want different things, and it is also the case that countries have historically prioritized climate and environmental issues very different".

The EU is also putting pressure on the shipping industry. Respondent G argues that the EU is waiting on IMO to come to solutions, and if they do not come up with these solutions, the EU will come in and regulate the market concerning emission reductions. One positive side of having regional regulations through the EU is that they can stimulate IMO to easier come to solutions (respondent A). However, respondent G argues:

> "For shipping in general, there are few things that are so tricky to deal with as such regulatory patches. This creates obstacles for free movement in the market, which one depends on in order to be able to operate in a good way".

5.2.1.2: Both a driver and a barrier

It is evident that politics and regulation on emission reduction act as both drivers and barriers for EnvU. Respondent C and F argue that new requirements, regulations, and regulatory tightening are strong drivers for shipping companies to change their operations. Moreover, policies aiming to reduce emissions also facilitate incremental innovations (Mäkitie et al., 2020). Politics and regulations on emission reductions can also be a hindrance for EnvU. This is especially the case for regulations that are uncertain, fragmented or too complex for companies to comply with, which have been the case for shipping in the past years (Poulsen et al., 2016).

However, this is changing. There seems to be increased emphasis on regulations aiming at reducing GHG emissions and a change in the structures of these regulations. In a national context, the Norwegian Government, for the first time in 16 years, published a White Paper on the Norwegian maritime industry focusing on the future of the Norwegian maritime industry regarding sustainability and Governmental targets regarding environmental regulations (Meld. St. 10 (2020-2021)). Respondent I argue that they have experienced a vacuum from 2009 but that things are now changing. This is important to Norwegian short-sea shipping, but as respondent A argues:

> "We are too slow in IMO, we are too slow in the EU, and we are too slow in Norway, and the industry is overdue. Everyone is overdue in relation to solving the problems we face".

As sustainability has become a major political concern, there is an increased number of environmental driven regulations (UNCTAD, 2019), which drive innovation and put pressure on the industry to achieve results on environmental issues. However, additional costs are linked to meeting new environmental regulations and demand (Poulsen et al., 2016), which pose financial challenges for shipping companies.

5.2.2: Politics and regulations supporting innovation

Contrasting politics and regulations on emissions reduction, politics and regulations supporting innovations focus more on the frameworks which drive innovations and sustainability in Norwegian short-sea shipping. Here, the state apparatus has developed and set in motion

programs, such as Green Shipping Program (GSP) and PILOT-E, aiming to support innovations within the value chain and thus contribute to achieving EnvU for Norwegian short-sea shipping.

GSP is a partnership program consisting of private and public actors, working as an effective tool for implementing governmental strategies. GSP started as "Grønt Kystfartsprogram" in 2015 consisting of 16 private companies and organizations and two Norwegian Ministries. In 2019, they changed the name to GSP, and today, 51 private companies and organisations and ten public observers are included (Grønt Skipsfartsprogram, n.d). GSP includes the whole value chain, from shipping companies, cargo-owners, government, and technology developers and carries out projects to test different theories, types of technologies and green solutions (respondent B). Respondent E highlights that GSP act as an accelerator for adopting green solutions within the Norwegian shipping industry. Many of the respondents highlight the importance of GSP for Norwegian short-sea shipping and the development of a more sustainable industry. As respondent G presents:

> "you do not sit on your own stone somewhere having a good idea, you sit and share it with completely different actors with different perspectives. This results in great ideas and interesting discussions which other actors can further develop and implement."

GSP stimulates cooperation and innovation within Norwegian short sea shipping and, through this act as an essential driver to decrease the environmental footprints of the whole value chain.

Another important instrument supporting innovation is PILOT-E. PILOT-E is a founding scheme developed by ENOVA, the Research Council and Innovation Norway, aiming at developing new, environmentally friendly, and competitive technologies and solutions and bring projects faster from idea to the market (Forskningsrådet, 2021). Respondent C presents that the investment support given by PILOT-E works as a risk-reliever for projects targeting innovation and realisation of new technologies. Furthermore, respondent C highlights that these technologies usually have a higher cost than conventional technology, and financial support are often needed to invest in those solutions. This financial support can be granted through PILOT-E. Through PILOT-E, actors can gather, and projects can be approved in all stages, from research to commercialization (respondent C and G). Respondent C highlights the importance of PILOT-E for driving cooperation and innovation:

> "We have also seen that by doing it that way, the actors have an easier time finding each other in good collaborative consultations, which means that you move the development faster than you otherwise would have achieved".

Furthermore, programs such as GSP and PILOT-E are also important in developing national policies and regulations. Innovation and technology must be approved for the use of ships, which is often a challenge. Through these programs, the industry can show that technologies are feasible, thus developing national regulations and policies aimed at these technologies.

However, many of the smaller companies operating in Norwegian short-sea shipping lack knowledge and resources required for applying for funding of internal low-and zero-emission projects. Applying for support from Norwegian support instruments can be perceived as resource-intensive and bureaucratic, consisting of too long and complicated processes (DNV GL, 2018).

5.3: Market and societal pressure

By supporting innovation through politics and regulations simultaneously as reducing emissions are important for driving EnvU. Nevertheless, the market in which Norwegian short-sea actors operating in, also plays an essential role. Politics and regulations facilitate and set the conditions for market structures. The following section of the analysis will present significant findings connected to the market and societal pressure.

5.3.1: Higher focus on the environment

The market of Norwegian short-sea shipping is influenced by its surrounding society and the general public high focus on environmental issues. Social awareness puts pressure on industries to adopt greener solutions. This pressure can be linked to various stakeholders, such as institutions, customers, citizens, and investors. For shipping in general, customers and stakeholders demand for green solutions can be characterized as a strong driver for innovation and the adoption of more environmentally friendly practices (Serra & Fancello, 2020).

My findings suggest that a higher focus on environmental issues varies from one shipping segment to another. In the passenger segment, high proximity to the passengers contributes to a high level of awareness of minimum environmental footprint. Respondent F highlights this by arguing that guest's expectations, which are the ones who in practice pay for their shipping operations, are essential. Suppose the guest think that the company contributes to high levels of pollutions. In that case, they may become negative to travel with the company and therefore,

they need to have good environmental strategies and communicate this to their customers (Respondent F).

In the bulk segment, a higher awareness of environmental issues can be seen in an increased focus from cargo-owners contributing to lowering the emission from the segment. Traditionally, the cargo-owners in the bulk segment have been focused more or less exclusively on price, but the industry is now seeing a change in this focus (Respondent A). Cargo-owners are now calling for more environmentally friendly solutions when transporting their goods. One example is from Heidelberg Cement (cargo-owner transporting rocks from east to west in Norway) and Felleskjøet (cargo-owner transporting grain from west to east in Norway), which joined forces with GSP in ordering a fossil-free vessel (Stensvold, 2021a). When the cargo-owners demand more environmentally friendly solutions, the market complies with these demands (Respondent G). Respondent G further argues:

> "But there must be a market for it and there must be long-term obligations, or you will not find it profitable".

The society surrounding us and the increased focus on climate do not only act as a driver for EnvU for the passenger and bulk segment but also highlighted as an important driver across Norwegian short-sea shipping (Respondent B, C and F). Respondent B argues that societal pressure contributes to investors wanting to have a greener portfolio. When desiring this, they will invest in green companies, which again will act as an incentive for companies to go green. Incentives such as this open up to innovations aiming at decreasing the environmental footprint of the shipping industry.

5.3.2: Competition and competitive advantage

The market of Norwegian short-sea shipping is under strong competition from other means of transportations, such as road, railroad, and air, which has increased in the last years (Meld. St. 10 (2020-2021)). These means of transportation are essential for shipping, for transport goods to and from ports. Moreover, actors in Norwegian short-sea shipping are also under considerable competition from European and international actors. Respondent H, representing the bulk segment, argues here:

> "We are in a market and a segment that has great competition, it is not only from Norwegian actors, but also European and international actors".

International competition makes it harder to set national barriers on the industry as this will weaken the international competition and the competitiveness of those companies operating internationally (respondent E). Norwegian short-sea shipping and its value chain are embedded both in national and international conditions, meaning that the segment's operating within this thesis defined context of Norwegian short-sea shipping is subject to more EnvU barriers compared to coastal shipping. Companies operating internationally are not only affected by Norwegian conditions but are also under pressure from international conditions such as international regulations on emission control (DNV GL, 2018). Respondent E argues that participating in international short-sea shipping involves strong international competition, making it hard to set strict national emissions reduction tools. National regulations aiming at reducing national emissions from shipping by increasing, for example, the cost can contribute to lower international competition and competitiveness for Norwegian short-sea shipping companies (respondent E).

Companies having proactive environmental strategies gain competitive advantages, thus financial revenues (Caniëls et al., 2016). When contributing to the development of green practices in Norwegians short-sea shipping, shipping companies can gain economic opportunities. Respondent B presents that having a low environmental footprint brings considerable competitive advantage to the shipping companies. However, green ships have low profitability as investments in green technology and solutions are expensive.

5.3.3: Length of commercial contracts

The length of commercial contracts between cargo-owners and shipping companies are an important factor for achieving EnvU. Traditionally, the length of commercial contracts between cargo-owners and shipping companies has in some segments of Norwegians short-sea shipping been characterized by short-time horizons (respondent A and C). Respondent C argues that the barriers related to the length of commercial contracts are more prominent for segments that have low earnings per voyage or per assignment, therefore, especially relevant for the bulk segment.

The bulk segment operates with four types of contracts; time-charter, spot-charter; bill of landing; and contracts of affreightment. The type of contract determines who pays for the fuel; for example, in time-charter, the cargo-owner usually pays for the fuel, while in contracts of affreightments, the shipping company pays for the fuels used. In the cases where the cargo-

owners pay for the fuel, the incentives for investments in energy-efficient and low-and zero-emission solutions are lower due to the difficulties of calculating direct financial returns from fuel savings or emission reduction (DNV GL, 2018). The respondents highlighted contracts of affreightment as common for the Norwegian bulk segment. The risk associated with these latter types of contracts is that if the customer's production drops or decreases, the shipping company would have less goods to transport, putting the shipping company at risk of low profitability (respondent H). As highlighted by respondent C, it is difficult to make investments that will earn you money in the long run if you do not know how long you have a contact or assignment. Respondent H, representing the bulk segment, argues:

> "It is clear that we represent an industry and a segment that is traditionally and historically a so-called low-margin industry, and that does not exactly make things easier".

Short contracts equal low predictability for shipping companies (Meld. St. 1(2020-2021)). Generally, longer contracts for shipping companies increase the probability to be granted loans from banks and financial institutions (Fjose et al., 2020). Respondents H and I, both representing the bulk segment, highlight this, arguing that financial institutions prefer that clients have long-term contracts and thus predictable income. Banks are usually sceptical of granting loans when shipping companies operate with short contracts, as these contracts do not provide enough security for the bank in terms of future income levels (Fjose et al., 2020). Respondent G highlights the importance of having longer contracts, arguing that long-term obligations and contracts with cargo-owners provide the ability to gain more capital for shipping companies, which can be used to invest in greener and more energy-efficient solutions.

Longer contracts have significant financial benefits and provide incentives to invest in greener solutions, thus driving EnvU. My findings suggest a movement within clients and cargo-owners, from being focused exclusively on price, to emphasising environmental issues, resulting in an increased focus and attention on longer commercial contracts (respondent H and G). This increased attention to the length of contracts is evident within the bulk segment (respondent C, H and G). This higher emphasis correlated to the increased attention on environmental issues within the market and general society.

5.3.4: COVID-19

Norwegian maritime industry is cyclical and affected by economic fluctuations within the market. From a historical perspective, the industry has had cycles with strong growth followed by recessions due to fall in global economy and declining demand for shipping. Previously, the maritime industry has experienced recessions during the financial crisis of 2008-2009 and the fall in oil prices in 2014-2015 (Meld. St. 10 (2020-2021)) and now, the COVID-19 pandemic.

COVID-19 have had implications on the whole Norwegian maritime industry with reduced economic activity resulting in lower demand for shipping services, national and international infection control and operational challenges linked to crew changes, access to foreign workers and ports and temporary leaves for employers (Meld. St. 10 (2020-2021)). The implication of COVID-19 differs depending on the shipping segments, where the passenger segment, in particular, has felt the consequences of the pandemic. In 2020, moving into 2021, the pandemic more or less stopped the passenger segment from operating between Norway and Europe. Companies saw a significant drop in revenue (respondent G), resulting in a high number of temporary leaves and ships in storage (Meld. St. 10 (2020-2021)). Respondent F, representing the passenger segment, highlights that they only have 3 of 7 ships operating in February 2021, which has significant consequences on their revenues. Respondent F further argues that the pandemic has decreased their opportunity space, which have implications on their ability to invest in green solutions. Compared to the passenger segment, the bulk has not experienced the same negative implications from the pandemic. Respondent I, representing the bulk segment, argues that they have experienced challenges in terms of the crew and dialogue with ports and the implications of maintaining safe distances between people.

The data suggest that the long-term implications of COVID-19 are hard to predict. However, the decreases in economic activity have negatively impacted the whole maritime value chain (Meld. St. 10 (2020-2021)), which can have both short-term and long-term implications. Respondent I argues that the long-run implication of COVID-19 linked to how the Norwegian Government speed up the economy after the pandemic, meaning how the Government tackle the aftermath can either speed up or sink sustainable development of Norwegian short-sea shipping.

5.4: Innovation, technology, and adaptability

Norwegian short-sea shipping and its segments are characterized by an aging fleet, low profitability, low margins, high competition, and lack of incentives to go green. These factors influence the adaptability and transformation into new technologies and innovations. Adaptability is linked to the actors in the value chain's ability to adapt new technologies and environmental solutions. Innovation, technology and adaptability are essential for driving EnvU in Norwegian short-sea shipping; however, it is important that the market invest capital into R&D and drive innovation and sustainability within the industry. Furthermore, the market (as well as politics and regulatory dimensions) must facilitate and drive adaptability for actors, making it easier for companies to implement new environmental solutions.

5.4.1: Fleet renewal

Fleet renewal is an essential tool in the green transition of Norwegian short-sea shipping. Respondent I argue that a shift towards more environmentally friendly solutions is similar to the transition witnessed when shipping went from sail to steam, or from steam to combustion engines. Renewal of the fleet is crucial for developing a more environmentally friendly industry, and the development of low-and zero-emission solutions are essential for Norway's importance in the global market (Norwegian Government, 2019).

My findings suggest that challenges related to an aging fleet are one of the most significant barriers for EnvU. In 2020, the average age of the Norwegian short-sea shipping fleet was 28 years (Stensvold, 2020). The age of the fleet is segment dependent, implying that some segments have a higher average fleet, and some have lower. The passenger segment (excluding cruise vessels) has an average age of 26 years, the cruise segment has an average age of 25 (Norwegian Government, 2019), and the bulk segment has an average age of 23,7 years (Fjose et al., 2020). Some challenges in fleet renewal are linked to ships being purpose-built for specific operations. Many of these ships are often unsuited for rebuilding or retrofitting with, for example, new motors or batteries, which demand space on the vessel due to design. The level of possibilities for retrofitting depends on the segment and type of vessels. As respondent A argues:

> "It will be short-sea shipping's greatest obstacle, renewal of the fleet and renewal to something other than we have today".

Companies' ability for fleet renewal requires information, capital, time, and human resources. Moreover, profitability for the company is crucial for investments in low-and-zero emissions solutions contributing to fleet renewal (DNV GL, 2018). Challenges related to fleet renewal is more evident in the bulk segment, explained by low profitability, short contracts, low predictability and many small actors, making the adaptability of this segment insufficient (respondent A; DNV GL, 2018). Respondent H, representing the bulk segment, highlights the difficulties an aging fleet have for EnvU within this segment. Respondent H argues that they have an average age of the fleet around 20 years, which is good in the bulk segment, while other bulk companies may have an average age of 30 to 35. When the fleet is old, it usually consists of vessels with aging technologies and moving forward, investing in new ships with new technologies will reduce emissions. However, this can be challenging due to insufficient funding and capital. Green technologies are expensive, and the bulk segment is a capital-intensive segment to operate within, leading to low profitability.

The importance of implementing new technologies to the fleet is highlighted by respondent C, arguing that it is important to use new technologies and make use of support schemes for these technologies. Respondent C further argues:

> "If you can demonstrate that the technology works and is available, it is also possible to come up with regulations and requirements. Then you can start making demands because it is possible to make it happen. So that goes vary hand in hand, but it depends on the actors who go ahead and take the risk of being first".

The Norwegian Shipowners' Association is now experiencing that their members are investing in new ships. Respondent G argues that the Norwegian short-sea shipping industry is now phasing out several old ships and investing in completely new ones. This has not happened in a very long time, as there has been a tradition to buy young second-hand vessels from abroad and modify these vessels for the Norwegian market. By doing this, the average age of the fleet will reduce. Furthermore, programs such as GSP work towards a green fleet renewal. Together with condemnation and loan schemes, this contributes to the development of low-and zero-emission solution and emission reductions (Meld. St. 10 (2020-2021)).

Innovation and technology contributing to fleet renewal is expensive, as it is capital-intensive to invest in low-and zero-emissions solutions (respondent D and H). In this regard, there is a distinction between investing or participating in technology development and implementing these solutions onboard ships. The actual implementation of low-and zero-emission solutions

is costly and involves risk as the technology is new, and green ships today have a low degree of profitability (DNV GL, 2018). However, these solutions also have a relatively short repayment time, due to saved fuel costs or lower environmental taxes. Financial deficits make it harder for shipping companies to invest in green solutions, and there must be various motivators and subsidies in place for the shipping companies to take the risk of investing in green technology. Moreover, profitability is essential for the adaptability to invest in fleet renewal and emission reduction measures (DNG GL, 2018).

My data also suggest that it is too cheap to contribute to emissions (respondent D and I). Respondent D argues that this makes it difficult for environmental technologies to be competitive with traditional technologies, which is especially evident when looking at phasing in alternative fuels. When it is more economical to use traditional fuels, and at the same time the infrastructure of alternative fuels is lacking, one can assume that the phasing in of these fuels is not profitable, and therefore, the green transition of the Norwegian shipping industry will take longer time.

Fleet renewal requires adaptability, which is essential for EnvU, while also being segment dependent. Adaptability is important, as shipping companies risk losing customers, profit, and environmental legitimacy if they do not implement environmental value and are committed to implementing environmental measures and solutions (Serra & Fancello, 2020). Adaptability is segment dependent, due to differences in profitability, predictability regarding contracts and investment capacity.

5.4.2: Alternative fuels

Current development projects point to various promising novel energy solutions; for example, hydrogen, biofuels, batteries, ammoniac, use of sails and hybrid solutions. My finding suggests that it is likely that the future will see a mix of these energy sources (DNV GL, 2019; Serra & Fancello, 2020; Mitsubishi heavy industries group, n.d). There is uncertainty on which fuels the industry will be dependent on in the future, but there is a focus on flexible solutions, which is pointed to as necessary by respondent C, E, G, and I. Respondent G argues:

> "… there is in a way a large bouquet of different solutions that will be the way to the goal. […]. In a way, there is not one technology that is the perfect solution that will solve everything, it is a combination of different solutions".

Likewise, respondent C highlights that it is important to consider the fuel which is applicable in the future when designing and building vessels:

> "How can you build a vessel in such a way that you are flexible in relation to future fuel mix? It is a key question when you build new which will last for 30 years, what fuel do you have then".

For shipping companies, this involves challenges as it is impossible to foresee the future regarding fuel mix. Respondent E argues here that there is a need for flexible motors and engines that can burn several types of fuels with little or no conversion. Designing these kinds of engines can prepare companies for future fuel mix, including fuels that are not on the market today. However, the data collection also points to narrower solutions adopted by specific segments and vessels. Respondent F argues that the industry will see narrower solutions, depending on vessel design, where the vessel is sailing and how far it sails. The data points to hydrogen and ammonia as promising solutions in a long-term perspective. However, there are many barriers connected to technical- and economic- regulatory challenges, new infrastructure (respondent A).

Alternative fuels involve a great deal of uncertainty on both access to infrastructure and production (respondent D). For the passenger segment, and especially for ferries, batteries have proven to be a viable energy source. However, when this segment operates internationally and over larger routes, batteries do not cover the energy demand. Some companies have started to use hybrid solutions, using batteries along with other energy sources, and have contributed to the availability of onshore battery charging facilities. Respondent F, representing the passenger segment, presents that they use shore-power in Oslo and other Norwegian ports and ports in Germany. The infrastructure of shore power has improved in the last years. However, this is currently used as a power source when in ports and not to charge onboard batteries. To make shore-power more attractive, it is crucial that the price of the electricity from shore-power is competitive with the price of using onboard power when in ports (DNV GL, 2018). Respondent I, representing the bulk segment, highlights this and argues that if they need to pay 1.3 NOK per kilowatt-hour as the Port of Bergen has, it is more economically sensible for them to produce the power generated by an onboard diesel generator.

For alternative fuels, the price is decisive for whether these fuels will be used. All other alternative fuel, except biofuels, require significant investments (DNV GL, 2018), and it must be more rewarding to use alternative fuels than it is today.

5.4.3: The risk of being first

The use of new technologies and innovations and the implementation of these within Norwegian short-sea shipping depend on those willing to take the risk of being the front runners. This means those within the industry willing to try out new solutions, develop new technologies and implement these into their operations. Norway has had a tradition to be in the driver seat internationally regarding implementing new technologies and solutions into the shipping industry (Helseth et al., 2019). Respondent G argues here:

> "When we start to look at our track record, we have the first fully electric ferry, we had the first hydrogen ferry, the first offshore ship which will be complete emission-free using ammonia, we have the first autonomous and entire electric RORO ship, we have the first fully electric and autonomous container ship, Yara Birkeland".

However, being first is a difficult position for shipping companies. Respondent B argues that uncertainty and lack of knowledge within the industry contribute to actors and shipping companies being more reluctant of being the first to make use of and implement new technologies and low emissions solutions. Lack of knowledge and information influence the adaptability of actors. Adaptability into new technologies requires new information, sufficient time and labour resources, and demand and require new ways of thinking and working (DNV GL, 2018).

Knowledge and information are essential for driving technology and innovation in Norwegian short-sea shipping. The strong maritime cluster and collaborating within the value chain facilitate knowledge creation. The creation of knowledge usually occurs within strong national networks, where actors representing international companies, research institutions, cargo-owners, and shipping companies collaborate on technological developments (Bach et al., 2020). This creates knowledge on all aspects of short-sea shipping and contributes to developing feasible solutions, infrastructures, and technologies. Respondent F argues here:

> "Making innovation more efficient and more accessible, it is probably a lot about trusting each other"

Respondent B further argues that cooperation, both between shipping companies and within the value chain, have led to a high degree of knowledge transfer regarding new technologies and environmental measures.

New technologies are expensive (respondent C, G), and respondent G argues that the first runners take a large promotion of the cost. Lack of incentives and low profitability pose a significant barrier for shipping companies wanting to implement new technologies and solutions into their operations. Respondent F argues that there is an immense risk of being the first, and that this risk must be taken by more than just the shipping company itself, for example, through regulatory and financial frameworks, support schemes, research and pilot projects. However, those who are the first runners in short-sea shipping are doing an important job for the industry's level of adaptability. The job these actors are doing make the way for other companies to follow which more parts of the value chain can profit on. Nevertheless, actors operating in the short-sea market have primarily a business to take care of, and there is no point in thinking "green" if the numbers are "red" (respondent C). Respondent I highlight this:

> "Environmental measures cost money and there is a lot of desire and will, but it does not help to do something green if you go bankrupt on the road".

Although being first involves risks and financial uncertainty, some shipping companies take this risk. Hagland, a Norwegian bulk company, is now retrofitting/rebuilding Hagland Captain from diesel to a hybrid solution consisting of biodiesel and batteries (Stensvold, 2021c). Hagland predicts that the vessel will reduce CO_2 emissions by 16% and NO_x reductions by 87 %, equivalent to 84 000 Volkswagen Passat driving 15 000 km each year (Respondent I). Moreover, respondent I highlight that the electrification of the excavator on board will save the shipping company 78,000 litres of diesel, which is equivalent to 210,000 kg with CO_2. Figure 9 show Hagland Captain before retrofitting.

Figure 8: Hagland Captain. Source: Hagland, n.d.

Furthermore, Egil Ulvans Shipping Company is developing a bulk vessel (Figure 10) using hydrogen and rotor sail. This is one of GSPs pilot projects and will show that zero-emission solutions are possible for longer routes on vessels with a load capacity of 5,500 tonnes. This is also the vessel that will transport materials for Heidelberg Cement and Felleskjøpet (Stensvold, 2021b).

Figure 9: Egil Ulvans Shipping Company vessel. Source: Norwegian Ship Design TNSDC, in Stensvold, 2021b

Chapter 6: Discussion

As shown in section 2.1, the shipping industry is moving towards a sixth innovation wave, focusing on technological solutions contributing to reducing the emissions from the industry. Emerging literature has conceptualized this through the concept of EnvU in GVCs. As shown in chapter 3, these emphasise the effects of value chain operations and strategies for reducing emissions through technical and operational measures. The following chapter will examine and discuss the conditions of EnvU in Norwegian short-sea shipping, thus highlighting the research questions:

> *Which significant drivers and barriers for environmental upgrading can be identified in Norwegian short-sea shipping?*
>
> *How is environmental upgrading connected to GVC governance?*

6.1: Dimensions of EnvU and their drivers and barriers

The analysis above identifies some important drivers and barriers for EnvU in Norwegian short-sea shipping, categorized into four dimensions. As highlighted in section 3.2.1, multiple external and internal drivers for EnvU have previously been identified. However, existing literature has focused on the main drivers contributing to EnvU, while barriers for EnvU have received less attention. I will argue that the barriers for EnvU, which in many ways are linked to the drivers, have the same importance. The drivers and barriers are deeply connected, and many dimensions of EnvU can act as both a driver and a barrier, depending on its structure and how it influences the industry. The importance of EnvU barriers is evident in the above study, as Norwegian short-sea shipping faces many obstacles in becoming more sustainable, thus achieve EnvU across the value chain.

6.1.1: Politics and regulations

Politics and regulations are essential external drivers for EnvU, as shown in section 3.2.1.1 and 5.2. The GVC framework explores both global and local dimensions (Figure 6), which is vital in politics and regulations. From a global perspective, governance is important, while from a local dimension, national institutional structures matter. Drawing on GVC governance dimensions and expanding this from the role of lead firms to the role of international governing bodies, such as IMO, this thesis understands the importance international governing bodies have

on EnvU of GVC. As shown in section 2.1.1, IMO act as the main regulatory agency responsible for minimizing the environmental impact of shipping. As Gereffi et al. (2005, p.99) argue, global regulations are essential for shaping and directing change within GVCs, which is also the case for shipping. International regulatory instruments, such as EEDI and SEEMP, have laid the groundwork for steering the industry towards more sustainable operations. However, even though these measures are of high importance in GHG reductions and act as means driving EnvU, they are insufficient. EnvU in shipping also requires replacing fossil fuels with low-and zero-emission fuels. Furthermore, measures such as EEDI and SEEMP will only slow down emissions rates. Absolute reductions are not foreseen due to expected growth (Poulsen et al., 2016). Through a policy—mix, as defined in section 3.2.1.1, IMO can both reduce emission and drive essential innovations in shipping, thus driving EnvU. MBMs can work as important here, as they discourage the use of high-emission fuels through taxes and economic incentives while also encouraging the adaption of low-emission solutions (Serra & Fancello, 2020). However, even though IMO have goals on emission reduction, few actual effective regulations are implemented across the industry. One example of a regulatory instrument providing actual effects on emissions and EnvU is IMO 2020, which provides a global cap on SO_X emissions. This is one of the first examples of IMO establishing a mechanism for pricing negative effects on the environment, requiring a maximum level of 0.5% in SOX content in maritime fuels (UNCTAD, 2019; DNV GL, 2019). In IMO 2020, we can see that such regulations stimulate innovation, thus contributing to EnvU in value chain operations.

Remembering GVC governance, national institutions and structures also have a high degree of importance, which is also the case of EnvU. As shown in the analysis above, regulations from IMO are important in emission reduction. National governmental structures and support schemes have also been and will be, essential for EnvU in Norwegian short-sea shipping. National policies and regulations, both regarding emission reduction and innovation support, encourage the industry and direct value chain actors to tackle environmental issues and thereby become more sustainable. It is important to remember that the national structures of shipping, whatever country, hold great power concerning sustainability trajectories, and therefore it is important for national governments to focus on these trajectories. At the same time, it is also essential for national governments to facilitate good international competitiveness for their value chain actors, thus contributing to value capture. For EnvU of GVCs, strict unilateral national emission regulations and taxes are not desirable, as these can lower competitiveness for value chain actors and lead to financial implications for actors operating in capital-inventive

markets, such as shipping. As shown in the analysis, due to suboptimal shipping operations and financial implications resulting from strict national regulations, there is a need for common, just and fair international regulations. However, international regulations have previously been characterized as fragmented and uncertain (Poulsen et al., 2016), which hinder EnvU. One explanation for this statement is that discussions regarding sustainability in the industry are relatively new compared to industries operating on land. However, this thesis shows an increased emphasis on environmental issues across the industry, positively affecting EnvU.

On the other hand, it is currently too cheap to contribute to GHG emission, making it difficult for environmentally friendly technologies to compete with traditional technologies. The need for common, just and fair international regulations can be drawn back to EnvU in all GVCs, as these will contribute to a fair playing-ground for GVC actors, thus decreasing national/regional regulatory concerns. While politics and regulations act as essential drivers for EnvU, it is also important to remember that these also can act as significant barriers. Therefore, it is fundamental for national and international to be focused on developing policies and regulations which facilitate fundamental and meaningful changes.

Real changes to the industry will not come without national and international regulations and incentives to go green. Rogge & Reichardt (2016) also emphasise the importance of long-term perspectives for green transitions to happen, as this provides important guidance for GVC actors. The importance of long-term perspectives in EnvU as seen in the importance of politics and regulations supporting innovation. Focusing on politics and regulations supporting innovation to facilitate long-term cooperation and knowledge transfer in GVCs will play an essential role for EnvU across GVC, not only Norwegian short-sea shipping. As highlighted in section 3.2, EnvU can be perceived as an innovation process, and through innovation, actors in GVC can move towards more sustainable operations. In Norwegian short-sea shipping, programs designed by the state apparatus, such as GSP and PILOT-E, have proven to be important for EnvU. GSP facilitates new ideas and cooperation within the value chain, which is essential for the further implementation of incremental innovations, while PILOT-E aims at developing new, sustainable, and competitive technologies. This also works as a risk reliever, as the processes of EnvU include a high risk for actors in the value chain.

However, obtaining financial support through funding programs is demanding for small companies. It is therefore important that programs, such as GSP and PILOT-E, facilitate manageable support schemes. Furthermore, innovations in the industry need investments and resources, and by accelerating this through governmental funding, the industry can be expected to benefit through innovations and novel technologies (Steen et al., 2019).

6.1.2: Market and societal pressure

In addition to politics and regulations governing EnvU in GVCs, the market and societal pressure constitute important factors of EnvU. Section 3.2.1 shows that the market demand and societal pressure are important external drivers for EnvU, while new market opportunities and reputation are an important internal driver. This also related to Norwegian short-sea shipping, which this thesis has shown. The market is affected by political and regulatory frameworks and impact actors' access to capital and predictability, though, for example, the length of commercial contracts. Furthermore, it is essential to consider competition, highlighting the competitive advantage of going green and considering significant shifts in the global economy resulting from crises when discussing EnvU in GVCs.

EnvU trends in GVC have increased simultaneously with increased social awareness (Poulsen et al.,2018b). It is evident from the analysis above that higher awareness of environmental issues from the market and society acts as an important incentive for GVC actors to go green. When the market and society in which the value chain is embedded becomes increasingly concerned with environmental issues, new market opportunities emerge. Shipping and EnvU are closely related, and the increased awareness on improving its environmental impacts facilitate change and EnvU. As De Marchi & Di Maria (2019) and Poulsen et al. (2016) argues, societal pressure increases the demand for greener products, opening new market opportunities, contributing to value creation and competitiveness for shipping companies. In the context of Norwegian short-sea shipping, value chain actors can utilize this by modifying their operations and developing new technologies, thus entering new markets of shipping operations. However, the market must be ready to accept such new technologies. This implies that the technology must be profitable in the long run and improve its competitiveness to traditional technologies. For Norwegian short-sea shipping, this is presently not the case for emerging technologies.

The analysis above shows that societal pressure contributes to GVC suppliers' wanting to have a green portfolio, which is beneficial for actors operating within green technologies and with

low emissions. These actors may finance investments through governmental funding and incentives. In Norwegian short-sea shipping, the desire to have greener portfolios can contribute to cargo-owners choosing shipping (instead of other transportation modes) as the most appropriate mode of transportation for their goods and products, realising the environmental benefits included in shipping. As Khan et al. (2020, p.772) argue, shipping companies have a substantial competitive advantage to go green. When going green, GVC actors can attract suppliers desiring to have greener portfolios; however, when most or all firms do the same, the competitive advantage will not give financial benefits.

Khan et al. (2020) and Poulsen et al. (2016) argues that EnvU in GVCs is more likely to happen when the lead firm is customer-faced with a high reputational risk. This is shown in the Norwegian short-sea shipping passenger segment. Moreover, I will also argue that EnvU in GVCs is likely to happen when including the whole value chain in close cooperation. The EnvU framework states that it is not sufficient to limit the scope of just one single firm (De Marchi et al., 2013b), which is also evident in Norwegian short-sea shipping. By including all parts of the value chain in collaboration towards common innovation and emission reduction goals, Norway has facilitated an impressive focus on sustainable development of its short-sea shipping industry.

This study has shown that the length of the commercial contract between cargo-owner and shipping company is of prime importance. A long-term contract provides financial health, predictability and hence better access to capital. The opposite seems to be the case for short-term contracts. External financing is essential for the companies' access to capital, enabling investments in innovations and technologies contributing to EnvU. The length of contracts has been pointed to as an essential barrier of EnvU, as they have traditionally (especially in the bulk segment) been characterized by short time horizons. However, cargo-owners are now more committed to longer contracts, which have significant financial benefits for the shipping companies. For the achievement of EnvU in Norwegian short-sea shipping, it is fair to say that longer contracts are essential within the industry.

EnvU in GVC depends on several varying parameters, such as regulations, societal awareness, and market structures. Likewise, EnvU is affected by economic fluctuations such as the COVID-19 pandemic. The pandemic has had significant effects on the global economy and caused a decline in demand, which has affected the shipping industry. Disruptions caused by the pandemic have raised questions related to globalization and interconnectedness and have set in motion trends that can reshape the maritime industry (UNCTAD, 2020). The pandemic

has highlighted the interdependency of GVCs and further reduced the manoeuvrability for Norwegian short-sea shipping segments in terms of profitability and issues related to foreign workers and travel restrictions. Furthermore, segments such as the passenger segment have experienced a complete stop in their operations, which have had financial implications for this segment, influencing green transitions. On the other hand, the bulk segment has not experienced the same implications. These differences tell us that EnvU in GVC is dependent on the specific operations value chain actors focus on, highlighting that decreases in economic activities have a negative effect on EnvU. Moreover, the long-term implications of COVID-19 on EnvU are hard to predict. How national and regional structures and markets speed up the economy can either sink or accelerate sustainable development in GVCs. While the pandemic has brought challenges to EnvU in Norwegian short-sea shipping, it has also contributed to a higher emphasis on the need for substantial efforts into EnvU.

Existing literature has highlighted market and societal pressure as important internal and external drivers for EnvU. However, this thesis has also shown that these dimensions also can act as essential EnvU barriers. For EnvU in GVCs to happen, market structures must facilitate the adaption of innovations and provide economic incentives for value chains actors to go green.

6.1.3: Innovation, technology and adaptability

EnvU can be perceived as an innovation process (De Marchi & De Maria, 2019), and it is essential to highlight the connections between EnvU and innovation. As Lema et al. (2019, p.5) argue, there is no overlap between upgrading and innovations. Innovation and upgrading are two concepts developed in different contexts, and by looking at these together, processes of GVC greening can be simplified. In the context of this thesis, innovation and new technologies are essential for EnvU. They contribute to significant decreases in emissions, thus steering the development of the whole value chain.

As shown in section 3.2.1.3, innovation is not a linear process but rather a continuous process involving vertical interaction and value chain cooperation. As De Marchi et al. (2013a) argues, upgrading in GVCs are stimulated by vertical interaction rather than horizontal interactions. This is also the case for Norwegian short-sea shipping, as vertical interactions across the value chain facilitate knowledge transfer and innovations. Actors in different parts of the value chain learn from each other and apply this in technology development, thus stimulating EnvU. Innovation processes in GVC require local expertise (Khattak et al., 2015), which the

Norwegian short-sea shipping facilities through close vertical interactions and cooperation across the different actors of the value chain.

While GVC literature emphasises the lead firm and its role in innovation and technology development, this thesis has shown that both firm interactions and national structures facilitating innovation are essential for EnvU in GVCs. This furthers the argumentation of Khattak et al. (2015), which state that traditional upgrading (economic and social) happens due to learning and innovation by firm interaction and governance structures. EnvU and value chain innovations are in Norwegian short-sea shipping stimulated by value chain cooperation and the overall governance structures steering the development trajectories. While the literature focus on governance implied by the lead firm in GVCs, this thesis has shown that governance structures laid out by national and international governments and organizations have the same importance of steering development, innovations and EnvU as the lead firm.

As shown in section 3.2.1.3 and 6.1.1, national (and international) governance structures focusing on environmental regulations facilitate innovation and EnvU by enforcing carbon-taxes, and emission standards are essential. Through these measures, innovation within the GVC is easier achieved, shown in fleet renewal of Norwegian short-sea shipping. The Norwegian short-sea shipping is encouraged to renew its fleet by national and international emissions regulations. The cost savings benefit due to enhanced fuel efficiency of novel technologies and is also an essential internal driver for EnvU (Poulsen et al., 2018b; Khan et al., 2020). Renewal of the fleet is highlighted as one of the most pressing challenges within the industry. For this to happen, value chain actors must have some degree of profitability, access to technologies and innovations, and knowledge of support and financing options. A substantial fleet renewal can contribute to Norwegian short-sea shipping companies increasing their international competitive advantages, as cargo-owners are increasingly focused on sustainable transport. Furthermore, fleet renewal is important to maintain companies' environmental legitimacy, working as an essential internal driver for EnvU. However, today there is low profitability in using greener ships, and the testing and implementation of new technologies are challenging and expensive. This acts as an essential barrier for EnvU. On the other side, fleet renewal can contribute to actors remaining in the "game", which according to Khan et al. (2020), is an essential driver for GVC actors to engage in EnvU.

There is a substantial risk linked to being front runners in implementing new technologies. A lack of knowledge, access to capital and technical uncertainty put those willing to be front runners in a demanding position. However, being front runner can contribute to new market

opportunities and competitive advantage (Khan et al., 2020). Norwegian shipping, across the different segments, have traditionally been willing to take the risk of being first developing and implementing new technologies, which have put Norway on the maritime map. This can arguably be explained by the strong maritime clusters, cooperation within the value chain, investors willingness to assume financial risk and governmental funding and incentives.

Norwegian short-sea shipping is a hard-to-adapt industry due to its many barriers, such as an aging fleet, short contracts, low profitability, high margins, high competition, and lack of incentives to go green. Adaptability requires investments into capital assets, new technologies, certification systems and human resources (Khan et al., 2020), which is hard when financial incentives are not present. Those value chain actors willing to be front runners have arguably a high degree of adaptability. They have managed to absorb and adapt to innovation processes, thus managing financial challenges. By showing that adaptability into new technological solutions contributing to emission reduction is possible, these value chain actors drive EnvU across the value chain. The analysis above shows that it is possible for companies in Norwegian short-sea shipping to adapt to low-emission solutions, regardless of the obstacles. The importance this has on EnvU across the GVC is significant.

6.2: GVC governance and power dimensions in Norwegian short-sea shipping

Governance structures are essential in GVCs and are essential aspects to discuss concerning EnvU of Norwegian short-sea shipping. As highlighted in section 3.1, governance is at the heart of GVC analysis and GVC governance is driven by the strategies and decisions made by specific actors within the value chain (Poulsen et al., 2016, De Backer & Miroudot, 2013; Gereffi & Fernandez-Stark, 2016). Moreover, governance considers national and regional structures and emphasise the importance of these structures (Gereffi et al., 2005). Due to the geographical embeddedness of actors within the value chain, national and regional structures influencing GVC power dimensions is essential. Norwegian short-sea shipping and its actors are embedded within its national structures, which greatly influence the governance and the green transition of the industry.

Literature on GVC highlights five governance structures: market, modular, relational, captive and hierarchy (Gereffi et al., 2005; Gereffi & Ferandez-Stark, 2016), which is relevant to discuss in connection to Norwegian short-sea shipping. From Table 4, presented in section

3.1.1, Norwegian short-sea shipping is characterized by multiple and interacting GVC governance structures, involving governance structures of *markets* (in terms of its emphasis of price), *modular* (in terms of its high volume of information flow across inter-firm relationships), and *relational* (in terms of its frequent interaction and knowledge sharing). The interacting GVC governance structures correlate with Gereffi & Fernandez-Stark (2016), highlighting that GVCs can be characterized by multiple and interaction governance structures. As the Norwegian shipping industry has matured and evolved, the governance structure has changed. It is reasonable to assume that the influence of *markets*, because of its emphasis on price rather than powerful lead firms, have decreased as the industry has experienced a significantly increased emphasis on environmental issues. On the other side, it is reasonable to assume that *modular* governance has increased simultaneously as global communication systems have advanced and that *relational* governance has increased simultaneously with a higher emphasis on value chain cooperation and knowledge sharing. This correlates with Gereffi et al. (2005) and Gereffi & Fernandez-Stark (2016), which argues that governance structures can change over time.

In Norwegian short-sea shipping, the cargo-owners hold significant power in relation to GVC governance, which one can assume is characterized by buyer-driven governance structures. Literature on producer-driven and buyer-driven chains argues that retailers in buyer-driven chains dictate how the chain operates (Gereffi & Fernandes-Stark, 2016). For Norwegian short-sea shipping, the cargo-owners have significant power over shipping companies and segments, such as bulk, by providing transportation assignments and profitability for the companies. However, cargo-owners have traditionally been focused on price, which has had negative implications on the investments of greener solutions for shipping companies. Today, the industry is witnessing more focus on environmentally friendly solutions from cargo-owners, which act as an incentive for shipping companies to invest in greener technologies and reduce their GHG emissions. This correlates with Poulsen et al. (2018b) arguing that EnvU trends have increased simultaneously with increased consumer awareness in the society.

Specific shipping companies hold limited possibilities for EnvU in terms of GVC governance. This is because the industry is dependent on changes within the value chain, requiring cooperation and coordination. While many companies have a proactive view of EnvU, it is important to remember that they first and foremost have a business to take care of. However, as presented in section 3.1.2.1, through cooperation and knowledge sharing, specific actors in

the value chain can encourage each other and motivate the adoption of more environmentally friendly solutions across the value chain.

Moreover, the end-user of products (the customers) also steers the governance and EnvU of Norwegian short-sea shipping through a higher societal awareness on climate issues. When the end-user demands more sustainable transportation, this puts pressure on shipping companies (and cargo-owners) and acts as an essential driver for innovation and adaptability. The analysis above highlights the importance of customers in the passenger segment. Here, guest's expectation put pressure on the shipping company to implement more sustainable shipping operations and practices to not lose customers, profit, and environmental legitimacy. This pressure correlates with Poulsen et al. (2016), which argues that pressure from societal groups contributes to actors in the value chain assessing and addressing their operations' environmental impacts. Furthermore, buyer-driven chains are also characterized by retailers requiring suppliers to meet specific standards and policies (Gereffi & Fernandes-Stark, 2016), which is not evident from the analysis. Pressure from national and international regulations on emissions reductions seems to be coming from several organizations and national and international pressure to comply with the Paris Agreement and the SDGs.

6.3: Broadening EnvU perspectives

There is a vast amount of literature in the scientific field on the greening processes of industries; however, perspectives of EnvU are under-investigated in the existing literature. A considerable amount of GVC literature focuses on the governance structures facilitating EnvU and the lead firm's significant role in greening processes (Gereffi et al., 2005; Gereffi, 2014; Poulsen et al., 2016; De Marchi & Di Maria, 2019). The lead firm in a GVC does, in fact, play an essential role in EnvU processes; however, I will also argue that national embedded aspects of politics and regulations facilitating innovation and thus EnvU in industries are essential for future research. It is important to view EnvU as an innovation process, where new technologies and organizational knowledge are produced and applied (De Marchi & Di Maria, 2019), and where these technologies and new knowledge are embedded in the whole value chain through cooperation. As witnessed in Norwegian short-sea shipping, facilitating the development and implementation of new technologies and knowledge through politics and regulations focusing on innovation has been essential for EnvU. Here, national embedded structures of politics have facilitated a strong cooperating and R&D within the value chain, thus stimulating innovation.

There is also a high focus on the drivers for EnvU in the existing literature; however, the implications of essential barriers are left out (De Marchi & Di Maria, 2019; Poulsen et al., 2016; Khan et al., 2020). By including barriers in further EnvU analysis of industries, one can gain a more detailed understanding of the complexities of EnvU processes, thus providing recommendations to policymakers and other stakeholders regarding how EnvU in shipping can be achieved. While the drivers are important, the barriers provide insight into pressing issues that industries need to tackle. Several drivers of EnvU can also act as barriers when the structure of the driver complicates or fragment EnvU processes.

Chapter 7: Conclusion

This thesis aims at examining and understanding the complex nature and conditions of EnvU in the context of Norwegian short-sea shipping. Hence, it aims at contributing to understanding the empirical perspectives of EnvU analysis in GVCs.

To address the research challenges presented in section 1.2, this thesis has employed a qualitative case study involving triangulated data collection. Nine semi-structured interviews were conducted, triangulated with secondary data from Governmental papers and reports, scientific reports, and news articles. This has enabled identification of the main drivers and barriers of EnvU in Norwegian short-sea shipping, highlighting the GVC governance structures facilitating EnvU.

This thesis has identified some of the main drivers and barriers for EnvU in the Norwegian short-sea shipping industry, linked to the dimensions of; politics and regulations; the market and societal pressure; and innovation, technology and adaptability. These dimensions are highly interconnected and involve a high degree of complexity, highlighting the importance of simultaneously looking at the whole phenomenon, connecting all parts of value chain operations together in the transition towards a more sustainable industry.

The findings of this thesis suggest that EnvU in Norwegian short-sea shipping is more likely to happen when national and international regulations (on emission reduction and which supports innovation) facilitate fair and just development across the industry and allow for deep collaboration across the value chain. Moreover, EnvU in short-sea shipping is also more likely to happen when the market structures do not hinder sustainable development and where there is a healthy amount of societal pressure working as an external force. Through the lens of EnvU, the results of this thesis can be applied to a broader global perspective.

Moreover, this thesis has highlighted the importance of GVC governance structures, which are proven essential for EnvU. Norwegian short-sea shipping is characterized by multiple and interacting governance structures, which in each of their ways enable EnvU. By emphasising the importance of national and international governance structures in EnvU processes, this thesis has shown that these structures need to facilitate a fair playing-ground across the shipping industry and its GVC actors, thus facilitating EnvU. Furthermore, this thesis has also set out to explore how cargo-owners, shipping companies and the customers steer GVC governance through a higher focus on environmental issues, cooperation and pressure from societal groups.

This thesis has some limitations and shortcomings. First, this thesis touch upon many academic fields, complicating the analysis. Secondly, the analysis rest on just nine interviews, which naturally restricts an inclusion of the whole value chain of Norwegian short-sea shipping. More importantly, as EnvU process touch on several complicated and interacting dimensions, the limit and scope of this thesis do not allow for an in-depth discussion into all the dimensions, leaving out essential knowledge.

7.1: Looking ahead

Analysing sustainability trajectories within global industries through an EnvU lens is important, and there are many interesting issues to be addressed based on the empirical work of EnvU. Further research may explore the barriers of the different GVC governance structures related to shipping, thus expanding EnvU literature. In this regard, it is also important to conduct more research into national embedded aspects of politics and regulations facilitating innovation. Furthermore, as the trends of EnvU develop, future research may investigate EnvU of deep-sea shipping, which is more challenging due to the limited options of new technologies and alternative fuels. However, it is significant to conduct research on this topic, as the emissions from deep-sea is greater compared to short-sea. Moreover, interesting perspectives could emerge by drawing the four types of economic upgrading into an EnvU analysis.

Bibliography

Bach, H., Bergek, A., Bjørgum, Ø., Hansen, T., Kenzhegaliyeva, A., Steen, M. (2020). Implementing maritime battery-electric and hydrogen solutions: A technological innovation system analysis. *Transport Research Part D: Transport and Environment*, *87*. DOI: https://doi.org/10.1016/j.trd.2020.102492

Bach, H., Mäkitie, T., Hansen T., Steen, M. (2021). Blending new and old in sustainability transitions: Technological alignment between fossil fuels and biofuels in Norwegian coastal shipping. *Energy Research & Social Science*, *74*. DOI: https://doi.org/10.1016/j.erss.2021.101957

Bair, J. (ED.). (2009). *Frontiers of Commodity Chain Research*. Stanford, CA: Stanford University Press.

Balcombe, P., Brierley, J., Lewis, C., Skatvedt, L., Speirs, J., Hawkes, A., Staffell, I. (2019). How to decarbonize international shipping: Options for fuels, technologies and policies. *Energy Conversion and Management*, *182*, pp.72-88. DOI: https://doi.org/10.1016/j.enconman.2018.12.080

Benito, G.R.G., Berger, E., de la Forest, M., Shum, J. (2003). A cluster analysis of the maritime sector in Norway. *International Journal of Transport Management*, *1*(4), pp.203-215. DOI: https://doi.org/10.1016/j.ijtm.2003.12.001

Bjerkan, K.Y., Seter, H. (2019). Reviewing tools and technologies for sustainable ports: Does research enable decision making in ports?. *Transportation Research Part D: Transport and Environment*, *72*. pp.243-260. DOI: https://doi.org/10.1016/j.trd.2019.05.003

Bouman, E. A., Lindstad, E., Rialland, A, I., Strømman, A, H. (2017). State-of-the-art technologies, measures, and potential for reducing GHG emissions from shipping – A review. *Transportation Research. Part D, Transport and Environment*, *52*, pp. 408-421. DOI: https://doi.org/10.1016/j.trd.2017.03.022

Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, *9*(2), pp.27-40. DOI: https://doi.org/10.3316/QRJ0902027

Bryman, A. (2012). *Social research methods* (4th ed.). Oxford: Oxford University Press.

Čampara, L., Hasanspahić, N., Vujičić, S. (2018). Overview of MARPOL ANNEX VI regulations for prevention of air pollution from marine diesel engines. *SHS Web of Conferences.*, *58*, DOI: https://doi.org/10.1051/shsconf/20185801004

Caniëls, M. C. J., Cleophas, E., Semeijn, J. (2016). Implementing green supply chain practices: an empirical investigation in the shipbuilding industry. *Maritime Policy & Management*, *43*(8), pp.1005-1020. Doi: https://doi.org/10.1080/03088839.2016.1182654

Cariou, P., Parola, F., Notteboom, T. (2019). Towards low carbon global supply chains: A multi-trade analysis of CO2 emission reductions in container shipping**.** *International*

Journal of Production Economics, *208*, pp.17-28. DOI: https://doi.org/10.1016/j.ijpe.2018.11.016

Crang, M., Cook, I. (2007). *Doing ethnographies*. London: Sage.

De Backer, K., Miroudot, S. (2013). Mapping Global Value Chains, OECD Trade Policy Paper, No.159. OECD Publishing, Paris: DOI: https://doi.org/10.1787/5k3v1trgnbr4-en

De Marchi, V. (2012). Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. *Research Policy, 41*(3). pp.614-623, DOI: https://doi.org/10.1016/j.respol.2011.10.002

De Marchi, V., Di Maria, E. (2019). Environmental Upgrading and Suppliers' Agency in the Leather Global Value Chain. *Sustainability*, *11*(23), 6530. DOI: https://doi.org/10.3390/su11236530

De Marchi, V., Di Maria, E., Micelli, S. (2013a). Environmental Strategies, Upgrading and Competitive Advantage in Global Value Chains. *Business Strategy and the Environment*, *22*(1). pp.62-72. DOI: https://doi.org/10.1002/bse.1738

De Marchi, V., Di Maria, E., Ponte, S. (2013b). The greening of Global Value Chains: Insights from the Furniture Industry. *Competition and Change*, *17*(4). Pp. 299-318. DOI: https://doi.org/10.1179/1024529413Z.00000000040

Di Vaio, A., Varriale, L., Lekakou, M., Stefanidaki, E. (2020). Cruise and container shipping companies: a comparative analysis of sustainable development goals through environmental sustainability disclosure. *Maritime Policy & Management*. DOI: https://doi.org/10.1080/03088839.2020.1754480

Dicken, P. (2015). *Global Shift: Mapping the Changing Contour of the World Economy* (7th ed.). London: Sage.

DNV GL. (2018*). Barrierer for lav-og nullutslippsløsninger for tørrlast med skip* [Barriers for low-and zero-emission solutions for dry cargo with ships] (Report No. 2018-0126). Available from: https://grontskipsfartsprogram.no/wp-content/uploads/2021/02/GKP_barrierestudie_torrlast__final_rev1.pdf

DNV GL. (2019). Assessment for selected alternative fuels and technologies. *DNV GL Maritime*. Available from: https://www.dnvgl.com/maritime/publications/alternative-fuel-assessment-download.html

ECSA. (2016). *Short Sea Shipping: The full potential yet to be unleashed*. European Community Shipowners' Association. Brussel. Available from: https://www.ecsa.eu/sites/default/files/publications/ECSA_SSS_Download%201_0.pdf

Fjose, S., Basso, M.Y., Aamo, A., Pedersen, S., Jakobsen, E. (2020). Kartlegging av nærskipsfart – sammensetning, alder, lønnsomhet og utfordringer med flåtefornyelse [Mapping of short-sea shipping- composition, age, profitability and challenges with fleet renewal] (Report No. 19/2020). Menon economics. Available from:

https://www.regjeringen.no/contentassets/c00fb69b0b9d49479f5130d7e222a013/menon-publikasjon-19-2020-endelig__.pdf

Forskningsrådet. (2021, Mars 09). *PILOT-E er evaluert – ordningen skaper merverdi for samfunnet og tar ut synergier i virkemiddelapparatet*. Available from: https://www.forskningsradet.no/nyheter/2021/pilot-e-er-evaluert/ [Accessed 08.04].

Galletta, A. (2013). *Mastering the Semi-Structures Interview and Beyond*. NYU Press.

Gereffi, G. (2014). Global value chains in a post-Washington Consensus world. *Review of International Political Economy, 21*(1), pp. 9-37. DOI: https://doi.org/10.1080/09692290.2012.756414

Gereffi, G., Fernandez-Stark, K. (2016). *Global Value Chain Analysis: A primer* (2nd ed.). Center on Globalization, Governance & Competitiveness. North Carolina, USA: Duke University.

Gereffi, G., Humphrey, J., Sturgeon, T. (2005). The Governance of global value chains. *Review of International Political Economy*, 12(1), pp. 78-104. DOI: https://doi.org/10.1080/09692290500049805

Glachant, M., Dussaux, D., Mènière, Y., Dechezleprêtre, A. (2013). *Greening Global Value Chains: Innovation and the International Diffusion of Technologies and Knowledge*. Policy Research Working Paper No. 6467. Washington, D.C.: World Bank.

Goger, A. (2013). The making of a 'business case' for environmental upgrading: Sri Lanka's eco-factories. *Geoforum, 47*, pp.73–83. DOI: http://dx.doi.org/10.1016/j.geoforum.2013.03.006

Grønt Skipsfartsprogram. (N.D*). Verdens mest effektive og miljøvennlige skipsfart* [The world most effective and environmentally friendly shipping]. Grønt Skipsfartsprogram. Available from: https://grontskipsfartsprogram.no/om-gront-skipfartsprogram/ [Accessed 07.04].

Hagland. (N.D). *Hagland fleet – Hagland Captain*. Hagland. Available from: https://www.hagland.com/fleet/hagland-captain/ [accessed 14.05.2021].

Hay, I.M. (2016). *Qualitative research methods in human geography* (4th ed.). Oxford University Press.

Helseth, A., Fjose, S., Jakobsen, E. (2019). *Grønn maritim: status for omsetning, eksport, sysselsetting og investeringer* [Green maritime: status for turnover, export, employment and investments]. (Report No. 66/2019). Menon Economics. Available from: https://www.menon.no/wp-content/uploads/2019-66-Gr%C3%B8nn-maritim.pdf

Helseth, A., Nygård Basso, M., Fjose, S. (2021). *CO2-avgift som virkemiddel for klimagassreduksjon i nærskipsfart* [CO2 tax as a tool for greenhouse gas reduction in short-sea shipping]. (Report No. 5/2021). Menon Economics.

Heywood, A. (2004). *Political Theory: an introduction* (3rd ed.). Palgrave Macmillan.

IMO. (2013). *IMO - What is it*?. International Maritime Organization. London, United Kingdom. Accessed by: https://wwwcdn.imo.org/localresources/en/About/Documents/What%20it%20is%20Oct%202013_Web.pdf

IMO. (2018). *Annual Report 2018: IMO Technical Cooperation*. International Maritime Organization. Available from: http://www.imo.org/en/OurWork/TechnicalCooperation/Documents/Annual%20Report%20-%20Publications/2018%20Annual%20Report%20publication.pdf

IMO. (2020a). Greenhouse Gas Emissions. International Maritime Organization. Available from: http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/GHG-Emissions.aspx [Accessed 22.09.2020].

IMO. (2020b). *International Convention for the Prevention of Pollution from Ships (MARPOL*). International Maritime Organization. Available from: http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx [Accessed 24.09.2020].

IMO. (2020c). *Sulphur 2020 – cutting sulphur oxide emissions*. International Maritime Organization. Available from: http://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx [Accessed 31.08.2020].

Joung, T.-H., Kang, S.-G., Lee, J.-K., Ahn, J. (2020). The IMO initial strategy for reducing Greenhouse Gas (GHG) emissions, and its follow-up actions towards 2050. *Journal of International Maritime Safety, Environmental Affairs, and Shipping*, *4*(1), 1–7. DOI: https://doi.org/10.1080/25725084.2019.1707938

Khan, M.J., Ponte, S., Lund-Thomaen, P. (2020). The 'factory manager dilemma': Purchasing practices and environmental upgrading in apparel global value chain. *Environment and Planning A: Economy and Space*, *52*(4), pp.766-789. DOI: https://doi.org/10.1177/0308518X19876945

Khattak, A., Stringer, C., Benson-Rea, M., Haworth, N. (2015). Environmental upgrading of apparel firms in global value chains: evidence from Sri Lanka. *Competition & Change*, *19*(4). pp.317-335. DOI: https://doi.org/10.1177/1024529415581972

Lee, T., Nam, H. (2017). A Study on Green Shipping in Major Countries: In the View of Shipyards, Shipping Companies, Ports and Policies. *The Asian Journal of Shipping and Logistics*, *33*(4), pp. 253-263. DOI: https://doi.org/10.1016/j.ajsl.2017.12.009

Lema, R., Pietrobelli, C., Rabellotti, R. (2019). Innovation in Global Value Chain. *In Handbook on Global Value Chains*. Cheltenham, UK: Edward Elgar Publishing. DOI: https://doi.org/10.4337/9781788113779.00032

Mäkitie, T., Steen, M., Thune, T.M., Lund, H.B., Kenzhegaliyeva, A., Ullern, E.F., Kamsvåg, P.F., Andersen, A.D., Hydle, K.M. (2020). *Greener and smarter? Transformations in five Norwegian industrial sectors*. (Report No. 2020/01091). Trondheim: SINTEF

Meld. St. 10 (2020 – 2021). Grønnere og smartere – morgendagens maritime næring. White paper on the development of a greener maritime industry, Ministry of Trade, Industry and Fishereis. Available from: https://www.regjeringen.no/no/dokumenter/meld.-st.-10-20202021/id2788786/

Mitsubishi heavy industries group. (N.D). *Advancing shipping's low-emissions future*. Available from: https://oilandgas.mhi.com/stories/advancing-shippings-low-emissions-future/ [accessed: 27.08.2020].

Munari F. (2012). Competition in Liner Shipping. In: Basedow J., Magnus U., Wolfrum R. (Ed.), *The Hamburg Lectures on Maritime Affairs 2009 & 2010. Hamburg Studies on Maritime Affairs* (International Max Planck Research School for Maritime Affairs at the University of Hamburg), *23*. Springer, Berlin, Heidelberg. DOI: https://doi.org/10.1007/978-3-642-27419-0_1

Navarrete, S.D.S., Borini, F.M., Avrichir, I. (2020). Environmental upgrading and the United Nations Sustainable Development Goals. *Journal of Cleaner Production*, *264*. DOI: https://doi.org/10.1016/j.jclepro.2020.121563

Neilson, J., Pritchard, B., Yeung, H. W. (2014). Global value chains and global production networks in the changing international political economy: An introduction. *Review of International Political Economy*, *21*(1), pp.1–8. DOI: https://doi.org/10.1080/09692290.2013.873369

Norwegian Government. (2019). *The Government's action plan for green shipping*. Strategy (Publication Number: T-1567 E). Available from: https://www.regjeringen.no/en/dokumenter/the-governments-action-plan-for-green-shipping/id2660877/

Norwegian Shipowner' Association. (2019). *Sustainability Report 2019*. The Norwegian Shipowners' Association Communication on Engagement (COE). Rederiforbundet: Oslo. Available from: https://rederi.no/rapporter/

Norwegian Shipowners' Association. (2021). *Maritime outlook 2021*. The Norwegian Shipowners' Association: Oslo. Available at: https://rederi.no/rapporter/

Noy, C. (2008). Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative research. *International Journal of Social Research Methodology*, *11*(4). p.327-344. DOI: https://doi.org/10.1080/13645570701401305

Pettit, S., Wells, P., Haider, J., Abouarghoub, W. (2018). Revisiting history: Can shipping achieve a second socio-technical transition for carbon emissions reduction? *Transportation Research Part D: Transport and Environment*, *58*, pp.292–307. DOI: https://doi.org/10.1016/j.trd.2017.05.001

Pike, A., Rodrigues-Pose, A., Tomaney, J. (2006). *Local and regional development*. London, England: Routledge.

Ponte, S., Gereffi, G., Raj-Reichert, G. (ED.). (2019). *Handbook on Global Value Chains*. Cheltenham: Edward Elgar Publishing.

Poulsen, R. T., Hermann, R. R., Smink, C. K. (2018a). Do eco-rating schemes improve the environmental performance of ships? *Marine Policy, 87*, pp.94–103. DOI: https://doi.org/10.1016/j.marpol.2017.10.006

Poulsen, R. T., Ponte, S., Lister, J. (2016). Buyer-driven greening? Cargo-owners and environmental upgrading in maritime shipping. *Geoforum*, 68, pp. 57–68. DOI: https://doi.org/10.1016/j.geoforum.2015.11.018

Poulsen, R. T., Ponte, S., Sornn-Friese, H. (2018b). Environmental upgrading in global value chains: The potential and limitations of ports in the greening of maritime transport. *Geoforum, 89*, pp.83-95. DOI: https://doi.org/10.1016/j.geoforum.2018.01.011

Rennings, K., Rammer, C. (2011). The Impact of Regulation-Driven Environmental Innovation on Innovation Success and Firm Performance. *Industry and Innovation, 18*(3), pp.255, 283. DOI: https://doi.org/10.1080/13662716.2011.561027

Reve, T., Sasson, A. (2012). *Et kunnskapsbasert Norge*. Oslo: Universitetsforlag.

Rogge, K.S., Reichardt, K. (2016). Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Research Policy*, *45*(8). pp. 1620-1635. DOI: https://doi.org/10.1016/j.respol.2016.04.004

Serra, P., Fancello, G. (2020). Towards the IMOs GHG Goals: A critical overview of the Perspectives and Challenges of the Main Options for Decarbonizing International Shipping. *Sustainability 2020*, *12* (8): 3220. DOI: https://doi.org/10.3390/su12083220

Stalmokaite, I., Hassler, B. (2020). Dynamic capabilities and strategic reorientation towards decarbonisation in Baltic Sea shipping. *Environmental Innovation and Societal Transitions, 37*. pp. 187-202. DOI: https://doi.org/10.1016/j.eist.2020.09.002

Steen, M., Bach, H., Bjørgum, Ø,. Hansen, T,. Kenzhegaliyeva, A. (2019). *Greening the fleet: A technological innovation system (TIS) analysis of hydrogen, battery electric, liquefied biogas, and biodiesel in the maritime sector.* (Report No. 2019/0093). Trondheim: SINTEF Digital

Stensvold, T. (2015, September 28). *Shipping nede i 2,2 prosent av globale CO2-utslipp* [Shipping down to 2.2 percent of global CO2 emissions]. Teknisk Ukeblad. Available from: https://www.tu.no/artikler/shipping-nede-i-2-2-prosent-av-globale-co2-utslipp/275602 [Accessed 09.05.2021].

Stensvold, T. (2020, Mars 12). *Grønt skipsfartsprogram: Serverer oppskrift for rederier og lasteeiere [*Green shipping program: serves recipe for shipping companies and cargo owners]. Teknisk Ukeblad. Available from: https://www.tu.no/artikler/gront-skipsfartsprogram-serverer-oppskrift-for-rederier-og-lasteiere/487169?key=0gweTnRf [Accessed 21.04.2021].

Stensvold, T. (2021a, January 26). *16 rederier vil seile med hydrogendrevet bulkskip* [16 shipping companies will sail with hydrogen-powered bulk carriers]. Teknisk Ukeblad. Available from: https://www.tu.no/artikler/16-rederier-vil-seile-med-hydrogendrevet-bulkskip/505917?key=vrtp6Dih [Accessed 21.04.2021].

Stensvold, T. (2021b, Mars 24). *Norsk rederi bygger verdens første hydrogendrevne lasteskip* [Norwegian shipping company builds the world's first hydrogen-powered cargo ship]. Teknisk Ukeblad. Available from: https://www.tu.no/artikler/norsk-rederi-bygger-verdens-forste-hydrogendrevne-lasteskip/508390?key=4K7QCHaS [Accessed 19.04.2021].

Stensvold, T. (2021c, April 9). *Hagland bestiller to lavutslipps bulkskip* [Hagland orders two low-emission bulk carriers]. Teknisk Ukeblad. Available from: https://www.tu.no/artikler/hagland-bestiller-to-lavutslipps-bulkskip/508932?key=3n0hjjea [Accesses 19.04.2021].

Tenold, S. (2019). *Norwegian Shipping in the 20th Century*. Palgrave Studies in Maritime Economics. Cham: Springer.

U.N. (2019). The Sustainable Development Goals Report 2019. (Report No.19/06517). United Nations. Available from: https://unstats.un.org/sdgs/report/2019/The-Sustainable-Development-Goals-Report-2019.pdf

U.N. (n.d). *The 17 goals*. United Nations. Available from: https://sdgs.un.org/goals [Accessed 26.04.2021].

UNCTAD. (2019). *Review of Maritime Transport 2019.* United Nations Conference on Trade and Development. Available from: https://unctad.org/en/PublicationsLibrary/rmt2019_en.pdf

UNCTAD. (2020). *Review of Maritime Transport 2020.* United Nations Conference on Trade and Development. Available from: https://unctad.org/system/files/official-document/rmt2020_en.pdf

United Nations. (1987). *Report of the world commission on environment and development: Our common future.* Oslo, Norway: United Nations General Assembly, Development and International Co-operation: Environment.

Wan, Z., Makhloufi, A., Chen, Y., Tang, J. (2018). Decarbonizing the international shipping industry: Solution and policy recommendations. *Marine Pollution Bulletin*, *126*. pp. 428-435. DOI: https://doi.org/10.1016/j.marpolbul.2017.11.064

Yin, R.K. (2003). *Case Study Research: Design and Methods*, 3rd ed. London: SAGE Publications Ltd

Appendices

Appendix A: Interview guide

Information ex ante:

Place of study and aim of the thesis. Short introduction to the thesis and myself. Information on consent and anonymity. Information on recording and the use of the recordings.

Introduction

1. Kan du starte med å fortelle om deg og din rolle i norsk shipping?
2. Hvordan jobber dere med EnvU/forbedring av miljøprofilen til shipping?

Regulations

1. Internasjonale reguleringer har en tendens til å være usikre og fragmenterte når det gjelder utslipp fra shipping industrien, hvordan håndterer dere dette og hvordan påvirker dette norsk nærskipsfart?
2. Hva slags utfordringer ser dere når det gjelder IMOs reguleringer av utslipp fra shipping industrien?
    a. Hvordan kan man håndtere disse utfordringene?
    b. Hva har disse utfordringene å si for norsk nærskipsfart?
3. Hvilke muligheter ser dere når det gjelder IMOs reguleringer om utslipp?
    a. Hva tenker du er viktig for å håndtere IMOs reguleringer på best mulig måte i norsk nærskipsfart?
    b. Hva slags rolle har Norge når det gjelder disse mulighetene?
4. Hvordan tenker dere at fremtiden vil se ut for internasjonale reguleringer av utslipp for nærskipsfarten?
    a. Hvordan kan dette påvirke norsk nærskipsfart?
    b. Påvirker deres forventinger om fremtidige reguleringer strategiske avgjørelser?

Drivers and barriers

1. Det finnes mange drivere (insentiver) og barrierer for utvikling av en mer bærekraftig nærskipsfart, hva slags drivere (insentiver) og barrierer ser dere på som de viktigste for norsk nærskipsfart?
    a. Og hvordan påvirker disse hverandre?
    b. Er det noen som er mer relevante enn andre?
2. De ulike segmentene i nærskipsfart, f.eks. ferjer, passasjerbåter, bulk eller container, har ulike utfordringer når det kommer til environmental upgrading, hvilke segmenter tenker du har de største utfordringene og hvorfor?
    a. Hvordan kan man håndtere disse utfordringene?
3. Samarbeid mellom aktører har vist seg å være viktig for bærekraftig utvikling av industrier, hvordan tenker du samarbeid er viktig for norsk nærskipsfart?
    a. Hvilken rolle har samarbeid i utviklingen av en mer bærekraftig nærskipsfart?
4. En viktig del av denne oppgaven handler om verdikjeden til nærskipsfarten, er det noen deler av verdikjeden du tenker har større problemer i denne sammenhengen?

a. Hvilken rolle har f.eks. vareeiere i reduksjon av reduksjon av klimagasser fra verdikjeden?

Future

1. Hvordan tenker dere fremtiden for norsk nærskipsfart ser ut?
    a. Hva slags teknologiske løsninger er mest lovende?
    b. Hva med alternative drivstoffmuligheter?
    c. Er det teknologiske løsninger eller drivstoff som nå er umodne, som dere tenker kan bli en mulighet i fremtiden?
    d. Hva slags løsninger ser dere på som mest lovende for nærskipsfarten for å gjøre denne industrien mer bærekraftig?
    e. Hvordan tenker du man kan implementere slike løsninger?
2. I Norge har fokus vært mye på batteri-teknologi, og nå også hydrogen. Hva tenker du om relevansen av disse løsningene for internasjonal shipping?

Closing up the interview

1. Er det noe mer du ønsker å tilføye?

Appendix B: Consent form

Vil du delta i forskningsprosjektet

"Environemtnal upgrading i norsk nærskipsfart»?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å analysere drivere og barrierer for «environmental upgradring» i norsk nærskipsfart. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Formålet med denne masteroppgaven er å få en bedre oversikt over norsk nærskipsfart mellom Norge og Europe og gå dypere i hvordan norske rederier håndterer «environmental upgradring», samt hvordan fremtiden for norsk nærskipsfart kan se ut. Dette vil bli sett på gjennom perspektivene Global Value Chain (verdikjede) og «environmental upgrading». Problemstillingen til denne oppgaven vil omhandle drivere og barrierer for environmental upgrading i norsk nærskipsfart.

Det samlede materialet fra denne masteroppgaven vil også bli brukt i forskningsprosjektene GREENFLEET og INTRANSIT (for SINTEF), som begge er meldt til NSD og finansiert av Forskningsrådet.

Hvem er ansvarlig for forskningsprosjektet?

Stiftelsen SINTEF/SINTEF Digital er ansvarlig for prosjektet. Masteroppgaven vil bli levert og vurdert av NTNU.

Hvorfor får du spørsmål om å delta?

Utvalget for denne masteroppgaven er representanter for interesseorganisasjoner (for eksempel Rederiforbundet), samt ledere i maritim sektor. Du blir spurt om å delta i dette prosjektet på grunn av din stilling i en etablert maritim organisasjon eller din rolle i norsk maritim sektor.

Utvalget er rekruttert gjennom SINTEFs etablerte nettverk og det vil bli spurt mellom 6 og 12 personer om å delta i dette prosjektet.

Hva innebærer det for deg å delta?

Hvis du velger å delta i dette prosjektet, innebærer det at du svarer på noen spørsmål i et intervju. Dette vil ta ca. 1 time. Intervjuet vil bli tatt opp og dine svar vil bli transkribert og registret elektronisk. Intervjuet inneholder spørsmål rundt nasjonale og internasjonale maritime reguleringer, drivere og barrierer for forandring av den maritime industrien, samt fremtidige bærekraftige løsninger.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket. Navnet og kontaktopplysningene dine vil bli anonymisert og det vil i oppgaven bare være informasjon rundt hvilken interesseorganisasjon/selskap du kommer fra.

Opplysningen vil være tilgjengelig for Markus Steen (veileder), samt for prosjektgruppene GREENFLEET og INTRANSIT ved SINTEF Digital.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Opplysningene anonymiseres når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er i mai/juni 2021. Etter prosjektslutt vil opptak og personopplysninger slettes, men det vil fortsatt foreligge transkriberinger av intervjuene hos prosjektgruppene GREENFLEET og INTRANSIT ved SINTEF Digital, slik at opplysningene fra intervjuene vil bli kunne bli brukt i disse forskningsprosjektene.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra Stiftelsen SINTEF/SINTEF Digital har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?
Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- Stiftelsen SINTEF/SINTEF Digital ved Markus Steen (Seniorforsker) ved e-post markus.steen@sintef.no. Eller ved student Mari Wardeberg ved e-post mari.wardeberg@ntnu.no.
- Vårt personvernombud: Thomas Helgesen, NTNU, ved e-post thomas.helgesen@ntnu.no

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Markus Steen (Forsker/veileder)

Mari Wardeberg

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet «Environmental upgrading i norsk nærskipsfart», og har fått anledning til å stille spørsmål. Jeg samtykker til:

- ☐ å delta i intervju om «environmental upgradring i norsk nærskipsfart»
- ☐ at intervjuene blir tatt opp via lyd
- ☐ at transkribering av intervjuene lagres etter prosjektslutt, til bruk i SINTEFs forskningsprosjekter GREENFLEET og INTRANSIT.

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

---

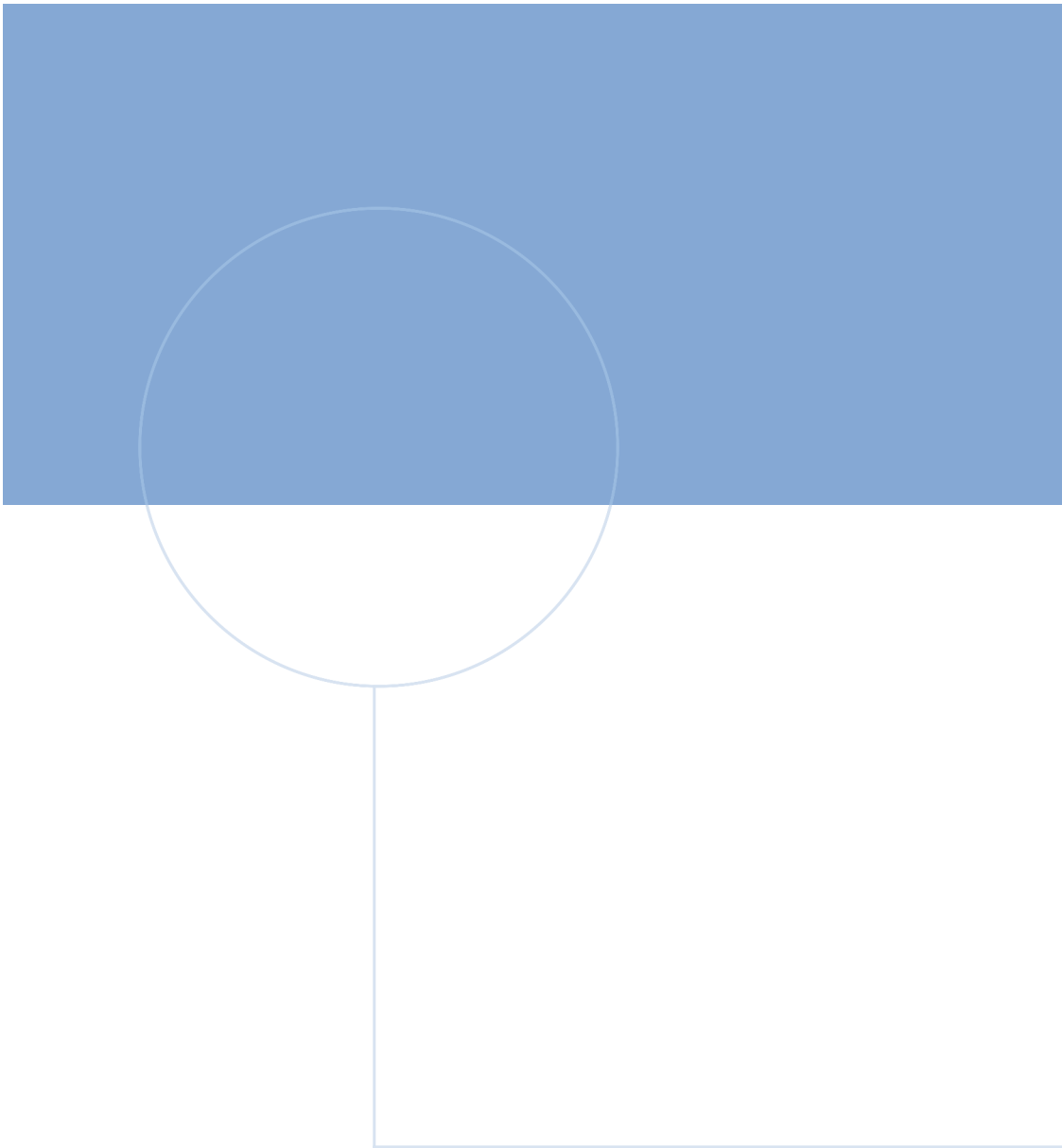
(Signert av prosjektdeltaker, dato)

Appendix C: Overview of selected documents for analysis

Document Type	Document Name	Author/Publisher	Year of Publication
Scientific paper	A cluster analysis of the maritime sector in Norway.	Benito et al.	2003
Website	IMO - What is it?	IMO	2013
Scientific paper	Implementing green supply chain practices: an empirical investigation in the shipbuilding industry.	Caniëls et al.	2016
Scientific paper	Buyer-driven greening? Cargo-owners and environmental upgrading in maritime shipping	Poulsen et al.	2016
Scientific paper	Overview of MARPOL ANNEX VI regulations for prevention of air pollution from marine diesel engines	Čampara et al.	2018
Report	Barrierer for lav- og nullutslippsløsninger for transport av tørrlast med skip	DNV GL	2018
Report	Grønn maritime: status for omsetning, eksport, sysselsetting og investering	Helseth et al.	2019
Report	Assessment for selected alternative fuels and technologies	DNV GL Maritime	2019
Report	The Government's action plan for green shipping	The Norwegian Government	2019
Report	Sustainability Report 2019	The Norwegian Shipowners' Association	2019

Report	Review of Maritime Transport 2019	UNCTAD	2019
White Paper	Grønnere og smartere – morgensdagens maritime næring	The Norwegian Ministry of Trade, Industry and Fisheries.	2020
Scientific paper	Implementing maritime battery-electric and hydrogen solutions: A technological innovation system analysis.	Bach et al.	2020
Report	Greener and smarter? Transformations in five Norwegian industrial sectors.	Mäkitie et al.	2020
Report	Kartlegging av nærskipsfart – sammensetning, alder, lønnsomhet og utfordringer med flåtefornyelse	Fjose et al.	2020
Report	International Convention for the Prevention of Pollution from Ships (MARPOL). International Maritime Organization	IMO	2020
News article	Grønt skipsfartsprogram: Serverer oppskrift for rederier og lasteeiere	Stensvold, Teknisk Ukeblad	2020
Scientific paper	Towards the IMOs GHG Goals: A critical overview of the Perspectives and Challenges of the Main Options for Decarbonizing International Shipping	Serra & Fancello	2020
Website	PILOT-E er evaluert – ordningen skaper merverdi for samfunnet og tar ut synergier i virkemiddelapparatet	Forskningsrådet	2021

Report	CO2-avgift som virkemiddel for klimagassreduksjon i nærskipsfart	Helseth et al.	2021
News article	16 rederier vil seile med hydrogendrevet bulkskip	Stensvold, Teknisk Ukeblad	2021
News article	Norsk rederi bygger verdens første hydrogendrevne lasteskip	Stensvold, Teknisk Ukeblad	2021
News article	Hagland bestiller to lavutslipps bulkskip	Stensvold, Teknisk Ukeblad	2021
Report	Advancing shipping's low-emissions future	Mitsubishi heavy industries group	N.D
Website	Verdens mest effektive og miljøvennlige skipsfart	Grønt Skipsfartsprogram	N.D



NTNU

Kunnskap for en bedre verden