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### Decarbonisation of Maritime Transport

**How does maritime industry lead the way towards decarbonisation? Greek shipowners' perspective**

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## **ABSTRACT**

The shipping industry is of great importance for the development and expansion of the global economy. Nevertheless, its contribution to GHG emissions and carbon emissions in particular is significant. Thus, challenges arise in the way the concept of decarbonization will be incorporated in the shipping industry aiding, expanding and further developing the triangle of sustainability. The Mediterranean Sea offers a less strict operational environment in terms of legislation. Though it is about to alter due to the imposition of sulphur emission limits from 2020 and the implementation of the European directive for the abatement of emissions at berth from 2025. Therefore, this study will examine through qualitative interviews with shipowners how the shipping industry is leading the way in achieving decarbonisation. Sample was taken from the Mediterranean area and specifically from Greece, since Greek maritime industry accounts for the transportation of 20% of global seaborne trade. The study comprises stakeholder theory along with behavioural theories in order to grasp the latent content of the respondents' reflections. Expansion of the LNG as marine fuel and a shift towards electrification for propulsion of vessels consist the main road map towards decarbonisation, as sketched from Greek shipowners' perspective.

**Keywords:** *Sustainability, Sustainable maritime shipping, Decarbonisation, Emissions, Shipowner, Maritime transport.*


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Gothenburg, 27 May 2019

A handwritten signature in black ink, appearing to be 'K. Koustoumpardis', written over a horizontal line.

Kyriakis Koustoumpardis

## **Abbreviations**

AMP: Alternative Marine Power

BWMS: Ballast Water Management System

CO<sub>2</sub>: Carbon dioxide

CH<sub>4</sub>: Methane

DSS: Deep Seas Shipping

Dwt: Deadweight tonnage

ECA: Emission control areas

EEDI: Energy Efficiency Design Index

ETS: Emission Trading System

GHG: Greenhouse Gas

HFCs: Hydro Fluorocarbons

HFO: Heavy fuel oil

IMCO: Inter-Governmental Maritime Consultative Organization

IMO: International Maritime Organization

IPCC: Intergovernmental Panel on Climate Change

LNG: Liquefied natural gas

LH<sub>2</sub>: Liquid Hydrogen

MBM: Market Based Mechanisms

MDO: Marine diesel oil

MEPC: Marine Environmental Protection Committee

MGO: Marine Gasoil

N<sub>2</sub>O: Nitrous Oxide

NO<sub>x</sub>: Oxides of Nitrogen

OPS: Onshore Power Supply

PFCs: Per Fluorocarbon

PM: Particulate Matter

PSL: Port State Leverage

RM: Rebate Mechanism

RO-RO: Roll-on-Roll-off

SECA: Sulphur emission control areas

SEEMP: Ship Energy Efficiency Management Plan

SF<sub>6</sub>: Sulphur Hexafluoride

SO: Ship Owner

SO<sub>x</sub>: Oxides of Sulphur

SSS: Short Sea Shipping

SVO: Straight vegetable oil

UN: United Nations

UNCLOS: United Convention on the Law of the Sea

UNCTAD: United Nations Conference on Trade and Commerce

VOCs: Volatile Organic Compounds

WCED: World Commission on Environment Development

## **Terminology**

Auxiliary engine: On-board diesel engine of small size used as alternative electrical power supplier for the ship. (Stopford, 2009)

Berth: Area of quayside in a port that a ship is loading and discharging its cargo. (Stopford, 2009)

Bulk carrier: vessel with a single deck that is designed to carry dry cargo such as coal, ore, sugar. (Stopford, 2009)

Charterer: Firm or person that hires a vessel from a shipowner either for a period of time or for its availability on cargo space for a single voyage. (Stopford, 2009)

Containership: vessel that is designed to carry containers. (Stopford, 2009)

Deep Sea Shipping (DSS): Transportation of commodities in which the crossing of an ocean is involved. (Opensea.Pro, 2019)

IMO: International Maritime Organization, agency within the UN that holds responsibility for legislating maritime regulations. (Stopford, 2009)

LNG carrier: Specialised ship designed for the transport of liquified natural gas at its boiling point of -162 degree Celsius. (The Project Definition, 2015)

MARPOL: International Convention for The Prevention of Pollution from Ships. (Lloyd's Register, 2019)

Tanker: Ship designated to carry liquid bulk cargo, with the cargo allocated in several tanks that consist the cargo space. (Stopford, 2009)

RO-RO ship: Vessels that are designed for the transportation of wheeled cargo with the aid of built-in ramps. (Marine Insight, 2019)

Short Sea Shipping (SSS): Transportation of either cargo and passengers by sea from one port to another, without crossing an ocean. (ECSA, 1999)

Shipowner: person who owns ships or is in possession of shares in a shipping company. (Collins dictionary, 2019)

Shipping company: a firm that has as its core business the transportation of goods or passengers in ships. (Investorwords, 2019)

## Table of contents

1. Introduction.....	1
1.1 Background.....	1
1.2 Description of the problem .....	2
1.3 Research purpose and question/s .....	2
1.4 Limitations and Scope.....	3
1.5 Disposition .....	4
2. Literature Review.....	5
2.1 Sustainable Maritime Shipping.....	5
2.2 Emissions from shipping and their impact.....	6
2.3 Regulatory framework and its business impact .....	8
2.4 Environmental Measures in Maritime Shipping .....	10
2.4.1. Technical measures EEDI.....	11
2.4.2. Operational Measures/ SEEMP .....	11
2.4.3. Alternative fuels.....	13
2.4.4 Alternative energy sources.....	13
2.4.5 Market-based mechanisms .....	16
2.5 Conceptual Framework.....	17
2.6 Greek maritime shipping status.....	19
3. Methodology.....	22
3.1 Research Design.....	22
3.2 Research approach .....	22
3.3 Research Method .....	23
3.4 Interview Design.....	24
3.4.1 Thematising .....	25
3.4.2 Interviewing .....	25
3.4.3 Transcribing.....	26
3.4.4 Analysing .....	26
3.5 Quality of the study.....	27
3.6 Ethical Considerations .....	28
4. Empirical Findings.....	29
4.1 Participants and Demographics.....	29
4.2 Implemented measures and Regulation compliance.....	31
4.3 Barriers and incentives.....	33



4.4 Shipowners propositions .....	36
4.5 Summary of key findings .....	38
5. Analysis and Discussion .....	40
5.1 Stakeholder theory perspective .....	40
5.2 Planned Behaviour theory perspective.....	42
5.3 Resource dependence theory perspective .....	43
5.4 Holistic approach and proposed roadmap .....	45
6. Conclusion .....	47
6.1 Research recap .....	47
6.2 Suggestions and recommendations .....	49
6.3 Future research.....	49
References.....	51
Appendix.....	67
Questionnaire:.....	67
List of Figures .....	69
List of Tables .....	69

# 1. Introduction

*In this section the research topic and factors that consist the background will be presented, to formulate the cornerstone of this dissertation. The identified problem will be introduced and described, accompanied with justification of this study's purpose and the formulated research questions. In conclusion, there will be a presentation of the scope and limitations and an illustration of the thesis disposition.*

## 1.1 Background

The shipping industry plays a pivotal role in the economic development of countries since business trade requires the facilitation of cargo movement from the point of production to the point of consumption (Goulielmos, 2010). On an international level, the shipping industry accounts for 90% of the worlds' transport of commodities in terms of volume (Yang, 2018). Thus, making it the backbone of the global economy with a trend of continuous growth due to augmented economic liberalisation and globalization of markets (ICS, 2018).

The shipping industry has already caught the eye of public attention and the concern regarding emissions making a subject under constant criticism, revealing a great environmental and business challenge for the industry (UNCTAD, 2009). The shipping sector sustains the focus and concern regarding environmental issues that arise from various groups of stakeholders and actors of the industry's relationship network such as regulators, investors, banks, insurers, charterers, media and public (Cogliolo, 2015). The reason is the impact of shipping on air quality and consequently human health and its contribution to climate change (Corbett et al., 2007; Eyring et al., 2010).

Though the seaborne transportation is regarded as the most energy-efficient mean of transport (Mortensen, 2009), CO<sub>2</sub> (Carbon dioxide) emissions produced by ship movements account for 3,3% of the total emissions worldwide and are foreseen to increase by the year 2050 in a percentage of 50-250, due to the increased demand in trade volumes (MEPC, 2018). Specifically, commercial shipping was estimated in 1996 to be responsible for 1,8% of global CO<sub>2</sub> emissions, while in 2007 the figure was risen to 2,7% and in 2014 dropped down to 2.2% (MEPC, 2014).

These reasons escalate the challenges of running the shipping sector in a sustainable way as of major importance in our century (Lirn et al., 2013).

## 1.2 Description of the problem

There is a plethora of research about measures taken towards environmental sustainability and their evaluation, along with the impact of mandatory measures adopted by legislative bodies and authorities on operational practices and business performance. However, there is little written with respect to how a roadmap towards sustainability is drawn by shipping companies themselves. The fact that the main focus of academia is around emission control areas and how maritime industry reaches compliance in order to operate in these discrete geographical areas reveals that there is also a gap towards how shipping firms behave outside those areas. According to the revised MARPOL (2008) Annex VI, it is stated that from 1/1/2020 the global fuel sulphur limit for all ships will be reduced to 0.50% m/m (mass by mass). Thus, it will be of interest and importance to investigate how ship owning firms will respond to such a change in a behavioural manner since there will be a large reduction in emissions on an international scale. Furthermore, scholars tend to put effort on the evaluation of the effectiveness of different measures that have either been imposed by a regulatory body or have been initiated by the industry itself in R&D context.

## 1.3 Research purpose and question/s

For member states of the EU, maritime governance as a structure is characterised as highly fragmented, with density concerning environmental policies and institutions in international and European level (Van Leeuwen & Kern, 2013). Though the development of a legislative framework with a proactive approach counts as a success for the EU, it is posed against the intention and will of having a unified international standard for the shipping industry in a global scale (Liu & Maes, 2011). Given the existing regulatory framework and its constant development and evolution, supported by the adoption, in 2018, of a strategy for the abatement of GHG emissions from ships that sets the specific target of achieving a reduction of at least 50% by 2050 compared to a 2008 baseline (MEPC, 2018), it is worthwhile to investigate how maritime companies intend to answer to this challenge.

The main research question to be answered is:

*“How does the maritime industry lead the way towards decarbonization of its business?”*

Complementary research questions to be answered are:

*“What is the level and type of current adoption of measures and what is needed to reach compliance?”*

*“What are considered as barriers and incentives towards decarbonization?”*

*“What is proposed by the industry itself towards decarbonization?”*

Thus, the sample for the investigation will be taken from the Mediterranean area, which is not a designated emission control area up to now, and specifically from Greece since Greek shipping is responsible for the transportation of 20% of the global seaborne trade (Union of Greek Shipowners, 2018). The methodology used to answer the questions will be that of personal interviews from corresponding administrative representatives of ship owning firms. The questionnaire will comprise both semi-structured and open ending questions with the intention to get reflecting responses from the respondents.

## 1.4 Limitations and Scope

The very nature of the study is considered to be subjective since it relies on the perceptions of the respondents about the examined topics of interest. Additionally, the researcher’s perceptions on the responses and meanings passed from the respondents and the meanings that derived from the transcripts are characterized by subjectivity. Therefore, subjectivity is one of the main limitations of this dissertation, along with the fact that is conducted by one Master student.

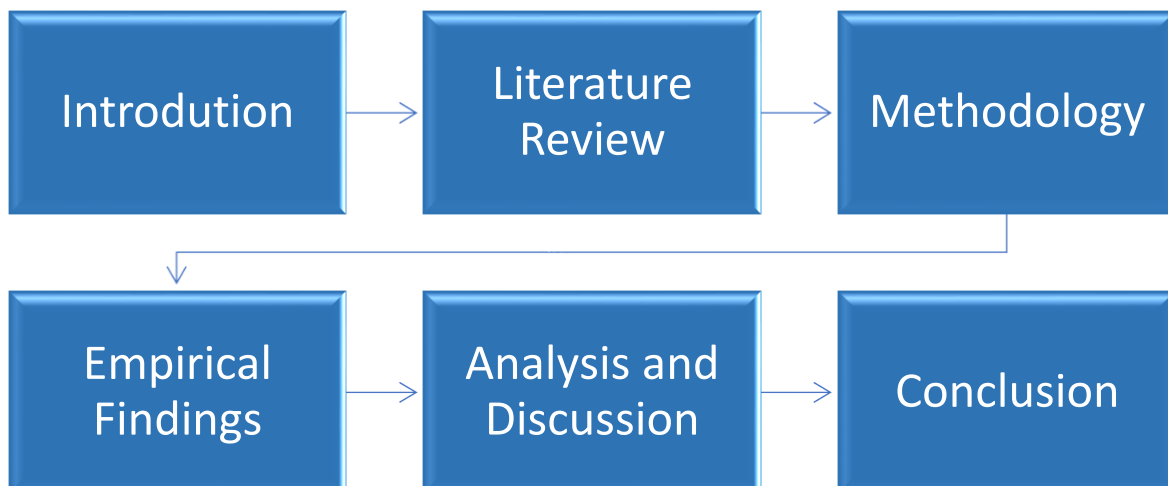
Another limitation that affects this study is that of time. The provided timeframe limits the time that could be devoted to better research the available body of literature and also the available time for responses from subjects in order to conduct the face-to-face interviews, transcribe-interpret-analyse the data and include them in the dissertation. Time limitation also prohibits the potential of re-interviewing the subjects in order to provide more supported results that could strengthen even more the study’s conclusions.

The number of interviews conducted is limited to seven. Therefore, the more increased the provision and expansion of the sample to be examined, the more representative the results could be and the more valid and reliable the conclusions that can be drawn. As for the industry itself, the current dissertation is only examining ship owning firms, due to the fact that they bare the decision of the specifications at the purchasing function, and not charters as they have a plethora of alternatives and are more flexible in their choices and business operations.

The scope of the study is within the shipping industry, though it is worth to state that the perspective to be examined is that of the shipowners' and more specifically Greek shipowners. As mentioned above, the reasons rely on the responsibility of operating and owning a vessel, along with the less strict operating environment that the Mediteranean area offers. The selected sample derived from a list of the 100 biggest Greek Shipowning firms that was provided to the author of this dissertation by the Union of Greek Shipowners and the Hellenic Chamber of Shipping.

## 1.5 Disposition

In the figure below, the outline that this dissertation is following is presented.



*Figure 1: Thesis disposition. Developed by the author*

## 2. Literature Review

*In this section there will be a provision of all theoretical concepts that serve to form the framework of reference under which the dissertation is conducted, and the analysis and discussion of the research questions will be performed. The scope of the master thesis is elaborated and comprises a review of sustainable shipping and emitted pollutants, the associated regulations and various compliance measures in the shipping industry, along with the conceptual framework and a brief description of the Greek maritime status.*

### 2.1 Sustainable Shipping

The term sustainability, or as initially referred to consumer consciousness for services and products that are economically-environmentally-societal friendly, was introduced 20 years ago to illustrate the level of reflection of an organization regarding its responsibility to its customers and upscaling it to society level in a holistic perspective (Matten & Moon, 2008). An alternative approach is the one of the triple bottom line posed by Elkington (1998), which comprises the aspects of people-planet-profit.

In the shipping context, the term sustainability comprises the fulfilment of present needs without jeopardising the needs of future generations, through balancing performance in three dimensions, namely economic, societal and environmental, as posed by Cheng et al. (2015). Carter and Jennings (2002) depicted environment, diversity, safety, human rights and philanthropy as the underlying dimensions of the concept. Hence, Yuen et al. (2016) provided a perspective for sustainability, from a stakeholder theory lens, by integrating the satisfaction of needs of social and environmental actors along with shareholders to reach and achieve sustainability.

As stated by Mansouri et al. (2015), maritime sustainability research has flourished in the last decade, revealing a trend that has awoken mostly due to the petition of exploring sustainable shipping practises. This can be supported by the fact that there is a plethora of literature regarding international regulations, namely EEDI (Energy Efficiency Design Index), SEEMP (Ship Energy Efficiency Management Plan), BWMS (Ballast Water Management System), that are developed to reduce the environmental impact of shipping activities (Albert et al., 2013; Tzannatos & Stournaras, 2014). Alternative fuels come to complement by aiming to ensure

differentiation of the provided service and high business performance on one the hand, and on the other minimize the environmental impact (Ballini & Bozzo, 2015; Maloni et al., 2013; Woo & Moon, 2014).

World Commission of Environment (WCED, 1987) referred to sustainability, from a cost perspective, defining it as the process where costs are internalised in order for actions to be truthfully valued as viewed through an intergenerational approach. On the other hand, Mcguire and Perivier (2011) have criticised the practices followed by shipping companies in an international scale. Specifically, they argue that the system of open registries prohibited the internalization of true costs associated with the shipping activity, namely environmental, social and labour, by the international community. Thus, giving the opportunity of offering a discounted internalized cost of maritime shipping, authors claimed to be artificial seeing from the lens of a holistic perspective of sustainability and questioned the general sustainable concept in a maritime context.

Nonetheless, the rising concern of the public opinion regarding environmental issues, namely the depletion of resources and pollution that is caused due to shipping activities deriving from the globalization of operations and business activities, are discussed in a wide basis by political leaders as well (Revkin, 2009; Rosenthal, 2009)

## 2.2 Emissions from shipping and their impact

According to the Intergovernmental Panel on Climate Change (IPCC, 2000) the main emissions that are listed under the Greenhouse Gas category are:

- Carbon dioxide (CO<sub>2</sub>)
- Methane (CH<sub>4</sub>)
- Nitrous Oxide (N<sub>2</sub>O)
- Hydro Fluorocarbons (HFCs)
- Per Fluorocarbon (PFCs)
- Sulphur Hexafluoride (SF<sub>6</sub>)

with CO<sub>2</sub> being in the highest rank in terms of figures and all of them presenting high correlation with the total amount of fuel consumption. As reviewed by Cullinane & Cullinane (2013), other emissions related to the shipping industry are:

- Oxides of Sulphur (SO<sub>x</sub>), which is emitted to the air when the remaining sulphur converts into sulphur dioxide
- Oxides of Nitrogen (NO<sub>x</sub>), emitted during the combustion process at high temperatures of fossil fuel
- Volatile Organic Compounds (VOCs), emitted due to the incomplete combustion process
- Particulate Matter (PM), it is generated through the combustion process and is correlated to the poor quality of fuels.

According to Lack et al. (2009), more than 60.000 premature deaths in a global scale are caused by this kind of emissions, revealing the impact upon human health, along with the monetary impact about health-related issues that are also found to be substantial. In particular, short term exposure to SO<sub>x</sub>, NO<sub>x</sub>, VOCs, Ozone, and PM can cause eye, nasal and throat irritations, nausea and respiratory difficulties for elderly and children, while in the long-run it was found that there is substantial impact in the central nervous system, along with cardiovascular issues, asthma, respiratory deficiencies and occurrence of emphysema, and carcinogenic effects (US EPA, 2008; 2009; Cullinane & Cullinane, 2013). The impact of shipping emissions extends to the environment in general affecting both fauna and flora, along with the impact on water-life through their contribution to phenomena such as acid rain and photochemical fog (Cullinane & Cullinane, 2013).

Besides the carbon footprint that can be depicted and pollutants that can be emitted during the time that a ship is on a route, concerns are already risen for emissions committed while a ship is at berth and their impact on the environment in a regional level, reaching the figure 55-77% of total emissions committed around port areas (Hulskote & Van Der Gon, 2010). That is caused because ships still leave their engines in a running mode to keep their necessary functions ongoing, such as heating and maintenance (Cullinane & Cullinane, 2013). Thus, exhaust emissions occurring in ports are of crucial importance since they can be three to five times larger in volume from those that can be emitted while cruising (Deniz et al. 2010; Tzannatos, 2010). Finally, the shipbreaking process can affect negatively both human and environmental condition due to the release and exposure of hazardous materials and substances, namely oil discharges and asbestos (European Commission, 2009).



## 2.3 Regulatory framework and its business impact

The corresponding agency that bears the responsibility of forming, developing and updating the regulatory and legislative framework of the maritime industry is the International Maritime Organization (IMO). The agency functions under the umbrella of the United Nations (UN) and is responsible to ensure the safety and security in the shipping context along with the prevention and the depletion of atmospheric and marine pollution that is caused by ships (IMO, 2019a). IMO, was formerly known as IMCO (Inter-Governmental Maritime Consultative Organization) until its name changed in 1982, was formally established in 1948 at an international conference in Geneva, came into force in 1958 and held its first meeting the following year (IMO, 2019b). The institutionalization was completed in 1982 by the adoption of the United Convention on the Law of the Sea (UNCLOS), in which jurisdictional issues risen from the adoption of MARPOL (International Convention for the Prevention of Pollution from Ships) in 1973 were resolved, and obligations regarding flag, port and coastal states were defined and set the basis for global environmental governance in shipping (Tan, 2006; Van Leeuwen et al., 2010).

MARPOL, being the main international convention that covers pollution and marine environmental issues, was adopted by the IMO in 1973 and consists of six Annexes (IMO, 2019c):

- Annex I: Regulations for the Prevention of Pollution by Oil (enforced 2 October 1983)
- Annex II: Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (enforced 2 October 1983)
- Annex III: Prevention of Pollution by Harmful Substances Carried by Sea and in Packaged Form (enforced 1 July 1992)
- Annex IV: Prevention of Pollution by Sewage from Ships (enforced 27 September 2003)
- Annex V: Prevention of Pollution by Garbage from Ships (enforced 31 December 1988)
- Annex VI: Prevention of Air Pollution from Ships (enforced 19 May 2005)

More specifically, for environmental matters a separate committee was established in 1975, called Marine Environment Protection Committee (MEPC), taking actions within the sphere of activity of IMO (IMO, 2019d).

MARPOL Annex VI was revised in 2008 setting the global limit of the sulphur content deriving from a ship's fuel up to 3,50% to be put in effect in 2012, a level of 0,50% to be effective from 2020 put under consideration, and also set Emission Control Areas (ECAs); the Baltic Sea in 2006 and the North Sea and English Channel in 2007 (Cullinane & Bergqvist, 2014; IMO, 2019e). The limit for those areas was set to 0,1% as of the beginning of 2015 dropping it from the level of 1,00% that was put in effect in 2010 (Cullinane & Bergqvist, 2014; Panagakos et al., 2014). To unify the regulatory framework outside ECAs the decision to set the level of 0,50% was finalised and will be put on fully obligatory effect on January 2020 for all EU sea territory (IMO, 2018a).

Complementary to IMO, the European Union (EU) and its Member States aid in the improvement of the legislative body by raising standards to issues regarding safety and protection of both human life and environment, issuing corresponding directives (Sotiroski, 2016). Towards the direction of emission reduction, the regulatory body took into consideration not only the emissions committed while at sea, but also those emitted while at berth, thus the Directive on the deployment of alternative fuels infrastructure (2014/94/EU) was issued. According to the directive, all European Member States need to facilitate the installation of shore-side electricity technology to provide ships with electrical power while at berth, and build LNG refuelling points in maritime and inland waterway ports by December 2025 (EU, 2014).

Costs and benefits are the main issues regarding environmental regulations that are under the microscope of academia and are discussed and given estimations, both at individual firm level and in an industry context (Rennings & Rammer, 2011; Cainelli et al., 2013). The impact of the strictness of these regulations was examined by the academia. Specifically, Kalli et.al. (2009) examined the impact upon transportation costs in the geographical context of Finland, while Cullinane and Bergqvist (2014) argued on the socio-economic benefits of ECA regulations and dictated the need of designating more areas such as the Mediterranean and seas around Asia as ECAs. Panagakos et al. (2014) investigated the possibility of upscaling the Mediterranean Sea as SECA and found that it would cause a modal shift towards road transportation due to the rise in transportation costs. Though, as they conclude, their case study needs generalization in order to receive further validation, since the designation of an area as a SECA relies on political decisions that could affect the final outcome. The difficulties for the adoption of a common regulatory framework for shipping emissions in the Mediterranean area due to the large heterogeneity of the littoral states with entirely different economies and

attitudes towards environmental issues were highlighted by Goulielmos, Giziakis and Christodoulou (2011).

Kehoe and Woxenius (2010) assessed the restriction of sulphur limits in the Mediterranean and Atlantic sea and found that the newly inserted limits will aid in the increase of costs in the dominant market share of Short Sea Shipping (SSS). Schembari et al. (2012) examined to what extent emissions from ships affect the air quality of the Mediterranean Sea. For the liner shipping, Chen et al. (2018) investigated the potential applicability of a route-choosing behaviour model. They pointed out that under certain conditions there could be an increase in total emissions in regional level.

As a result, firms initiated the incorporation of the terms of environmental responsibility in their corporate actions embedding the concept in managerial literature in correlation to environmental performance in firm level (Dummett, 2006; Yliskylä-Peuralahti & Gritsenko, 2014).

## 2.4 Environmental Measures in Shipping

Kyoto protocol remained the most important initiative in implementing binding targets and setting obligatory limits for GHG emissions, though two of the most important sectors, namely international aviation and shipping were not enclosed since there was a disagreement in the approach for setting by country responsibility (UNFCCC, 2005; Giziakis & Christodoulou, 2012). Shipping's impact upon climate was included in the agenda of IMO in 2003 where the adoption of Resolution A.963 (23) dictated the MEPC (Marine Environment Protection Committee) to form regulations concerning CO<sub>2</sub> emissions in view of technical, operational and market-based measures (IMO, 2004). Among the operational measures, as illustrated below, scholars include also alternative fuels and alternative forms of energy as potential applicable solutions towards forming a sustainable shipping sector.

#### 2.4.1. Technical measures EEDI

As indicated by the IMO (2018b) this type of measures are pointing to the reduction of CO<sub>2</sub> emissions through the optimization of the energy consumption of ships. The IMO introduced and made obligatory the usage of the EEDI (Energy Efficiency Design Index). The EEDI is applied in newly built ships, from July 2011 and onwards, to ignite technological and engineering breakthroughs regarding hull optimization, engine performance, waste heat recovery, propellers (MEPC, 2011). Though the choice as to what technologies and means are used to reach the levels of compliance with the indicated formula are up to the firm that orders a ship, to ensure that the industry is directed to the path of innovation, the index gets tighter and more demanding every five years, with the initial phase requesting for a 10% decrease of CO<sub>2</sub> levels (IMO, 2018a).

Despite the profound good intentions of the index, literature has identified controversies of such implementation. Psaraftis and Kontovas (2013) stated that EEDI reductions can be achieved by using engines that operate in less revs/minute, meaning that no technological advancements are required in practice. Ozaki et al. (2011) commented on the fact that bigger ships with better fuel economy, which means smaller EEDI, are pursued due to harsh competition. Devanney (2011) conducted an empirical study on large crude carriers and found that CO<sub>2</sub> emissions are to some extent increased by use of EEDI. This occurred since more fuel was consumed, with the vessel operating in higher revs/minute, to minimize and supplement the energy used onboard. Hence, it is revealed that efficiency of the design of the ship does not take into full consideration various operational choices that affect the actual energy efficiency (Cichowich et al., 2015). Furthermore, the uncertainty of demand could pose implications to the actual performance of ships since the depending on the full/half load could alter the energy consumed per goods transported (Wan et al., 2016).

#### 2.4.2. Operational Measures/ SEEMP

The IMO during the MEPC 58 (MEPC 58/INF.7) introduced the SEEMP in its discussions on ship efficiency management plan as a derivative of the created coalition in the maritime industry. The SEEMP is regarded as an operational measure that aims at the improvement of the cost effectiveness and operational energy efficiency of a ship and encourages shipping companies to manage their ships and fleet in an effective manner over time (MARPOL, 2008).

Among operational measures that are included in the SEEMP are trim optimization, weather routing and slow steaming (Dewan & Yaakob, 2018).

Reichel et. al. (2014) define the act of finding the exact trim that gives the minimal resistance for service speed and loading conditions as trim optimization, while De Wit (1990) stated that choosing the optimal route, with respect to weather conditions, that ensures the minimum consumption of fuel is regarded as weather routing. Though, as mentioned by Dewan & Yaakob (2018), those solutions seem to reach maturity, there is no data of great significance that complements their positive affection towards costs and savings (Rehmatulla & Smith, 2015). Thus, the concept of slow steaming is regarded to be more applicable due to the increase of fuel prices along with the fact of tightening of the regulatory framework (Cariou, 2011).

Armstrong (2013) argued that the most significant and widely used operational strategy is the one of slow steaming. The reduction of sailing speed for maritime vessels, otherwise called slow steaming, shows an increase in implementation and became a common practice especially in the segment of container liner shipping, as posed by Notteboom and Cariou (2013).

Concerning greenhouse gas emissions, Psaraftis and Kontovas (2010) examined and argued about the potential of reducing speed, altering the number of ships consisting a fleet, and commented on the usage of in-transit inventory holdings to cope with environmental needs for protection. Due to the fact that slow steaming is responsible for increasing the total time of the voyage, Cariou (2011) pointed out the doubt of slow steaming being a solid solution and a sustainable strategy for dealing with CO<sub>2</sub> emission reduction. The author dictated that it could be feasible within a specific spectrum of bunker prices and for major lanes of trade.

On the other hand, Kollamthodi et al. (2008), Buhaug et al. (2009), Corbett et al. (2009), Faber et al. (2010) have previously accepted the slow steaming strategy in a more wide-open manner as an effective strategy for reducing greenhouse gas emissions. Lindstat et al. (2013) conducted an analysis on the effectiveness upon direct emissions through the lens of sea and freight market conditions. Whether the aforementioned strategy can serve also as a cost-reductive one was investigated by Woo and Moon (2014), whose model for optimal speed that comprises both cost-effectiveness and emission reduction, dictated a speed of 17,4 knots within an operating range of 14-22 knots. Finally, a comprehensive overview was provided by Psaraftis and Kontovas (2015) regarding decision models upon slow steaming in the maritime transport context and the fundamental trade-off that exists within it.

### 2.4.3. Alternative fuels

The definition of alternative fuels is any other fuel that is used for powering a ship, besides those that are currently and mainly used by the industry, i.e. heavy fuel oil (HFO) and marine diesel oil (MDO), as stated by Gilbert et al. (2018). Authors claim in their study the twofold importance of incorporating the usage of alternative fuel in the shipping industry. The first is to reach regulatory compliance in terms of sulphur emissions in Emission Control Areas and globally, as well as align with NO<sub>x</sub> and PM emissions in the short-term. Additionally, the long-term goal is to address to GHG emission reduction issue. Their list of important alternative fuels consists of: Liquefied natural gas (LNG), Methanol, Liquid Hydrogen (LH<sub>2</sub>), Bio-diesel, Straight vegetable oil (SVO), Bio-LNG.

Eide et al. (2013) dictate that biodiesel and vegetable oil are the most suitable alternatives to substitute MDO and HFO respectively that require the minimum modifications in a ship's engine to be applicable. Another applicable solution that shows increased adoption in a worldwide scale is the LNG as more cost-efficient than Marine Gasoil (MGO) (Strømman et al., 2006) and as Lowell et al. (2013) argued the usage of LNG presents promising results in terms of reducing air and climate pollutants, giving support to Tzannatos and Nikitakos (2013) that claimed a reduction of 20-23% in CO<sub>2</sub>, NO<sub>x</sub> by 85%, PM and SO<sub>x</sub> by almost 100% through the shift from marine fuel oil to LNG.

On the other hand, Gilbert et al. (2018) made an assessment on alternative fuels taking the full-life cycle perspective. They found LNG as a suitable option to reach compliance with the regulatory framework, though they do not promote it into a low GHG emission fuel, while biofuels could be considered as a viable solution only if they do not compromise the land-usage and the creation of more emissions in the upstream of the attempt of producing it. Hua et al. (2017) compared, with the same approach, the operation between HFO and LNG and found that with the latter CO<sub>2</sub> emissions diminish, along with other pollutants, though methane emissions increase.

### 2.4.4 Alternative energy sources

According to Freire and Andrade (2015), 4 merchant ships exist that rely on nuclear power for propulsion with the fourth, namely the Servorput, regarded as a pioneer with respect to its

nuclear propulsion system and its logistics functions. This reveals the potential future the nuclear power has concerning the shipping niche and in particular the aid to provide a service of higher speed and by cutting the air emitted pollutants (Vergara & Mckesson, 2002; Carlton et al., 2011; Hirdaris et al., 2014). Although the operational fuel cost is low (Sawyer et al. 2008), the capital investment needed to initiate the development of such a vessel is significantly high (Carlton et al. 2013), but the major challenge and concern is that of safety and especially of the disposal of radioactive waste due to their catastrophic impact upon human health and environment (Féron et al. 2008).

Carlton et al. (2013) present five wind exploiting techniques for ships, namely soft sails, kites, wind sails, wind turbines and flettner rotors, whose greater advantage is that they are totally free from exhaust pollutants and their severest disadvantage is that they rely heavily on wind strength. Thus, Ren and Lützen (2017) consider them as a supplementary form of alternative energy. Although the return of investment on these systems is 3-5 years and fuel saving costs account to 10-35%, problems can be faced with loading and unloading along with the shrinkage of the maximum capacity of the ship due to the fact that such installations require space, especially on deck (O'Rourke, 2006).

Another form of energy that could act as a supplement according to Carlton et al. (2013) is solar energy by installing photovoltaic systems with its main advantage being also the emission freedom. Though, as mentioned by Lakatos et al. (2011) solar energy is highly depended on weather conditions and the available surface required on deck in order to be installed is significantly large, showing similar implications to the wind exploiting systems. A cost-benefit analysis made by Glykas et al. (2010) showed the return of such an investment depends highly on fuel prices and is estimated to minimum 10 years, while the commercial value of photovoltaic system lasts for 25-30 years.

Auxiliary engines are typically used by ships while at berth to cover their needs for electrical power for communications, lights, hot water supply, heating and support of onboard equipment (Winkel et al., 2016). To substitute the operation of auxiliary engines, vessels could be plugged-in with an electrical supply from shore, practice which is called cold ironing/shore-side electricity/Onshore power supply (OPS) (see fig. 2)/Alternative Maritime Power (AMP) (Sciberras et al., 2015). The impact of committed emissions led ports into investing on infrastructure to facilitate shore-side energy provision as a solution that reduces both emissions committed as well as the noise caused as examined by Nicholas (2017). The author though

mentions that investments must be made from shipowners as well in order for this technology to be compatible to ports, such as the port of Gothenburg and Antwerp, that have already invested in such a concept (Acciaro et al., 2014).



*Figure 2: Onshore Power Supply (OPS). Source: DNVGL, 2018*

Despite the mandatory character of the regulation, the shipping industry has already expressed a general distrust due to the high implementation costs, along with the low rate of return of the investment (Grey, 2016). So far, according to Nicholas (2017), the main solution that vessel operators implement is the one of scrubbers and cleaner fuels. Though as the author dictated the solution of cold ironing is better in terms of emission reduction and does not require the usage of scrubbers or of cleaner fuel to cover onboard needs, however the upfront cost and operational costs (purchasing electricity from ports) seem to be prohibiting factors for adopting such a measure.

To solve the issue of cost of investment and who bears the responsibility of suffering such a financial burden, Winkel et al. (2016) proposes that governmental support must complement the initial investment costs, a reduction on tax electricity used for shore-side electricity. Hence, the success of the concept relies on the high cooperation of shore-side stakeholders along with shipowners.



#### 2.4.5 Market-based mechanisms

The concept of market-based mechanisms (MBM) is based on the ground of provision of financial or market motivations for firms to improve their behaviour and performance regarding environmental issues, along with their response to such motivations and incentives (Van Leeuwen & Van Koppen, 2016).

Shi (2016) stated the emerged need for adoption and implementation of market-based measures in the international shipping industry with Wan et al. (2018) dictating the gap that technical and operational measures leave towards decarbonization. The IMO evaluated the proposals of the state-members (MEPC, 2010) and Papageorgiou et al. (2017) reviewed, examined and assessed through fuzzy logic modelling the most important:

- The *Global Emission Trading System (ETS)*: referred to a global cap-and-trade system including allowances that can be sold in global auction, and target year with cap on total emissions, to control maritime emissions. The implementation requires ships to be registered in an international ETS body and allowances formed in respect to their CO<sub>2</sub> emissions, with the auction returns being invested in emission mitigation projects in developing countries.
- The *GHG Fund*: for every purchased ton of bunker fuel a levy must be paid with the generated revenue being invested in projects to lessen the gap between the target set of emissions and the emitted ones by the industry. Implementation will also require the registration of bunker fuel suppliers to facilitate inspections and the provision of a Bunker Delivery Note.
- The *Port State Leverage (PSL)*: an emission charge will be paid by each ship upon arrival on a port with respect to the amount of fuel that was consumed during the undertaken voyage. A global emission target will serve a basis for the levy, with ships that exceed targets in terms of efficiency being rewarded. This measure shows directness in reducing emissions, though takes no consideration of the ships design, operations or its energy source.
- The *Rebate Mechanism (RM)*: the calculation of the rebate is done depending on a by value share of global imports made in a county. There is no actual efficiency target, though it can be combined with any other maritime MBM that can generate revenue.

Van Leeuwen (2010) poses that market-based mechanisms and their adoption diverges from what the IMO is using so far as common practises which mainly comprise setting standards for individual ships at their initial state during their construction, as well as discharge and equipment settings. Worthington (2013) argues upon the character of MBMs, dictating that in relevance to the strictness of regulations, those mechanisms are perceived to be more business-friendly due to the flexibility of a firm to decide for itself and have a choice upon its response. Giziakis and Christodoulou (2012) found that Greek shipping companies are not in favour of the implementation of market-based measures showing preference on the adoption of technical and operational ones. The successful outcome of these mechanisms was examined by Mol and Oosterveer (2015), who identified CSR (corporate social responsibility) and sector's or firm's environmental orientation and objectives as influencing factors, with Carroll (1991) defining CRS as the actions implemented by a firm in order to fulfil its economic, legal, ethical and philanthropic responsibilities at the same time.

Wan et al. (2018) pinpointed the need for a full cost-benefit analysis to comprehend the best applicable policy, to ensure balance between environmental and economic factors and the associated trade-offs, especially for the most sensitive developing countries. On the other hand, Lema and Papaioannou (2013) took a stakeholders' view and concluded that the usage of specific instruments could be endorsed, due to the involvement of benefits and gain for a country, though their environmental effectiveness could be questioned.

## 2.5 Conceptual Framework

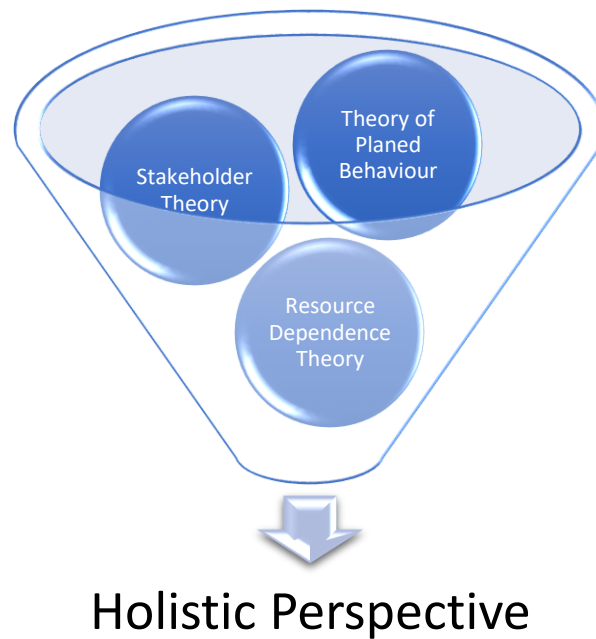
Shipping firms in their majority seem to respond to concerns regarding environmental issues and adopt green shipping practices, greening their operations, since they enable the flows of trade in transportation and act as intermediates in the global supply chain (Wong et al., 2009; Yang et al., 2009). Shipping companies, due to regulatory control and to facilitate the necessity for responding to their CSR obligations, raise their standards regarding environment and society (Lam, 2015; Lai et al., 2013), leading to a reformation of the already established green image as a business purpose (Hicks, 2007). Therefore, Green shipping is referred to the usage of resources and energy for commercial and merchant purposes by a ship, with respect to the reduction of those resources and energy to ensure the diminishing of GHG emissions and other environmental pollutants generated (Lee & Nam, 2017).

The fact that the shipping industry is highly regulated, motivated academia to study the institutional theory and factors that affect the industry. Specifically, Yang (2018) examined institutional pressures on green performance, revealing their correlation between internal and external green practices along with external green collaborations. Institutions are one of the main stakeholders in the shipping context therefore they affect actions and decisions to be made when addressing sustainability issues (Parmigiani et al., 2011). Freeman (2010) stated that stakeholder theory implies managers contribute in sustainable practices due to moral obligations, while Meixell and Luoma (2015) used it to give an explanation on what motivates a firm towards practising sustainable.

However, the stimulus of performing sustainable activities might not derive from the pressure or dictation of stakeholders as Wolf (2014) posed. The theory of planned behaviour dictates that the implementation of green shipping practices relies on subjective norms, attitude and perceived control (Ajzen, 1991). Yuen, Tai and Wong (2017) argued on the tendency of shipping firms to implement green shipping practices when they are perceived as aligned with the firm's competitive strategies.

The resource dependence theory poses that for a firm to survive it is of crucial importance to acquire and maintain the necessary resources from its outer environment, namely financial, knowledge, time, materials, capabilities that will add value to the firm (Pfeffer, 1972; Hillman et al., 2009). To facilitate and ensure the availability and accessibility on resources, implementing sustainable shipping practices are viewed, according to Lun et al. (2016), as tools to strengthen relationships with stakeholders and enhance trust and commitment.

Yuen et al. (2017) integrated the perspectives of stakeholder theory, the planned behaviour theory and the resource dependence theory to form a conceptual model to analyse the drivers and outcomes of performing green shipping practices. The authors pointed out that these theories are complementary to each other and form the antecedents of green shipping practices. The above-mentioned model (see fig. 3) will be the guide and serve as a conceptual basis to the construction of the questionnaire used to perform the investigation to answer the research questions. The rationale relies on the fact that the authors' approach was under a holistic triadic level which comprises drivers-practice-performance. Thus, providing a coherent nomological comprehension of the correlation between the latent investigated variables that are included in each theoretical perspective.



*Figure 3: Conceptual Framework Model (Yuen et al., 2017). Developed by the author*

## 2.6 Greek shipping status

Through the pass of time, seaborne trade required ships to become bigger and tailormade with high grade of specialization due to the internalization and formalization of the industry (Vorbach, 2001). Ships that comprise the global fleet are categorised depending on the carried cargo with RO-RO (roll-on-roll-off) ships, (dry) bulk carriers, tankers, refrigerated ships (reefers) and multipurpose ships forming the corresponding categories (Van Leeuwen, 2015). The category of cargo and the region affects and differs the growth in seaborne trade (Institute of Shipping Economics and Logistics, 2011), with economic crisis decreasing such a growth especially caused by the overcapacity of the global merchant fleet, fact that puts shipping rates under constant pressure (UNCTAD, 2012; Sand, 2015).

Greece remains in recession, under economic supervision and facing a slowest rate of growth according to data from the European Central Bank within the eurozone for the year 2017 (Chrysolora, 2018). However, the shipping industry ranks second, behind the tourism industry, in terms of importance to the Greek economy which started to show significant growth in modern times since the 19<sup>th</sup> century, though it is active since the 5<sup>th</sup> century BC (Gaille, 2018).

Greece is placed in the top five ship owning countries, among Japan, China, Germany and Singapore, in terms of cargo carrying capacity accounting 309 million dtw (deadweight tonnage), presenting a total fleet of 4.199 vessels and holding the largest share of oil tankers (UNCTAD, 2017). Moreover, as illustrated in Figure 4, bulk carriers along with chemical and product tankers show a substantial ratio to the global fleet (Union of Greek Shipowners, 2018).

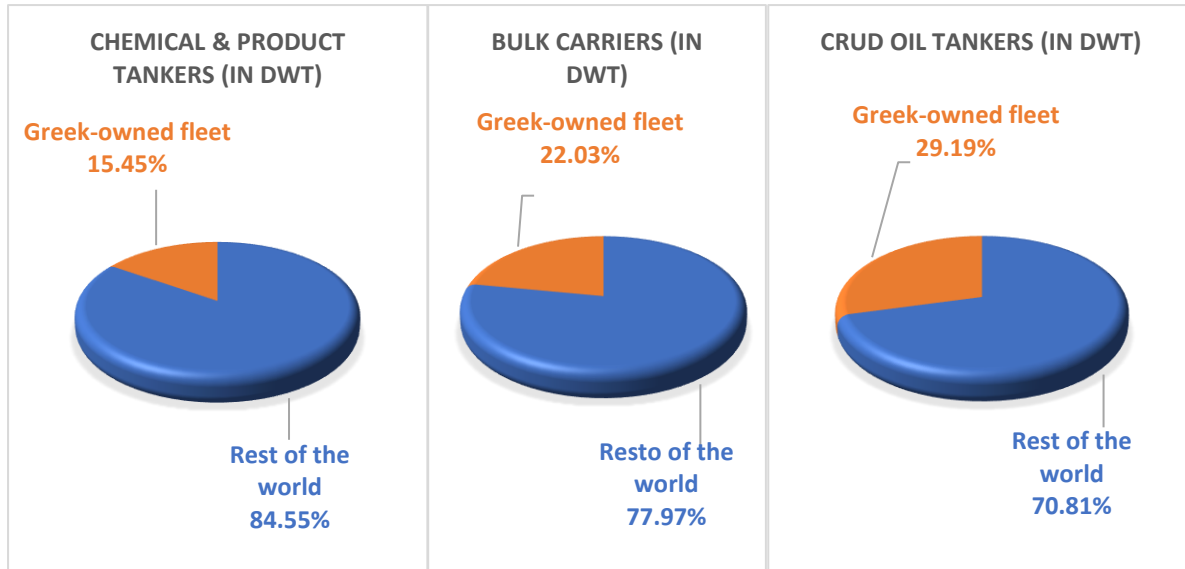


Figure 4: Ratio of Greek-Global fleet (Union of Greek Shipowners,2018). Developed by the author

Given the fact that 0.15% of world population is Greek and Greek seaborne trade covers the 20% of the global trade reveals the importance and significance of the Greek maritime industry in a global scale (ibid). More specifically, the Greek Merchant Fleet displayed an increase by 0,4% in 2018 in comparison to 2017 (Hellenic Statistical Authority, 2019). The Greek maritime transport industry presented an increase in foreign exchange earnings by a figure of 16.19% from 2016 to 2017 and reached the amount of 9.14 billion euros, provided by a highly diversified fleet, as shown in figure 5, operating in a worldwide span (Union of Greek Shipowners, 2018).

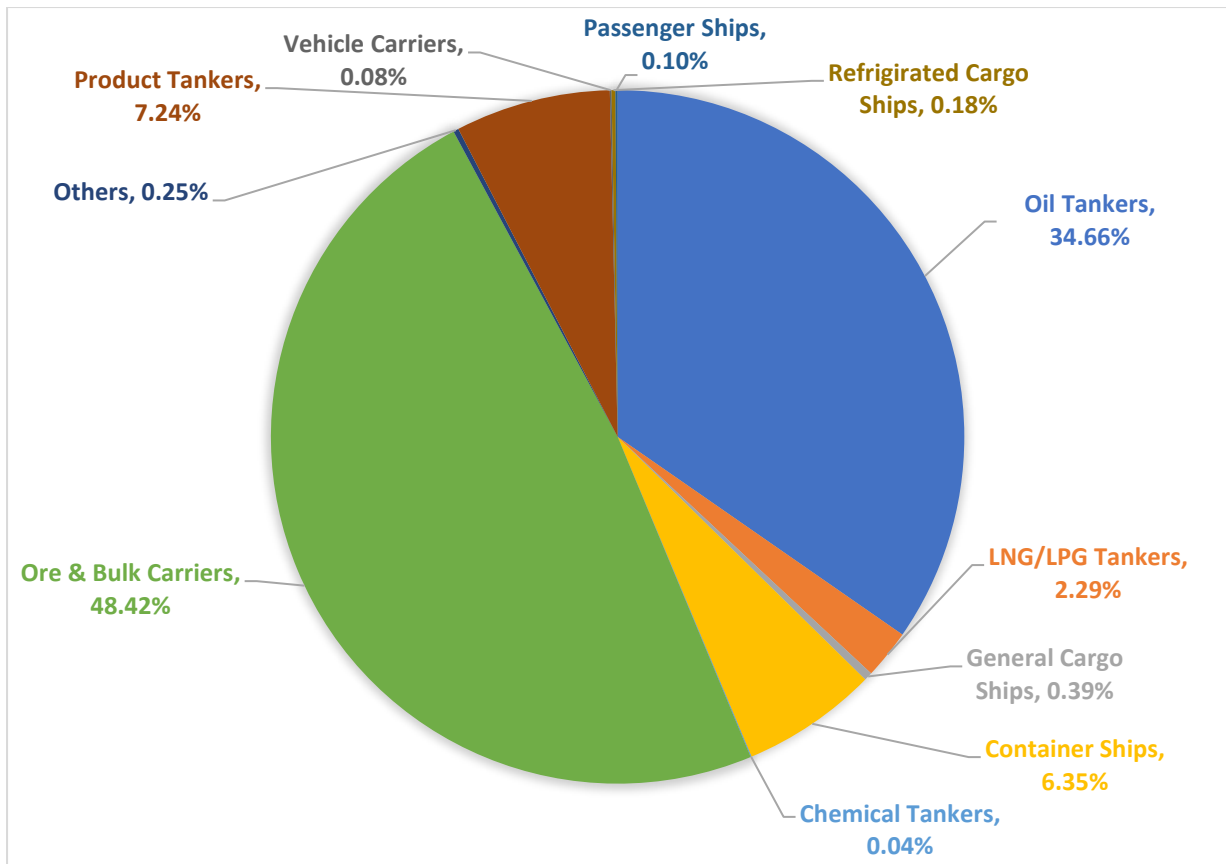


Figure 5: Ship type analysis of the Greek-owned fleet in dtw (Union of Greek Shipowners, 2018). Developed by the author

### 3. Methodology

*In this section the provision of the theoretical concepts in view of the methodological approach for conducting the current dissertation will follow. This is done with the intention to provide the relevant scientific background that will enable the research questions to be answered in the most proper manner. Furthermore, it will provide the justification and the rationale of the selected approach and method.*

#### 3.1 Research Design

It is essential for the reader to be informed in advance on the path that was followed in order to reach specific findings, since studies that lack in the provision of the methods and methodology used suffer from severe lack of trustworthiness (Biggham, 2008). Choosing and adopting a particular type of research strategy affects the final outcome of a dissertation (Rudestam & Newton, 2007), while there is a collection of approaches, namely experimental research, grounded theory, surveys, case studies (Biggham, 2008). According to Collins and Hussey (2013) there are two paradigms under which a research can fall into. The first is the paradigm of positivism, where the singularity and the objectivity of social reality is posed and therefore it shows independence from the researcher. On the other hand, the second paradigm is interpretivism, where the construction of reality is social and under subjectivity.

The authors point out the different approaches that fall under those two main paradigms. In positivism, the data to fulfil the scientific goal is of quantitative nature, while for interpretivism the collection of qualitative data is used to answer research questions. Both quantitative and qualitative approaches present distinctive features, and the choice among them relies on the nature of the problem to be put under investigation along with the purpose that is going to serve (Kvale, 1996; Rudestam & Newton, 2007).

#### 3.2 Research approach

As argued by Collins and Hussey (2013) in a deductive approach, which is commonly used in paradigms of positivism, empirical observations are used to test a developed conceptual and

theoretical framework and therefore show a tendency to move from general inferences to particular instances. The opposite path is followed under the inductive approach used in paradigms of interpretivism, where the tendency is to move from particular instances towards general inferences, revealing a top-down and bottom-up, in terms of direction, respectively for each approach (Goddard & Melville, 2004).

Sounders et al. (2012) pinpoint that the establishment of a theoretical framework aids in formulating the research questions and results drawn from the empirical data can be compared to existing and dictated theoretical framework. According to the authors, there is a potential of developing a new theory by identifying patterns and relationships between phenomena. Hence, the chosen approach for the current dissertation will be the inductive one.

### 3.3 Research Method

Collins and Hussey (2013) define the term method, in the research context, as the technique that is used in order to collect and analyse data. In the search of relationships and patterns and their expression in numbers qualitative methods are more applicable, since the corresponding answers to relevant research questions tend to generally measure variables (Kvale, 1996; Biggham, 2008; Pope & Mays, 2006). Rudestam and Newton (2007) pinpoint that the causal relationship between the examined variables gives the researcher the opportunity to draw its conclusions upon the subjected groups or classes that present collective differences, but they also mention that such a method is impractical when applied to human subjects in a social science context.

On the contrary, as argued by Kvale (1996), general quality in the research context is in regard to what kind of character lies within something, and the main focus of the researcher is to put emphasis on processes and underling meanings, rather than measure the frequency or quantity of phenomena (Biggham, 2008; Pope & Mays, 2006). Therefore, those methods collect the point of view and interpretations of the subjects to form knowledge and construct theoretical frameworks (Rudestam & Newton, 2007).

There are significant differences between the two methods and the tools they use, as posed by Rudestam & Newton (2007), with the most distinctive one being in terms of expression of data. In quantitative the expression of data is numerical, and the researcher uses statistical analysis



to interpret results, while in qualitative is in words with the researcher using text analysis for the results. Moreover, the authors state that quantitative methods are performed in controlled research situations, seek objectivity and emphasis is put on predicting and explaining. Though, in qualitative the occurrence of the research is performed in a natural context, seeking for subjectivity and a holistic perspective of the examined phenomena, with weight been put on meaning, exploration and description. Collins and Hussey (2013) characterize the results of quantitative researches as of low validity but scoring high in terms of reliability, enabling the generalizability of the results from the sample to the population. The opposite characteristics describing the qualitative ones, i.e. high validity and low reliability, where results can be transferred, in terms of generalization, from one setting to another similar one.

In qualitative research, the researcher forms a theoretical and conceptual framework using the literature review, which serves as secondary data (Collins & Hussey, 2013). Then begins analysing the existing knowledge in a qualitative manner in order to develop a general pattern (Kvale, 1996) and the research questions to be investigated. These questions can be changed and reshaped depending on the findings of existing literature throughout the research process (Pope & Mays, 2006). Methods that are used in qualitative research for the collection of primary data are observations, interviews, analysis of texts, transcripts, documents (Collins & Hussey, 2013). Current dissertation will use the concept of personal interviews to complete the collection of primary data.

### 3.4 Interview Design

Openness is one of the most valuable characteristics of qualitative interviews (Kvale, 1996) elevating them as fundamental in the list of qualitative methods (Easterby-Smith et al., 2002). Collins and Hussey (2013) mainly discuss two types of interviews, namely the unstructured and the semi-structure. The former refers to the provision of low intensity of guidelines and consequent questions rely on the evolvement of the conversation, whereas in the later type the researcher has prepared in advance some questions to foster the development of the conversation around the main topics of interest.

In the present dissertation the followed application will be that of semi-structured, consisting of a series of open-ended questions along with some closed questions to be answered in a face-to-face context. The mixture of these two types of questions is considered as a way of

increasing the optimization of the results that can be drawn from the interview (Collins & Hussey, 2013).

According to Kvale (1996) an interview investigation process consists of seven sequential stages, namely thematizing, designing, interviewing, transcribing, analysing, verifying, reporting. For conducting the current research, the stages chosen and put most focus on where that of thematizing, interviewing, transcribing and analysing, since the decision relies on the researcher due to the fact that there is no standard technique and rules for the different stages of the interview (Kvale, 1996)

### 3.4.1 Thematizing

The identification of the objectives of the research need to be completed prior to the adoption and implementation of the data collection method (Easterby-Smith et al., 2002), therefore the term *thematizing* refers to the formulation of the very purpose of the research and the description of the topic of interest before the initiation of the interview (Kvale, 1996).

A thorough investigation of the current body of literature concerning different types of measures regarding sustainability. The former combined with the conceptual frameworks in adopting and implementing sustainable shipping practices, along with the existing regulatory framework issued by relevant legislation bodies in relation to the maritime industry fostered the formation of the research questions.

In particular the purpose of the investigation is how the maritime industry itself, as expressed by the ship owning companies, leads the way to decarbonization and shows the way towards sustainability. Therefore, interviewing top-managers dealing with the sustainability policy of a firm was decided to be an appropriate approach.

### 3.4.2 Interviewing

Undertaking and interview allows the researcher to understand how beliefs and values are formed in the perception of subject and how they developed over time (Easterby-Smith, 2002). Therefore, the term *interviewing* includes the reflecting perspective to the seeking knowledge along with the reaction on an interpersonal level of the situation (Kvale, 1996). Hence, to

comprehend the interviewees response upon a matter and its perceptions upon it, semi-structured interviews are deemed appropriate (Easterby-Smith, 2002).

As conveyed by Collins and Hussey (2013), using semi-structured interviews consisting of both open and close questions will enable the provision of the research with rich qualitative data, performance to be undertaken in the natural working environment of the interviewee in a face-to-face manner to ensure the comfort of the subject. The closed questions allowed the researcher to keep control of the interview and enable the steering and direction of questioning, while at the same time the open-ended questions facilitated the freedom of expression and the provision of reflecting responses from the participants part.

### 3.4.3 Transcribing

The transcription of an oral speech into a written text to proceed to the analysis part is what is referred by Kvale (1996) as *transcribing* and includes actions of video and audio recording, as well as keeping notes and remembering. In the current dissertation all interviews were audio recorded and notes were kept ensuring that no information of potential significant value could not be captured and used in the formation of the results and analysis. For interviews that are conducted in Greek language, additional transcribing procedure was necessary. Performing the proper translation of terminology and concepts in the English language in a manner that will not affect the validity and reliability of the study in terms of cultural or linguistic perspectives is of great importance.

### 3.4.4 Analysing

The decision that must be made as to what method will be implemented to draw conclusions in regard of the basis of the purpose and the investigated topic along with the nature of material derived from the interview is referred to as *analysing* (Kvale, 1996).

To ensure the provision of an in-depth analysis the six steps of interview analysis, as posed by Kvale (1996), namely:

- Subject describes; spontaneous response of their experience, feelings and actions in relations to the topic

- Subject discovery; of new meanings and relationships during the interview
- Interpretation of interview; comprehend the meanings of the interview and respond back to the interviewee with confirmation of understanding the received messages
- Interpretation of the transcribes by the interviewer; this step involves structuring and clarifying the material and developing of the meanings of the material
- Re-interviewing; a “self-correcting step” where the subject comments on the interpretations of the interviewer
- Action; subjects gain new insights through the interview and now act according to that basis.

### 3.5 Quality of the study

The two terms that affect and characterise the solidity, rigorousness and serve as measurements to the total quality of a research are, according to Collins and Hussey (2013), the terms of validity and reliability. Whether the data that was collected forms a representative, reflective and accurate status of the examined concepts is referred to as *validity*, while the non-provision of different results upon repetition of the study is referred to as *reliability* (Collins & Hussey, 2013)

Blumberg et al. (2011) argue that validity is separated in two forms, the external and the internal. Authors outline the former as concerning the usage in a more generalized population or generated in another sample frame, and the latter regarding the method used for the collection of the primary data and its efficiency in respect to relevant data collection. Furthermore, they pose that validity can be affected by the quality of the provided underlying theory as well as the implemented data collecting method.

Current dissertation aimed at providing a substantial theoretical framework to serve as a solid base for the development of secure results. Substantial justification is given through the literature of the chosen methodological approach and its applicable method and consistency. Hence, it is considered that the aforementioned affect in positive manner both terms of quality of the current research.

### 3.6 Ethical Considerations

Moral values and principles under which a research is conducted form the term ethics in the research content (Collins & Hussey, 2013), and for the used method of interviews consist of confidentiality, informed consent, consequences and anonymity if requested (Kvale, 1996; Collins & Hussey, 2013; Bell & Bryman, 2007).

According to Kvale (1996) briefing the participant in advance about the purpose and the interview procedure prior to the performance of the interview, covers the part of the informed consent, along with the provision of an introductory background of information about the researcher initially via e-mail. Thus, the author stated that the willingness of the participant is to be revealed by their positive response.

In this dissertation confidentiality, consequences and anonymity were secured via a signed by both parties of a standard consent form provided and issued by the ship owning firms. In the form is mentioned that all transcribes are safely stored and will be deleted after the completion and final submission of the current dissertation, and that no harm is intended for all participants and their corresponding organizations, ensuring their anonymity if it is dictated so.

## 4. Empirical Findings

*The chapter is dedicated to exhibit the results that derived by conducting 7 separate interviews, with the intention of gaining insights about the potential of reaching decarbonization in maritime transport. Focus is upon answering the main research question “How does the maritime industry lead the way towards decarbonization of its business?”. Results are categorized and presented under four subsections, while the chapter is finalised with a summary of key findings.*

### 4.1 Participants and Demographics

The aim of getting a holistic overview and gain insights from the involved actors was achieved due to the fact that answers came from participants that represent ship owning firms from all sizes in respect of their economic robustness. This also translates to the number of vessels that sort the firms’ fleet, with the sample consisting of firms with large, medium and small size fleet. Moreover, the displayed firms comprise their fleet either with the same type of vessels or with a mix fleet.

The type of business that actors are involved in, in terms of cargo carried, comprise a wide assortment since the fleet that is used is mixed operating both for scheduled legs and on the spot market, along with commercial extension to both passenger liner transportation and cargo carriage. Thus, the sample involves actors that operate all kinds of vessels giving the ability to the research to be more widely applicable and more reflective to the intended holistic approach of the shipowners’ perspective.

Regarding the operations of firms, the sample comprises firms that operate on both national and international level, with legs being carried out in both ECAs and outside of them. Thus, support is given to the study’s intention of examining the behaviour of the Greek ship owning firms regardless of their geographical spawn of operation, but at the same time including actors that operate both in short sea shipping (SSS) and in deep sea shipping (DSS).

Due to the signed consent forms issued by the firms and agreed by the author, which include anonymity restrictions and legal clauses, the names of the ship owning firms as well as the names of the representatives will not be mentioned or revealed. Thus, they will be coded under

the code name SO (Ship owner) and a corresponding number to aid the identification and characterization of each firm.

Among the participants, SO1 is considered to be the biggest Greek ship owning company in terms of profitability and economic performance. The firm operates sole and heavily in the LNG market, hence the company's fleet consists of 28 LNG tankers, 5 of them aging 13 years and 23 of them just being 3 years old. Thus, the average fleet age is nearly 5 years old. The company has ordered and are under construction six more vessels of same type in a well-known South Korean shipyard.

The next 3 participants to be presented score high in the ranks of the biggest firms in terms of fleet size. SO2 displays a fleet of 86 vessels in total, consisting of tankers, bulk carriers and containerships with an average age of 8 years. The firm has under order 3 tankers and 2 LNG carriers in an attempt to enter the LNG market. The firm trusts Japan and South Korea to complete the project of newbuilding ships. SO3 owns 79 vessels of the same mixture type as SO2 with an average age of 10 years. The firm has one tanker under order in a South Korean shipyard. SO4 has a fleet numbering 72 vessels of tanker and bulk carrier type with an average age of 9 years. The firm aims to enter the LNG market therefore, 4 LNG carriers are under order in South Korean shipyard.

As a medium sized firm, in terms of fleet, but high in profitability ranks, SO5 possesses 59 vessels all of which are containerships, aging 11 years in average. The firm has no new ships under order, though if they chose in the future the choices are two. They would consider two choices for the newbuilt ship. One option would be a Chinese shipyard as more cost-saving solution that also provides an adequate level of expertise. Alternative option would be a South Korean shipyard due to high level of expertise and traditional good business relationships that are already established from previous collaborations.

Lower in the ranks SO6 operates 13 bulk carriers of 12 years in active operations. The firm has not placed any orders for new ships, but potentially the choice would be of a Japanese shipyard due to better quality of expertise. Lastly, SO7 operates as regional passenger liner shipping, being active in the short sea shipping segment (SSS), with two RO-RO ships that are 8 years old. The firm currently lies on the second-hand market for acquiring vessels, though in the future they would choose a Greek shipyard since they trust their expertise in the construction of RO-RO ships.

Depending on the firm’s internal structure and their perception upon sustainability, different kinds of managers and departments implicate in order to find the best possible solution to deal with the subject. More specifically the identified departments and leading managers respectively are either operation, technical and lastly the safety and quality. The first four participating companies have assigned the issue of sustainability to technical department with a senior leading manager respectively. SO5 and SO7 have operations department while SO6 has appointed the safety and quality department to bear the responsibility. Thus, it can be stated that the mode of perception of sustainability, in terms of internal structure, is of technical approach. Hence, it reveals a first impression of the corporate culture and the initial mindset that ship owning firms have towards sustainability and should rely heavily on solving its technical implications.

Table 1 below summarises the main demographic findings of the study.

<i>Interviewee</i>	<i>Department</i>	<i>Fleet Size</i>	<i>Type of Fleet</i>	<i>Avg. Age</i>	<i>Ships Under Order</i>
<i>SO1</i>	Technical	28	LNG tankers	5 years	6 LNG tankers
<i>SO2</i>	Technical	86	Tankers, Bulk Carriers, Containerships	8 years	3 Tankers, 2 LNG tankers
<i>SO3</i>	Technical	79	Tankers, Bulk Carriers, Containerships	10 years	1 Tanker
<i>SO4</i>	Technical	72	Tankers, Bulk Carriers	9 years	4 LNG tankers
<i>SO5</i>	Operational	59	Containerships	11 years	-
<i>SO6</i>	Safety & Quality	13	Bulk Carriers	12 years	-
<i>SO7</i>	Operational	2	RO-RO ships	8 years	-

*Table 1: Main Demographic Results*

## 4.2 Implemented measures and Regulation compliance

All participating companies were familiar with the EEDI, the SEEMP and for Alternative fuels the sample widely identified HFO, MDO and LNG. Regarding the category of alternative fuels, SO1, SO5 and SO6 were familiar with the entire assortment. As for alternative sources of energy, all participants were familiar with OPS. Nevertheless, SO1 was the only firm to be familiar and aware of all the assortment of the alternative fuels and alternative energy sources and furthermore identified the ETS from the market-based mechanisms.



The familiarity with the measures comes in high accordance with the implementation of the green shipping practices from the ship owning firms and particularly their focus on an array of measures in the spectrum of operational and technical sphere. More specifically participants stated that they focus highly on the energy efficiency on board along with a combination of operational measures that provide the maximum result in reducing the emissions committed while at sea. The firms seek those measures to ensure compliance with the obligatory framework of regulations that is posed by the legislative body. Namely it was identified that compliance with the 2020 global sulphur regulation is already achieved by the installation of scrubbers and modifications in the engines to run on compliant fuels. Additionally, the mandatory compliance to the 2025 directive for emissions at birth is also dealt with the installation of cold ironing and LNG systems to cover the power supply of the ship.

The extension of the green shipping practices goes beyond the mandatory proposed solutions by the legislative body for the majority of the participants. As a major actor in the LNG market, SO1 is highly investing in the evolution of LNG systems, along with SO2, SO3, SO4 who are focusing on the implementation of ballast water treatment systems, high efficiency autopilots, electronic lubrication systems, while SO5 puts effort on perceiving ISO 9001, 14001 and 50001 standards. For SO6 and SO7 the focus is put on having the best possible maintenance of the vessels to keep them operating in the most efficient manner. For all participants the extension of waste disposal, zero-spills and safety on-board was of critical importance since it prologues the very policy of sustainability that each firm is trying to implement and promote as it is also depicted in their CSR reports.

An overall result that can be drawn is that the assortment of the implemented methods and the extension of the adopted measures increase in relation to the firm's size. Another crucial finding is that all firms have already reached compliance with the regulations and directives, despite the fact that the regulations and directives have not yet entered fully into force.

As stated generally from all participants, the reasons for adopting green shipping practices and in particular the adopted measures that they implement are various and not single-sided. All participants to a wide extent promoted a rationale of reaching compliance with regulations, reducing the impact of their operations in the environment and enhance their responsible actions towards the society and the environment. Among the impacts of measures that participants voiced of are commercial, under the lens of business relationships, meaning that measures can aid and enhance the quality of business relationships that are formed between

industry actors, or on the other hand aid in the termination of relationships that are not in accordance and alignment to their policy.

Another dimension was that of the environmental impact, and the effort that is put on perceiving the integrity of the environment and its resources. The economic impact was identified by the participants in connection with the preservation of resources and business relationships. The measures act concurrently as cost-saving practices, since efficiency is achieved, but also as indication of high quality of service that can be provided and as actual KPIs.

Table 2 summarises the main findings regarding respondents' notions around measure application and compliance to the regulatory framework.

#### *Main findings on implemented measures and regulation compliance*

- *Familiarity with measures is in accordance with implementation*
- *Focus on Operational and Technical measures*
- *Already achieved regulatory compliance*
- *Adoption relies on:*
  - *regulation compliance*
  - *reduction of environmental business impact*
  - *enhancement of socio-environmental responsibility*
- *Economical/Commercial and Environmental impact of measures*

*Table 2: Findings on implementation and compliance*

### 4.3 Barriers and incentives

The perception of sustainability as expressed by the representatives of the examined firms revealed differences to some extent, though the bottom line for each participant comprised all the three aspects that literature and academia have commented on, namely people, planet, profit.

SO1 thought of sustainability as a balance to be kept between costs, safety and environment when undertaking business activities. On the other hand, SO2, SO3 and SO4 revealed a more business-centred perspective of the term sustainability. As they mentioned sustainability to their context is similar to either business (SO2 and SO3) or corporate (SO4) sustainability, where the firm is the centre of the responsibility to manage and coordinate demands of environmental, social and financial nature. Thus, ensuring a successful, responsible, ethical and ongoing result.

For SO5 the term is also inner-centred with the extension of investing in R&D projects and programmes that will ensure and improve their operations while at the same time enhance their efforts of reducing the firm's carbon footprint. For SO6 and SO7 the scale yields more towards the safety on-board and the compliance with regulations, which in turn leaves a clear field of operations to ensure the most profitable transportation. Since the companies are of lower economic robustness, their sustainability goes around ensuring compliance and safety and focuses on ways to be profitable for their continuity and existence in the market. That policy was also depicted to the level and the extension of their adopted measures.

Two major barriers and prohibiting reasons for not expanding the adopted and implemented measures were pointed out by the shipping firms. The first was the technical difficulties due to different engine characteristics. This means that the possible solutions are restricted, and the options are narrowed down in every case. Another prohibit factor is the implementation cost for each proposed measure. This was a common factor for all the examined ship owning companies. Although they would be willing to follow a better solution, the cost or the risk, as explicitly pinpointed by SO5, of a new technology with no previous recording or rate of successful results in such a highly competitive, rough and strict business environment could jeopardise the very existence of the firm.

This reveals the tendency of the all firms to follow a very careful path and make efforts to retain a balance towards the sustainability triangle comprising the profitability, the preservation of the planet's resources and the safety of people while conducting their operations. It can be said that the heftier the firm is, the more the horizon of safety and environmental concerns are widened, and the firm is placed in the centre as the actor to bear the responsibility and take action towards sustainability beyond their obligations, as posed from the regulatory framework.

The firms commented on the incentives that would consider in order to expand the adopted measures. The improvement of the current status relies on the variables of the sustainability

triangle (people-planet-profit) and their reciprocal relationships perform. Shipowners 1,2,3,4 and 5 stated that for the selection of a measure, the fulfilment of both environmental, commercial or economical and technical criteria must be aligned. Specifically, for those participants, the expansion of the implemented measures would have to comprise the technical adjustability with the fleet and the ability to withstand the modifications. Another element is that of promising positive results to the abatement of emissions, otherwise there is no actual interest of following and investing in a measure that would potentially backfire from a future directive or legislation. Lastly the choice depends on having also positive results in terms of efficiency and reduce the cost of operations. As stated by the representatives, the implications of the cost reduction could be exploited commercially and aid in the development and enhancement of the clientele and the service provided to them. Thus, the selected measure should be implicated multidimensional in order to be promoted as eligible and be incorporated.

On the other hand, SO6 and SO7 would consider the expansion of the assortment of measures through freeing up capital from the reduction of port fees and taxation on tonnage carried. They consider that monetary incentives should be given from authorities and governments to firms in order for them to develop a plan for expansion and adoption of measures. The capital that could be in a way saved from taxation and port dues, could be allocated in widening the implemented methods and further enhancing the firms position in the market.

Participants stated that all three dimensions of the formed criteria that impact the selection of the measure are affected by their stakeholders. Each firm recognizes different stakeholders, though their impact expands to the aforementioned monetary/commercial, environmental and technical dimensions. Among the identified stakeholders of the participants were the legislative bodies (IMO, EU, port authorities) whose work and decisions affect and impact on the industry. Participants stated (SO1, SO5, SO6) that collaboration with those actors can aid in forming both cost-effective and planet-saving solutions. Additionally, the collaboration between business actors (competitors, customers, suppliers) could also aid in the formation of adequate and viable solutions that will ensure sustainability, as mentioned by SO2, SO3, SO4, SO7. They identified oil companies as their major stakeholder since they are highly depended on the provision of fuel to conduct their operations, along with their customers to whom they want to provide lucrative in terms of cost and high-end services. They agreed that collaboration throughout the chain is mandatory for finding applicable solutions that will lead to cost-saving and emission abatement results.

Regarding their notion about the regulatory framework and the legislative body along with their impact, the sample presents a variation. SO1 stated that the legislative body is seen as a valuable partner in forming future conditions of operations and ensuring the continuity of operations and business of maritime transportation. Shipowners 2,3,4,5 viewpoint the work of authorities as a safety barrier and the barer of the responsibility of bridging the gap between the societal, the economical and the environmental aspects. Thus, ensuring that business is conducted and leaded to a more sustainable manner, and consequently providing a collaborative and authoritative aspect. SO6 and SO7 share the respectful view towards the legislative body and framework and its intentions, though, they insert the variable of risk upon its decisions. They mention that their manoeuvrability is limited, and there is a high risk of facing critical business consequences if the decisions of the body are too radical or require a huge cost in order to reach compliance. Hence, the perception upon regulators is more of an authoritative one.

Table 3 is briefly representing the main aforementioned findings.

<ul style="list-style-type: none"> <li>• <i>Cost, Risk and Technical difficulties identified as barriers</i></li> </ul>
<ul style="list-style-type: none"> <li>• <i>Spectrum of perception on sustainability increases along with the firm's growth</i></li> </ul>
<ul style="list-style-type: none"> <li>• <i>Required incentives are of Commercial/Economical, Environmental and Technical nature</i></li> </ul>
<ul style="list-style-type: none"> <li>• <i>Stakeholder identification relies on their business impact upon the firm</i></li> </ul>
<ul style="list-style-type: none"> <li>• <i>3 general notions towards legislative body; partnership, collaborative, authoritative</i></li> </ul>

*Table 3: Notions on barriers, incentives, stakeholders and sustainability*

#### 4.4 Shipowners propositions

The two scopes that were heavily mentioned from scholars across the literature review were those of cost and environment. Measures throughout the chapter were criticised and examined under the lens of cost-effectiveness and the positive rate of results regarding their success of diminishing the carbonized impact of maritime transport.

Upon deciding the measures and policy for incorporating green shipping practices, all participants agreed that in the absence of a regulatory framework they would still engage the already implemented measures. They would endorse the development and continuous incorporation of technological advancements and put effort on finding solutions for fuel and energy effectiveness since there is a reciprocal relationship between the benefits that can be gained in costs and environmental issues.

Upon solely the cost-effectiveness of measures SO1 highlights the usage of EEDI, while as for solely environmentally friendly reasons the usage of LNG is promoted due to low emissions. SO2, SO3, SO4 identify the combined usage of EEDI along with the SEEMP and the usage of compliant fuel as both monetary and environmental applicable solutions. The selection of operational measures and specifically the optimization of the fleet and the trim along with the selection of correct staff to operate the fleet and aid in such a direction was prompted by SO5. The maximum effect in terms of environmental friendliness that can be achieved through cold-ironing and the promotion of LNG was stated also by SO5. The implementation of slow steaming and speed limitation were regarded as solid, straightforward and viable solutions for both cost and environment from SO6 and SO7 along with the usage of distillate compliant fuels.

According to SO1 the total decarbonization of maritime transport will be feasible but far in the future and it could be achieved only by disengaging from the usage of conventional fuel and energy sources. Thus, they have turned their business to the LNG market and work on the promotion of such a policy. For SO2,3,4 the total decarbonization is infeasible in the near future but it could be possible through the limitation of demand for shipping services, the improvement in energy efficiency and from technological breakthroughs that will actually ensure zero carbon emissions. SO2 and SO4 are considering a turn of business to the LNG market, through the ordering of such vessels, but the steering of the entire fleet towards such an alternative source of energy would require enormous amount of time and expenditure. The opinion of technological breakthroughs is also shared by SO5, SO6 and the collaboration among stakeholders is paramount in order to set the rails of such a project. Though for SO7 the initiation of running a vessel entirely on electrical power would be the recommended but is regarded as far-fetched at the moment. However, considering that the energy needed to operate in SSS is less than in open-sea, it is thought by the firm that the segment of SSS could shift its energy reliability towards electricity.

## 4.5 Summary of key findings

The sample covers most of the existing ship types along with the coverage of both SSS and open-sea shipping, in a wide range of the shipping market segments from actors that diversify in economic and fleet size. Thus, opinions from almost all type and size of shipowners were included to ensure a holistic perspective.

Technical and Operational measures were fully recognised, with MDO and LNG being the predominant alternative fuels. Regarding the alternative sources of energy, OPS was extensively recognized. The implemented methods are of technical and operational nature and a combined mixture of both categories, while MBMs were highly disregarded. Compliance with both 2020 global sulphur regulation and 2025 EU directive has already been reached with the investment in scrubbers, the use of alternative fuels and the installation of cold ironing systems respectively. Moreover, depending on the size of the firm, the adopted green shipping measures are further extended and go beyond the obligatory propositions of the legislative body.

Prohibiting reasons for the expansion of the adopted and implemented measures are of technical nature and in regard with engine compatibility issues along with the cost of investment and the implied risk of implementation. On the other hand, environmental effectiveness was qualified as an incentive along with the positive commercial implications of the selected measure. Moreover, the improvement of technical operability and optimization of business operations were added in the list of incentives upon selection of a practice, with the monetary aspect of tax and port dues reduction noted as well.

Collaboration among the different type of identified stakeholders is of pivotal role among the development, selection and expansion of the current list of suggested and implemented measures. Specifically, upon the legislative body, as the size of the firm increased the more of partner role of it is recognised in a partner-authority spectrum. Though the total decarbonization of the maritime transport is a very far-fetched concept, shipowners endorse the further development and enhancement of EEDI and SEEMP along with their optimized combination, the promotion and expansion of the use of LNG and the steady steering and advancement towards electrical power.

Responses that formed the key findings are briefly illustrated under clusters in Table 4 below.

Interviewee	Implemented measures	Compliance measures	Barriers	Incentives	Stakeholders	Propositions
SO1	Technical Operational Atl. Fuels	LNG, OPS systems	Technical and Cost	Environmental, Economical, Technical	IMO, EU, Port Authorities	LNG
SO2	Technical Operational Atl. Fuels	Scrubbers, OPS systems, LNG, HFO, MDO	Technical and Cost	Environmental, Commercial, Technical	IMO, EU Oil Companies, Competitors, Customers, Suppliers	Technological breakthroughs, LNG, Limitation of demand
SO3	Technical Operational Atl. Fuels	Scrubbers, OPS systems, HFO, MDO	Technical and Cost	Environmental, Economical, Technical	IMO, EU Oil Companies, Competitors, Customers, Suppliers	Technological breakthroughs, Limitation of demand
SO4	Technical Operational Atl. Fuels	Scrubbers, OPS systems, LNG, HFO, MDO	Technical and Cost	Environmental, Commercial, Technical	IMO, EU Oil Companies, Competitors, Customers, Suppliers	Technological breakthroughs, LNG, Limitation of demand
SO5	Technical Operational Atl. Fuels	Scrubbers, OPS systems, HFO	Technical, Cost and Risk	Environmental, Commercial, Technical	IMO, EU, Port Authorities	Technological breakthroughs
SO6	Technical Operational Atl. Fuels	Scrubbers, OPS systems, HFO	Technical and Cost	Tax and Port due reduction	IMO, EU, Port Authorities	Technological breakthroughs
SO7	Technical Operational Atl. Fuels	Scrubbers, OPS systems, HFO	Technical and Cost	Tax and Port due reduction	IMO, EU Oil Companies, Port Authorities, Competitors, Customers, Suppliers	Technological breakthroughs, Electricity

Table 4: Brief clustered presentation of responses



## 5. Analysis and Discussion

*Empirical results derived from the questionnaire will be discussed and analysed with respect to the conveyed conceptual framework. The results will be seen through the lenses and the perspective of the three theories that comprise the conceptual framework, namely the stakeholder theory, the theory of planned behaviour and the resource dependence theory. The chapter will end with the provision of a holistic perspective that rises from the three complementary theories along with a proposed model that answers the main research question.*

### 5.1 Stakeholder theory perspective

According to the field of business that each actor is involved in, there were different kind of stakeholders that were presented. Maritime transport is considered to be highly affected in general by regulators, as academia dictated, hence the concept of decarbonization as well. It was revealed that the road towards decarbonization of the maritime industry is affected by the legislative body, though the type of influence and its impact differs depending on the size of the firm. One of the main results is that the shipping industry, from the shipowner's perspective, is following a proactive strategy rather than reactive (Yuen et al., 2017) when it comes to regulation compliance. The non-designation of the Mediterranean sea as an emission control area did not lead to differentiation of implemented green shipping practices that are implemented in ECAs. This notion is further enhanced by the fact that though there is still available time for the full enforcement of the 2020 global sulphur regulation and the 2025 EU directive, the time framework will not be exploited or used to for another strategy.

The firm's size has a significant correlation with the impact and the perception of the regulatory body. As the firm's size increases, the level of responsibility is increased due to the level and magnitude of business that is conducted. Firms tend to put themselves in a more central role when dealing with their moral and environmental responsibilities as their size increases. Thus, it was revealed that the perception of the regulatory framework is moving on a spectrum where the one end is the authoritative perception and the other end the partnership perception. The more robust the company becomes, the more responsible in return (Drobetz et al., 2014; Pawlik et al., 2012), as it was conveyed by the level of adopted measures. Additionally, as firms move

towards the partnership end when it comes to the relationship perception with the regulators, the more robust position they possess and vice versa.

This movement on the spectrum and as the relationship transforms into a more collaborative one, leaves space for the involvement of other actors that affect the performance of the company and increases perception of importance towards them. Thus, the strength of the firm decreases its dependency upon the regulators and increases the importance and the focus that is put on other categories of stakeholders, such as suppliers and customers. The similarities of the implemented methods along with the way that they are developed as a firm increases its size and its magnitude shows characteristics of mimetic nature. Consequently, the highly competitive environment of the shipping industry dictates an ongoing process of keeping up with updating and improving the implemented methods, in accordance to what the leaders of the industry are conducting (Drobotz et al., 2014; Shin & Thai, 2015). The causal relationship between the implemented methods, their development and expansions are viewed through the scope of competitive advantage and serve as differentiating factors for the enhancement of the business performance. Hence, the leading companies of the shipping industry turn into a more collaborative spirit for the relationship with the regulators for uncovering better and viable solutions.

The results of the collaborative relationship with the regulators are further exploited and induced in the relationships with suppliers and customers who become the focal point that affects business performance. In the context of including actors across the supply chain the shipowners showed a normative approach (Zhu & Sarkis, 2007) when it comes to sustainability and decarbonization in extension. The development of the normative behaviour in the inner/competitive environment of the firm is the one that will aid in the formation of an appropriate green supply chain management. The importance of such an implication lies on the fact that shipowners bear the responsibility of ownership of the vessel, thus sustain the responsibility of being the central actor that will affect the market mostly both upstream and downstream.

The normative approach of the actor is further supported by the fact that in absence of the regulators, they would rely on the already structured inner norms to develop their strategy for decarbonising their operations. Thus, it can be said that the intra normative behaviour, along with the inner mimetic behaviour, combined with the collaborative relationship with legislative body leads into forming a pressure towards suppliers into following and developing solutions

and services towards decarbonization. On the other hand, such a practice leads to the provision of differentiated services affecting the formation of the future market, when looking the downstream part of the chain. Hence, the normative approach is highly connected with the monetary benefits that can potentially be gained and the improvement of the business performance.

## 5.2 Planned Behaviour theory perspective

Theory of planned behaviour poses that the adoption or the performance of sustainable shipping practices is correlated with the company's attitude, where attitude is the reflection of the firm's beliefs on the outcome of the selection (Yuen et al., 2017). The notion firms have towards sustainability is aligned to what academia poses and is reflected around the triple bottom line of people-planet-profit (Elkington, 1998). In this context the people aspect is reflected with the provision of safety, while the planet aspect is connected with the environmental integrity and resource preservation. Lastly the profit aspect is an operational derivative under the two previous lenses through a dynamic relationship among them, along with the reciprocal relationships coming from the outer environment of the firm.

The proactive approach that was showed by the shipping firms, along with the perception that there will be no field for conducting business unless it is secured, preserved and sustainable is aligned with Hargett and Williams (2009) and Yuen, Thai and Wong (2017). Authors posed managerial philosophy towards sustainability and the viewpoint of incorporating sustainability into the values, goals, and objectives of the firm as suitable solutions, rather than a must-do trade-off. Examined shipping firms supported such a statement since they positioned themselves in the center of the responsibility and perceive the conduction of business and operations as an outcome with respect to the first two aspects of the triple bottom line (people and planet).

Glanz, Rimer and Viswanath (2008) posed that the norms an entity is encountering are influenced by the approval or disapproval of specific behaviors by the outer environment. Yuen et al. (2017) extended it to the shipping context by posing stakeholders as the outer environment that approved or reject a certain behavior. The position as a central actor showed by shipping firms, combined with the proactive strategy towards regulation compliance and the development of normative behavior when referring to the outer environment contradicts the

notion of approval or disapproval. Though the solutions offered and suggested from various stakeholders in the shipping industry are operational, technical and market-based, the approval or disapproval derives from the central actor, in this instance the shipowner. The evaluation of each proposed choice is filtered and, as posed in the results, the already developed normative and proactive approach endorses straightforward and real-life applicable solutions. Such a behavior is also supported by the fact that the expansion and further development of the implemented measures is correlated with ensuring actual results in terms of emission reduction and resource preservation. Hence, the market-based mechanisms were not supported and were instead disregarded.

### 5.3 Resource dependence theory perspective

As mentioned in the literature review the existence of a firm is correlated with its access to resources that originate from the outer environment (Pfeffer, 1972; Hillman et.al., 2009). In the shipping context the outer environment has the form of stakeholders. Among the need of gaining access to resources lies the element of power that yields within each stakeholder category and the associated relationships, forming dependency bonds among actors (Yuen et al., 2017).

According to Stopford (2009) operational costs and specifically voyage cost, where the fuel cost is included, accounts for the 40% of the total costs. This explains the high rank that oil companies have among the list of the identified stakeholders and reveals the high dependency upon acquiring fuel resources. The fact that firms do not solely implement either technical or operational solutions, but rather choose to implement and seek for the best compilation of them is two-folded. The first is due to the subjected costs, whose minimization will free-up financial resources and secondly the efficiency will lead into the exploitation of less fuel resources per voyage. Thus, serving as an environmentally friendly combination. The second aspect is further enhanced by the fact that, though in a slow pace, firms tend to enter the LNG market (through their orders of newbuildings') and by considering the potential of electric-based solutions. Ultimately, the need for disengagement from oil companies, in terms of resource acquisition, is of major concern.

This reaction to the stimuli of the intra environment of the firms motivates and shapes the attitude of the planned behaviour (Yuen et al., 2017). The shift towards alternative solutions

such as the promotion of LNG and electrical power solutions shows a positive shift and enhancement of the behavioural attitude towards sustainability and its practices (Staats, 2013) that in turn leads to endorsement of specific behaviour (Chaiklin, 2011) and hence to encouragement of the aforementioned alternative strategies.

Among the resources that derive from the environment is knowledge and capabilities as posed in previous sections on which the development for both technical and operational solutions rely apart from the financial factor. The development of MBMs that are real-life applicable and without loopholes is far-fetched (Wan et al., 2018), the rejection of a global levy scheme (Giziakis & Christodoulou, 2012) which is further supported by current results boosts the dependency upon knowledge concerning operational and technical measures.

The willingness of the sector to overcome the technical deficiencies which are recognised as barriers to the further development of the assortment of green shipping practices is viewed through the motivation of investing the freed-up capital. The origins of the freed-up capital derive from improving the implemented green shipping practices since the proposed incentives must be of proven success both in environmental and financial terms.

Such a steer derives from the fact that shift in behaviour could originate from learning (Vogel & Wanke, 2016) of what measures suit best in order to comprise the aspects of the triple bottom line. The partnership with regulators will increase the associated pressure to other types of stakeholders so as to steer the industry in developing solutions that actually lead to decarbonization. The initiation of promotion of LNG as power source and the development of electrical power systems for operating vessels are correlated to the positive business performance. As results showed, they can be exploited commercially, thus bring satisfaction to stakeholders and bond through commitment and trust ensuring the ongoing access to financial resources (Lun et al. 2016; Yuen et al., 2017).

Hence, the institutional pressure moves more upwards the supply chain, and initiates the formation of the future clientele on the downstream. The implications here for the upstream part could be of altering the criteria of sustainable supplier selection for the shipping sector. For the downstream part, could be the alteration of the shipping customer relationship management as well as the development of a more sustainable behaviour of the demand, since, as Wan et al. (2018) pose, the rising demand for transportation is a contributing factor to the increase of emissions.

## 5.4 Holistic approach and proposed roadmap

Over time shipping industry has shown that the response regarding coping with emissions is slow and, in many cases, both shipping nations and the industry behaved in reluctance towards improving global rules (Upton, 2016). This is also supported by the fact that the values and interests of different stakeholders vary and conflict leading to the slow development of a solid roadmap (Wan et al., 2018), which in turn leads to the non-provision of a solid and real-life applicable plan until the year 2023 (Green4sea, 2016). Practical implications of MBMs like monitoring and collecting fuel data emissions along with the difficulties on allocating the responsibility due to flag of registry and geographical spawn of operation, make their development time consuming (Wan et al., 2018). Since emissions are related to fuel consumption for empowering the engine (Cariou, 2011), the outcome could be controversial to whether they will essentially lead to decarbonization of maritime transport.

Solutions of technical nature could face difficulties in terms of compatibility and engineering applicability and sustain economic infeasibility, like converting a vessel to run on LNG (Wan et al., 2018). This comes also at the cost of a hefty investment along with on-board storage space sacrifice (Verbeek et al., 2011). Actors in the maritime shipping sector, as the results revealed, are more than willing to invest in solutions that are comprising both environmental and financial benefits. Their tendency to disengage their dependency from consuming fossil fuel used to empower vessels, along with their slow attempts to enter the LNG markets with suitable vessels is of noticeable importance.

Regulators should follow the example of the automotive industry where the primary discussion of banning the internal combustion engines is initiated (Coren, 2018). Thus, instead of spending time and money resources on seeking solutions that concern the further improvement of existing engine efficiency, the focus should be put on the provision of technological breakthroughs that will actual lead to emission abatement. Given the fact that LNG usage could result in up to 60% reduction of emissions (Cariou, 2011), and examined actors sough solutions towards electrification and LNG, the regulatory pressure and focus must be put to such direction.

The scenario of decarbonizing the maritime transport is put way in the future and requires an enormous amount of money. Though the initial step is to formulate a corresponding regulatory

framework that is unified globally, to shift towards the development of compatible and economical feasible solutions for the application of LNG and electrical power. In turn of promoting an emission trading scheme, stakeholders should be obliged by regulations to contribute monetarily in the development of such solutions through investments, due to the fact that manufacturers solely cannot bear such a burden and shipowners need time and money to alter their fleet. Additionally, the current regulatory framework needs to be unified. The development of further restrictions will act as a prohibiting factor towards the shift to LNG and electrical power, since they will further intrigue the commitment of evolving the efficiency of current applications.

The road map could be developed in two stages with the first including the development of LNG burning engines for vessels operating in DSS. The second requires applicable electric solutions for vessels that operate in SSS with a gradual expansion to DSS when the technological advancements allow such an upscale. At the same time, the expansion of OPS in ports is of paramount importance. Institutional pressure along with collaboration and close partnership, though far in the future, will lead in real-life applicable solutions, shape a sustainable demand with the extension of enhancing the environmental awareness downstream the supply chain.

## 6. Conclusion

*The purpose of this chapter is to conclude the dissertation by summarising the whole master thesis research with the provision of a research recap. The chapter further provides suggestions and recommendations along with the portrayal of future research possibilities.*

### 6.1 Research recap

Focus of scholars and academia is put on examining the maritime transport and industry from a quantitative approach, about the implemented methods and their business and environmental impact with a calculative perspective. Hence, the dissertation contributed as another piece of literature of qualitative approach that provides insights from a behavioural aspect to the concept of decarbonization aiming to provide a holistic overview of how it can be achieved.

This study had as main purpose to investigate the feasibility of the concept of decarbonization and how a road map towards such a direction could be formed. The study went through a behavioural aspect, thus relied in the combination of stakeholder theory mixed with behavioural theories. Its significance lies on the fact of providing an alternative theoretical perspective and approach to the concept of decarbonization by gathering qualitative data as to how decarbonization is viewed and could potentially be achieved.

The dissertation had as focal point the examination of shipowners' viewpoint since they bear the responsibility of owning, operating and providing the maritime shipping industry with associated vessels. Moreover, the implementation of stricter regulations in the Mediterranean Sea, in order to unify the framework, raised concerns on how actors will react and how that geographical area responds to decarbonisation.

To answer the main research question of *“How does the maritime industry lead the way towards decarbonization of its business?”*, practical and perception aspects needed to be examined, thus leading to the formation of three complementary sub-questions as illustrated in section 1.3. The results were analysed under the lenses of stakeholder theory, the theory of planned behaviour and the resource dependence theory, ending with a holistic approach and a road map derived from the conclusions of the three aforementioned theories.



*“What is the level and type of current adoption of measures and what is needed to reach compliance?”*

Results showed that the familiarity and the implemented measures are closely aligned, and the selected measures are mainly of technical and operational nature. Energy efficiency was in the centre of interest for the shipowners, while the extension of the green shipping practices goes beyond the suggested measures. Compliance to the newly issued regulations and directives is already achieved, and the assortment of implemented methods expands as the size and economic robustness of the firm increases. The latent intentions of the actors were multidimensional with regulation compliance being one aspect along with monetary benefit that can be gained through usage of less resources. At the same time enhancing responsibility towards the business impact upon the environment could be occurred. Benefits extend to the enhancement of positive commercial implications and strengthening of business relationships.

*“What are considered as barriers and incentives towards decarbonization?”*

Identified barriers were of technical nature and involve compatibility of the potentially applicable solutions as well as the high cost of investment that is required along with the associated risk. Both technical compatibility and financial feasibility go along in the list of incentives that actors request in order to expand the adopted measures, but not unless they guarantee successful results in the abatement of emissions. This kind of success cannot be achieved by each actor working and operating in isolation, but rather with close collaboration and the formation of partnerships among stakeholders. Environmental sustainability is fully aligned with corporate and business sustainability. Thus, the triangle of people-planet-profit is dynamic and concurrent making environmental goals to be in accordance with business goals and performance.

*“What is proposed by the industry itself towards decarbonization?”*

The results revealed a high motivation in investing to new technologies with the aim of reaching a decarbonized maritime transport in the future. As revealed from the shipowners' perspective, what is needed are measures that are solid in their outcome and straightforward. Hence the rejection of the MBMs. The concept of decarbonization could not be achieved unless actors involved disengage from the internal combustion engine and its environmental impact.

The continuous development of measures and applications with respect to the internal combustion engine will never lead to actual decarbonization. Shift towards LNG is observed, since the results are immediately apparent in terms of emission reduction, while the concern is also focused on the development of electric power solutions initially for the SSS sector.

## 6.2 Suggestions and recommendations

The institutional pressure and in this case the pressure that can be exerted by the legislative body should aim in the unification of the concept of sustainability. Thus, developing a global and unified legislative framework of regulations and directives will set the same rules for all actors, upscaling the concept of decarbonization in a global level. Hence, the responsibility will be induced to every country and every nation that is involved in maritime industry and transport in extend.

The formation of the appropriate legislative framework must be aligned with the technological advancements and aid in their formation and development with regard to the final target of decarbonizing the industry. Instead of the introduction of an emission trading scheme, the development of an international investing/fundraising framework is proposed in order to facilitate a steady and smooth disengagement from internal combustion engine. The time and financial resources to be consumed for developing further efficiency applications in that type of engine and for the collection of emission data to develop a trading scheme, could be used for the development of LNG and initially small-scale electrical solutions. Then expansion and further development towards fully electrical propulsion could be initiated in a large scale. Since the automotive industry has already expanded its business operations in seeking and developing solutions around LNG and electricity, the shipping industry due to its large scale of operation could move to the same direction.

## 6.3 Future research

The limitations that this dissertation is subjected to could act as recommendations for future research. Further investigation with a bigger sample could add validity and reliability to the results of this master thesis and could potentially reveal factors and data that were not collected. The scope of investigation could further expand to other actors and stakeholders of the shipping

industry. Therefore, future research could involve engine manufacturers, shipyards, charterers, freight forwarders in order to investigate their point of view regarding decarbonization. Additionally, cultural differences as a moderating factor for implementing sustainable shipping practices could be examined with the expansion of the research to other Mediterranean countries that are involved in the maritime industry. Results and conclusion that are drawn from the Mediterranean could then be compared with other regions and ultimately could be sorted and potentially reveal what the industry requires in a global scale and level.

During the research, implications were risen in regard to actors that are involved upstream and downstream the supply chain, from a shipowner's perspective. Hence, it would be of scientific interest to examine how the shipping industry is implementing sustainable supplier selection methods and criteria under the lens of aiming decarbonisation. Additionally, for the downstream it would be worth investigating the formation of sustainable customer relationship management under the restrictions and implications of decarbonisation.

## References

- Acciaro et al., 2014. Energy management in seaports: A new role for port authorities. *Energy Policy*, 71, pp.4–12.
- Ajzen, I., 1991. The theory of planned behaviour. *Organ. Behav. Hum. Decis. Process.* 50 (2), 179–211.
- Albert et al., 2013. Ballast water regulations and the move toward concentration-based numeric discharge limits. *Ecological Applications*, 23(2), pp.289–300.
- Armstrong, V.N.N., 2013. Vessel optimisation for low carbon shipping. *Ocean Engineering*, 73, pp.195–207.
- Ballini, F. & Bozzo, R., 2015. Air pollution from ships in ports: The socio-economic benefit of cold-ironing technology. *Research in Transportation Business and Management*, 17, pp.92–98.
- Bell, E. & Bryman, A., 2007. The Ethics of Management Research: An Exploratory Content Analysis. *British Journal of Management*, 18(1), pp.63–77.
- Biggham, J., 2008. *Succeeding with your master's dissertation: a step-by-step handbook*, Maidenhead: McGraw Hill/Open University Press.
- Blumberg et al., 2011. *Business research methods* 3. European., London: McGraw-Hill Higher Education.
- Buhaug et al., 2009. "Second IMO greenhouse gas study." *International Maritime Organization, London*.
- Cainelli et al., 2013. Environmental performance, manufacturing sectors and firm growth: structural factors and dynamic relationships. *Environmental Economics and Policy Studies*, 15(4), pp.367–387.
- Cariou, P., 2011. Is slow steaming a sustainable means of reducing CO<sub>2</sub> emissions from container shipping? *Transportation Research Part D: Transport and Environment*, 16(3), pp.260–264.
- Carlton et al., 2011. The nuclear propulsion of merchant ships: Aspects of engineering, science and technology. *Journal of Marine Engineering & Technology*, 10(2), pp.47–59.

- Carlton et al., 2013. Future ship powering options: exploring alternative methods of ship propulsion. *London: Royal Academy of Engineering*.
- Carroll, A.B., 1991. The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. *Business Horizons*, 34(4), pp.39–48.
- Carter, C. & Jennings, M. 2002. Social responsibility and supply chain relationships. *Transportation Research Part E*, 38(1), pp.37–52.
- Chaiklin, H., 2011. Attitudes, behavior, and social practice. *J. Soc. & Soc. Welfare*, 38, 31.
- Chen et al., 2018. Provision of Emission Control Area and the impact on shipping route choice and ship emissions. *Transportation Research Part D: Transport and Environment*, 58, pp.280–291.
- Cheng et al., 2015. Sustainability in maritime supply chains: Challenges and opportunities for theory and practice. *Transportation Research Part E*, 78, pp.1–2.
- Chrysolora, E., 2018. *Greece remains an economic pariah*. Kathimerini, ekathimerini.com [Online] Available at: <http://www.ekathimerini.com/227527/article/ekathimerini/business/greece-remains-an-economic-pariah> [Accessed 08 Feb 2019].
- Cichowicz et al., 2015. Dynamic energy modelling for ship life-cycle performance assessment. *Ocean Engineering*, 110(PB), pp.49–61.
- Cogliolo, A., 2015. Sustainable shipping green innovation for the marine industry. *Rendiconti Lincei*, 26(1), pp.65–72.
- Collins dictionary, 2019. Definition of ‘shipowner’. [Online] Available at: <https://www.collinsdictionary.com/dictionary/english/shipowner> [Accessed 22 Apr 2019].
- Collis, J. & Hussey, R., 2013. *Business Research: A Practical Guide for Undergraduate and Postgraduate Students* Fourth., Palgrave Higher Ed M.U.A.
- Corbett et al., 2007. Mortality from ship emissions: a global assessment. *Environmental science & technology*, 41(24), pp.8512–8.
- Corbett et al., 2009. The effectiveness and costs of speed reductions on emissions from international shipping. *Transportation Research Part D*, 14(8), pp.593–598.

- Coren, M., 2018. Nine countries say they'll ban internal combustion engines. So far, it's just words. [Online] Available at: <https://qz.com/1341155/nine-countries-say-they-will-ban-internal-combustion-engines-none-have-a-law-to-do-so/> [Accessed 27 Apr 2019].
- Cullinane, K. & Bergqvist, R., 2014. Emission control areas and their impact on maritime transport. *Transportation Research Part D: Transport and Environment*, 28, pp.1–5.
- Cullinane, K. & Cullinane, S., 2013. Atmospheric Emissions from Shipping: The Need for Regulation and Approaches to Compliance. *Transport Reviews*, 33(4), pp.377–401.
- Deniz et al., 2010. Estimation of shipping emissions in Candarli Gulf, Turkey. *Environmental Monitoring and Assessment*, 171(1), pp.219–228.
- Devanney, J., 2011. The impact of the energy efficiency design index on very large crude carrier design and CO<sub>2</sub> emissions. *Ships and Offshore Structures*, 6(4), pp.355–368.
- Dewan, M. & Yaakob, O., 2018. Barriers for adoption of energy efficiency operational measures in shipping industry. *WMU Journal of Maritime Affairs*, 17(2), pp.169–193.
- De Wit, C., 1990. Proposal for Low Cost Ocean Weather Routeing. *Journal of Navigation*, 43(3), pp.428–439.
- DNVGL, 2018. INDUSTRY; *A proactive approach on safety*. [Online] Available at: <https://www.dnvgl.com/expert-story/maritime-impact/a-proactive-approach-for-safety.html> [Accessed 15 May 19]
- Drobetz et al., 2014. Corporate social responsibility disclosure: The case of international shipping. *Transportation Research Part E*, 71, pp.18–44.
- Dummett, K., 2006. Drivers for Corporate Environmental Responsibility (CER). *Environment, Development and Sustainability*, 8(3), pp.375–389.
- Easterby-Smith, M., Thorpe, R. & Lowe, A., 2002. *Management research: [an introduction]* 2. ed., London: SAGE.
- Eide et al., 2013. CO<sub>2</sub> abatement potential towards 2050 for shipping, including alternative fuels. *Carbon Management*, 4(3), pp.275–289.
- Elkington, J., 1998. *Cannibals with Forks: The Triple Bottom Line of 21<sup>st</sup> Century*. New society Publishers, Gabriola Island, BC.

European Commission, 2009. *An EU strategy for better ship dismantling* (Vol. COM (2008) 767). Communication from the Commission to the European Parliament. [Online] Available at [http://ec.europa.eu/environment/waste/ships/pdf/com\\_2008\\_767.pdf](http://ec.europa.eu/environment/waste/ships/pdf/com_2008_767.pdf) [Accessed 25 Jan 19].

ECSCA (European Community Shipowners' Associations), 1999. Short Sea Shipping; The full potential yet to be unleashed. [Online] Available at: [https://www.ecsa.eu/sites/default/files/publications/ECSCA\\_SSS\\_Download%201\\_0.pdf](https://www.ecsa.eu/sites/default/files/publications/ECSCA_SSS_Download%201_0.pdf) [Accessed 22 Apr 2019]

EU (European Union), 2014. Directive of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure, Brussels: Official Journal of the European Union L307/1. [Online] Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0094&rid=9> [Accessed 20 Feb 2019].

Eyring et al., 2010. Transport impacts on atmosphere and climate: Shipping. *Atmospheric Environment*, 44(37), pp.4735–4771.

Faber et al., 2010. "Going Slow to Reduce Emissions: can the current surplus of maritime transport capacity be turned into an opportunity to reduce GHG emissions?." *Seas at Risk*.

Féron et al., 2008. Corrosion issues in nuclear waste disposal. *Journal of Nuclear Materials*, 379(1), pp.16–23.

Freeman, R.E., 2010. *Strategic management: a stakeholder approach*, Cambridge: Cambridge University Press.

Freire L. & Andrade D., 2015. Historic survey on nuclear merchant ships. *Nuclear Engineering and Design*, 293, pp.176–186.

Gaille, B., 2018. *21 Greek Shipping Industry Statistics and Trends*. BrandonGaille Small Business & Marketing Advice. [Online] Available at: <https://brandongaille.com/21-greek-shipping-industry-statistics-and-trends/> [Accessed 08 Feb 2019].

Gilbert et al., 2018. Assessment of full life-cycle air emissions of alternative shipping fuels. *Journal of Cleaner Production*, 172(C), pp.855–866.

Giziakis, C. & Christodoulou, A., 2012. Environmental awareness and practice concerning maritime air emissions: the case of the Greek shipping industry. *Maritime Policy & Management*, 39(3), pp.353–368.

Glanz, K, Rimer, BK, & Viswanath, K ,(eds) 2008, Health Behavior and Health Education : Theory, Research, and Practice, Wiley, Hoboken.

Glykas et al., 2010. Application and cost-benefit analysis of solar hybrid power installation on merchant marine vessels. *Ocean Engineering*, 37(7), pp.592–602.

Goulielmos, A.M., Giziakis, C. & Christodoulou, A., 2011. A Future Regulatory Framework for CO2 emissions of Shipping in the Mediterranean Area. *International Journal of Euro-Mediterranean Studies*, 4(1), pp.39-60.

Green4sea, 2016. Industry stakeholders react on the EU ETS decision. [Online] Available at: <https://www.green4sea.com/industry-stakeholders-react-on-the-eu-ets-decision/> [Accessed 27 Apr 2019].

Grey, E., 2016. *Shore-side power: a key role to play in greener shipping*. SHIP TECHNOLOGY. [Online] available at: <https://www.ship-technology.com/features/featureshore-side-power-a-key-role-to-play-in-greener-shipping-4750332/> [Accessed 20 Feb 2019].

Goddard, W., & Melville, S. 2004. *Research methodology: An introduction*. Juta and Company Ltd.

Goulielmos, A. M., 2010. What can we learn from 259 years of shipping cycles?. *International Journal of Shipping and Transport Logistics*, 2(2), 125-150.

Green4sea, 2016. Industry stakeholders react on the EU ETS decision. [Online] Available at: <https://safety4sea.com/industry-stakeholders-react-on-the-eu-ets-decision/> [Accessed 8 Dec 2018].

Hargett, T. & Williams, M., 2009. Wilh. Wilhelmsen Shipping Company: moving from CSR tradition to CSR leadership. *Corporate Governance*, 9(1), pp.73–82.

Hellenic Statistical Authority, 2019. Greek Merchant Fleet: November 2018 (Provisional data). Piraeus, Greece. [Online] Available at: [https://www.statistics.gr/en/statistics?p\\_p\\_id=documents\\_WAR\\_publicationsportlet\\_INSTANCE\\_qDQ8fBKKo4IN&p\\_p\\_lifecycle=2&p\\_p\\_state=normal&p\\_p\\_mode=view&p\\_p\\_cacheability=cacheLevelPage&p\\_p\\_col\\_id=column-2&p\\_p\\_col\\_count=4&p\\_p\\_col\\_pos=1&\\_documents\\_WAR\\_publicationsportlet\\_INSTANCE\\_qDQ8fBKKo4IN\\_javax.faces.resource=document&\\_documents\\_WAR\\_publicationsportlet](https://www.statistics.gr/en/statistics?p_p_id=documents_WAR_publicationsportlet_INSTANCE_qDQ8fBKKo4IN&p_p_lifecycle=2&p_p_state=normal&p_p_mode=view&p_p_cacheability=cacheLevelPage&p_p_col_id=column-2&p_p_col_count=4&p_p_col_pos=1&_documents_WAR_publicationsportlet_INSTANCE_qDQ8fBKKo4IN_javax.faces.resource=document&_documents_WAR_publicationsportlet)



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Hicks, S., 2007. Morals make the money. *Australian CPA*, 70(4), 72-73.

Hillman et al., 2009. Resource dependence theory: a review. *J. Manage.* 35 (6), 1404–1427.

Hirdaris et al., 2014. Considerations on the potential use of Nuclear Small Modular Reactor (SMR) technology for merchant marine propulsion. *Ocean Engineering*, 79, pp.101–130.

Hua et al., 2017. Alternative fuel for sustainable shipping across the Taiwan Strait. *Transportation Research Part D*, 52(PA), pp.254–276.

Hulskotte, J.H.J. & Denier van Der Gon, H.A.C., 2010. Fuel consumption and associated emissions from seagoing ships at berth derived from an on-board survey. *Atmospheric Environment*, 44(9), pp.1229–1236.

ICS (International Chamber of Shipping), 2018. Shipping and World Trade. [Online] Available at: <http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade> [Accessed 05 Dec 2018]

Institute of Shipping Economics and Logistics, 2011. Shipping Statistics and Market Review; Market Review Analytical Focus World Seaborne Trade and World Port Traffic. ISL Institute of Shipping Economics and Logistics, Bremen. [Online] Available at: [https://infoline.isl.org/index.php?module=Downloads&func=prep\\_hand\\_out&lid=678](https://infoline.isl.org/index.php?module=Downloads&func=prep_hand_out&lid=678) [Accessed 08 Feb 2019].

Investorwords, 2019. Shipping company, Definition. [Online] Available at: [http://www.investorwords.com/11089/shipping\\_company.html](http://www.investorwords.com/11089/shipping_company.html) [Accessed 22 Apr 2019]

IMO (International Maritime Organization), 2004. Resolution A.963(23) Adopted on 5 December 2003, (Agenda item 19). In: IMO Policies and Practices Related to the Reduction of Greenhouse Gas Emissions From Ships. [Online] Available at: [http://www.imo.org/blast/blastDataHelper.asp?data\\_id=26597&filename=A963\(23\).pdf](http://www.imo.org/blast/blastDataHelper.asp?data_id=26597&filename=A963(23).pdf) [Accessed: 8 Dec 2018].

IMO (International Maritime Organization), 2018a. Energy Efficiency Measures. [Online] Available at:

<http://www.imo.org/en/ourwork/environment/pollutionprevention/airpollution/pages/technical-and-operational-measures.aspx> [Accessed 8 Dec 2018].

IMO (International Maritime Organization), 2018b. EEDI- rational, safe and effective. [Online] Available at:

<http://www.imo.org/en/MediaCentre/HotTopics/GHG/Pages/EEDI.aspx> [Accessed 8 Dec 2018].

IMO (International Maritime Organization), 2019a. Introduction to IMO. [Online] Available at: <http://www.imo.org/en/About/Pages/Default.aspx> [Accessed 04 Feb 2019].

IMO (International Maritime Organization), 2019b. Brief History of IMO. [Online] Available at: <http://www.imo.org/en/About/HistoryOfIMO/Pages/Default.aspx> [Accessed 07 Feb 2019].

IMO (International Maritime Organization), 2019c. International Convention for the Prevention of Pollution from Ships (MARPOL). [Online] Available at: [http://www.imo.org/en/about/conventions/listofconventions/pages/international-convention-for-the-prevention-of-pollution-from-ships-\(marpol\).aspx](http://www.imo.org/en/about/conventions/listofconventions/pages/international-convention-for-the-prevention-of-pollution-from-ships-(marpol).aspx) [Accessed 07 Feb 2019].

IMO (International Maritime Organization), 2019d. Marine Environmental Protection Committee (MEPC). [Online] Available at: <http://www.imo.org/en/MediaCentre/MeetingSummaries/MEPC/Pages/Default.aspx> [Accessed 07 Feb 2019].

IMO (International Maritime Organization), 2019e, Prevention of Air Pollution from Ships. [Online] Available at: <http://www.imo.org/en/ourwork/environment/pollutionprevention/airpollution/pages/air-pollution.aspx> [Accessed 08 Feb 2019].

IPCC (Intergovernmental Panel on Climate Change), 2000. Emissions Scenarios [Online] Available at: [https://www.researchgate.net/publication/258375254\\_IPCC\\_Special\\_Report\\_on\\_Emissions\\_Scenarios](https://www.researchgate.net/publication/258375254_IPCC_Special_Report_on_Emissions_Scenarios) [Accessed 04 Dec 2018].

Kalli et al., 2009. Sulphur content in ships bunker fuel in 2015: A study on the impacts of the new IMO regulations and transportation costs. *Ministry of Transport and Communications*, 31.

Kehoe, J., & Woxenius, J., 2010. *Assessment of the impact of the application of new sulphur limits to the Mediterranean and the Atlantic European Seas*. SKEMA-Sustainable Knowledge Platform for the European Maritime and Logistics Industry.

Kollamthodi et al., 2008. "Greenhouse gas emissions from shipping: trends, projections and abatement potential." *AEA Energy and Environment*.

Kvale, S., 1996. *Interviews: an introduction to qualitative research interviewing*, Thousand Oaks: SAGE.

Lack et al., 2009. Particulate emissions from commercial shipping: Chemical, physical, and optical properties. *Journal of Geophysical Research: Atmospheres*, 114(D7), p.n/a.

Lai et al., (2013). Measures for evaluating green shipping practices implementation. *International Journal of Shipping and Transport Logistics*, 5(2), 217-235.

Lakatos et al., 2011. Advantages and Disadvantages of Solar Energy and Wind-Power Utilization. *World Futures*, 67(6), pp.395–408.

Lam, J.S.L., 2015. Designing a sustainable maritime supply chain: A hybrid QFD–ANP approach. *Transportation Research Part E*, 78, pp.70–81.

Lee, T. & Nam, H., 2017. A Study on Green Shipping in Major Countries: In the View of Shipyards, Shipping Companies, Ports, and Policies. *Asian Journal of Shipping and Logistics*, 33(4), pp.253–262.

Lema, E., & Papaioanou, D., 2013. Policy instruments and recent advances of the greenhouse gas regulating framework in shipping. *Interdisciplinary Environmental Review*, 14(3-4), 238-252.

Lindstad et al., 2013. Assessment of profit, cost and emissions by varying speed as a function of sea conditions and freight market. *Transportation Research Part D-Transport And Environment*, 19, pp.5–12.

Lirn et al., 2013. Green shipping management capability and firm performance in the container shipping industry. *Maritime Policy & Management*, 41(2), pp.1–17.

Liu, N. & Maes, F., 2011. Prevention of Vessel-Source Marine Pollution: A Note on the Challenges and Prospects for Chinese Practice Under International Law. *Ocean Development & International Law*, 42(4), pp.356–367.

Lloyd's Register, 2019. *MARPOL. International Convention for the Prevention of Pollution from Ships; What does MARPOL cover?* [Online] Available at: <https://www.lr.org/en/marpol-international-convention-for-the-prevention-of-pollution/> [Accessed 15 Feb 2019]

Lowell et al., 2013. Assessment of the fuel cycle impact of liquefied natural gas as used in international shipping. *The International Council on Clean Transportation, Washington, DC.*

Lun et al., 2016. Adoption of Green Shipping Practices. In *Green Shipping Management* (pp. 17-29). Springer, Cham.

Maloni et al., 2013. Slow steaming impacts on ocean carriers and shippers. *Maritime Economics & Logistics*, 15(2), 151-171.

Mansouri et al., 2015. Multi-objective decision support to enhance environmental sustainability in maritime shipping: A review and future directions. *Transportation Research Part E*, 78, pp.3–18.

Marine Insight, 2019. *What are Ro-Ro Ships?*. [Online] Available at: <https://www.marineinsight.com/types-of-ships/what-are-ro-ro-ships/> [Accessed 17 Apr 2019]

MARPOL, 2008. ANNEX VI, EEDI & SEEMP. [Online] Available at: <https://www.marpol-annex-vi.com/eedi-seemp/> [Accessed 11 Feb 2019].

Matten, D. & Moon, J., 2008. "Implicit" and "explicit" CSR: A conceptual framework for a comparative understanding of corporate social responsibility. *Academy Of Management Review*, 33(2), pp.404–424.

McGuire, C. & Perivier, H., 2011. The Nonexistence of Sustainability in International Maritime Shipping: Issues for Consideration. *Journal of Sustainable Development*, 4(1), p.72.

Meixell, M.J. & Luoma, P., 2015. Stakeholder pressure in sustainable supply chain management. *International Journal of Physical Distribution & Logistics Management*, 45(1/2), pp.69–89.

MEPC (Marine Environmental Protection Committee), 2010. *Reduction of GHG Emissions from Ships; Full report of the work undertaken by the Expert Group on Feasibility Study and Impact Assessment of possible Market-based Measures*. MEPC 61/INF.2, London, UK. [Online] Available at: <http://www.martrans.org/documents/2009/air/MEPC61-INF2.pdf> [Accessed 13 Feb 2019].

MEPC (Marine Environmental Protection Committee), 2011. *Report of the Marine Environment Protection Committee on its sixty-second session*. MEPC 62/64, London, UK. [Online] Available at: <http://www.crs.hr/Portals/0/MEPC%2062-24.pdf> [Accessed 8 Dec 2018].

MEPC (Marine Environmental Protection Committee), 2014. *Reduction of GHG Emissions from ships; Third IMO GHG Study 2014*. MEPC 67/6, London, UK. [Online] Available at: [http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/MEPC%2067-6%20-%20Third%20IMO%20GHG%20Study%202014%20-%20Executive%20Summary%20\(Secretariat\).pdf](http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/MEPC%2067-6%20-%20Third%20IMO%20GHG%20Study%202014%20-%20Executive%20Summary%20(Secretariat).pdf) [Accessed 07 Feb 2019].

MEPC (Marine Environmental Protection Committee), 2018. *Initial IMO strategy on reduction of GHG emissions from ships*. MEPC 72/17. [Online] Available at: <http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Marine-Environment-Protection-Committee-%28MEPC%29/Documents/MEPC.304%2872%29.pdf> [Accessed 05 Dec 2018].

Mol, A.P. & Oosterveer, P., 2015. Certification of markets, markets of certificates: Tracing sustainability in global agro-food value chains, *Sustainability*, 7, 9, pp. 12258-12278.

Mortensen, N.B., 2009. *Ship fuel efficiency in a historical perspective*. Bull. General 104 (2009), 38–46.

Nicholas, M., 2017. Applying Cold-Ironing Regulation in Southeast Asian Ports to Reduce Emissions. *Asia-Pacific Journal of Ocean Law and Policy*, 2(2), pp.296–316.

Notteboom, T. & Cariou, P., 2013. Slow steaming in container liner shipping: is there any impact on fuel surcharge practices? *The International Journal of Logistics Management*, 24(1), pp.73–86.

Opensea.Pro, 2019. *Dry bulk market: shall we trade short sea or deep sea?* [Online] Available at: <https://opensea.pro/blog/short-sea-vs-deep-sea> [Accessed 14 Apr. 2019]

O'Rourke, R., 2006. Navy Ship Propulsion Technologies: Options for Reducing Oil Use - Background for Congress. 42.

Ozaki et al., 2011. An evaluation of the energy efficiency design index (EEDI) baseline for tankers, containerships, and LNG carriers.

- Panagakos et al., 2014. The possible designation of the Mediterranean Sea as a SECA: A case study. *Transportation Research Part D*, 28(C), pp.74–90.
- Papageorgiou et al., 2017. A Fuzzy Logic Modeling of Measures Addressing Shipping CO<sub>2</sub> Emissions. *Journal of Intelligent Systems*, 26(3), pp.439–455.
- Parmigiani et al., 2011. Efficiency meets accountability: Performance implications of supply chain configuration, control, and capabilities. *Journal of Operations Management*, 29(3), pp.212–223.
- Pawlik et al., 2012. Corporate social responsibility in maritime logistics. In *Maritime Logistics: Contemporary Issues* (pp. 205-226). Emerald Group Publishing Limited.
- Pfeffer, J., 1972. Merger as a response to organizational interdependence. *Adm. Sci. Q.* 382–394.
- Psaraftis & Kontovas, 2010. Balancing the economic and environmental performance of maritime transportation. *Transportation Research Part D*, 15(8), pp.458–462.
- Psaraftis, N. & Kontovas C., 2013. Speed models for energy-efficient maritime transportation: A taxonomy and survey. *Transportation Research Part C*, 26(C), pp.331–351.
- Psaraftis, N. & Kontovas, C., 2015. Slow steaming in maritime transportation fundamentals, trade-offs, and decision models. In *Handbook of ocean container transport logistics: making global supply chains effective*. pp. 315–358.
- Pope, C. & Mays, N., 2006. *Qualitative research in health care* 3. ed., London: BMJ Books.
- Rehmatulla, N. & Smith, T., 2015. Barriers to energy efficiency in shipping: A triangulated approach to investigate the principal agent problem. *Energy Policy*, 84, pp.44–57.
- Reichel et al., 2014. Trim Optimisation - Theory and Practice. *TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation*, 8(3), pp.387–392.
- Ren, J. & Lützen, M., 2017. Selection of sustainable alternative energy source for shipping: Multi-criteria decision making under incomplete information. *Renewable and Sustainable Energy Reviews*, 74, pp.1003–1019.
- 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.

Revkin AC, 2009. Obama speaks on climate at the U.N., New York: The New York Times. [Online] Available at: <https://dotearth.blogs.nytimes.com/2009/09/22/obama-speaks-on-climate-at-the-un-summit/> [Accessed 05 Feb 2019].

Rosenthal E., 2009. Biggest obstacle to global climate deal may be how to pay for it., New York: The New York Times [Online] Available at: <https://www.nytimes.com/2009/10/15/science/earth/15climate.html> [Accessed 05 Feb 2019].

Rudestam, K.E. & Newton, R.R., 2007. *Surviving your dissertation: a comprehensive guide to content and process* 3. ed., Los Angeles: SAGE Publications.

Sand, P., 2015. The Shipping Market in 2014 and Looking Forward. [Online] Available at: [https://www.bimco.org/news/market\\_analysis/2015/0102\\_reflectthe\\_shipping\\_market](https://www.bimco.org/news/market_analysis/2015/0102_reflectthe_shipping_market) [Accessed 08 Feb 2019].

Sawyer et al., 2008. Analysis of High-Speed Trans Pacific Nuclear Containership Service. *Design & Operation of Container Ships*.

Sounders, M., Lewis, P. & Thornhill, A., 2012. *Research methods for business students* 6. ed., Harlow; New York: Pearson.

Schembari et al., 2012. Impact of a European directive on ship emissions on air quality in Mediterranean harbours. *Atmospheric Environment*, 61, pp.661–669.

Sciberras et al., 2015. Electrical characteristics of cold ironing energy supply for berthed ships. *Transportation Research Part D*, 39(C), pp.31–43.

Shi, Y., 2016. Reducing greenhouse gas emissions from international shipping: Is it time to consider market-based measures? *Marine Policy*, 64, pp.123–134.

Shin, Y. & Thai, V., 2015. The Impact of Corporate Social Responsibility on Customer Satisfaction, Relationship Maintenance and Loyalty in the Shipping Industry. *Corporate Social - Responsibility and Environmental Management*, 22(6), p.381.

Staats, A.W., 2013. *Social Behaviorism and Human Motivation: Principles of the Attitude-Reinforcer-discriminative System*. Academic Press.

Stopford, M., 2009. *Maritime economics* 3. ed., London: Routledge.

Strømman et al., 2006. Hybrid life-cycle assessment of natural gas-based fuel chains for transportation. *Environmental science & technology*, 40(8), pp.2797–804.

Sotiroski, L., 2016. The EU and International legal Framework in Maritime Safety. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 25(1), 297-313.

Tan, A.K.-J., 2006. *Vessel-source marine pollution: the law and politics of international regulation*, Cambridge: Cambridge University Press.

The Project Definition, 2015. *LNG Carrier*. Available at: <https://www.theprojectdefinition.com/lng-carrier/> [Accessed 17 Apr 2019].

Tzannatos, E., 2010. Ship emissions and their externalities for the port of Piraeus – Greece. *Atmospheric Environment*, 44(3), pp.400–407.

Tzannatos, E. & Nikitakos, N., 2013. Natural gas as a fuel alternative for sustainable domestic passenger shipping in Greece. *International Journal of Sustainable Energy*, 32(6), pp.724–734.

Tzannatos, E. & Stournaras, L., 2014. EEDI analysis of Ro-Pax and passenger ships in Greece. *Maritime Policy & Management*, 42(4), pp.1–12.

UNCTAD (United Nations Conference on Trade and Development), 2009. *Multi-year expert meeting on transport and trade facilitation*. [Online] Available at: <https://unctad.org/en/pages/MeetingsArchive.aspx?meetingid=15862> [Accessed 04 Dec 2018].

UNCTAD (United Nations Conference on Trade and Development), 2012. *Review of Maritime Transport 2012*. [Online] Available at: [https://unctad.org/en/PublicationsLibrary/rmt2012\\_en.pdf](https://unctad.org/en/PublicationsLibrary/rmt2012_en.pdf) [Accessed 08 Feb 2019].

UNCTAD (United Nations Conference on Trade and Development), 2017. *Review of Maritime Transport 2017*. [Online] Available at: [https://unctad.org/en/publicationslibrary/rmt2017\\_en.pdf](https://unctad.org/en/publicationslibrary/rmt2017_en.pdf) [Accessed 08 Feb 2019].

UNFCCC (UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE), 2005, Information on greenhouse gas emissions from international aviation and maritime transport. SBSTA/2005/INF.2. Bonn, Germany: United Nations Framework Convention on Climate Change. [Online] Available at: <https://unfccc.int/sites/default/files/resource/docs/2005/sbsta/eng/inf02.pdf> [Accessed 08 Feb 2019].



Union of Greek Shipowners, 2018. Greek Shipping and Economy 2018. [Online] Available at: <https://www.ugs.gr/en/greek-shipping-and-economy/greek-shipping-and-economy-2018/> [Accessed 03 Dec 2018].

Upton, J., 2016. Shipping Industry Mulls Modest Steps to Slow Warming. [Online] Available at: <https://www.climatecentral.org/news/shipping-industry-modest-response-to-climate-change-20811> [Accessed 27 Apr 2019].

U.S. EPA, 2008. Integrated Science Assessment for Oxides of Nitrogen – Health Criteria (Final Report, Jul 2008). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/071, 2008.

US EPA. (2009). Cap and trade: Acid rain program results [Online] Available at: <https://grist.files.wordpress.com/2009/06/ctresults.pdf> [Accessed 10 Dec 2018].

Van Leeuwen, J., 2015. The regionalization of maritime governance: Towards a polycentric governance system for sustainable shipping in the European Union. *Ocean and Coastal Management*, 117, pp.23–31.

Van Leeuwen, J., & Kern, K., 2013. The external dimension of European union marine governance: institutional interplay between the EU and the international maritime organization. *Global Environmental Politics*, 13(1), 69-87.

Van Leeuwen et al., 2010. Who greens the waves? : changing authority in the environmental governance of shipping and offshore oil and gas production., p.2010.

Van Leeuwen, J. & Van Koppen, K., 2016. Moving Sustainable Shipping Forward: The Potential of Market-based Mechanisms to Reduce CO<sub>2</sub> Emissions from Shipping. *The Journal of Sustainable Mobility*, 3(2), pp.42–66.

Verbeek et al., 2011. *Environmental and Economic aspects of using LNG as a fuel for shipping in The Netherlands*. Delft: TNO.

Vergara, J.A. & McKesson, C.B., 2002. Nuclear propulsion in high-performance cargo vessels. *Mar. Technol.* 39 (1), 1e11.

Vogel, T., & Wanke, M., 2016. *Attitudes and attitude change*. Psychology Press.

Vorbach, J.E., 2001. The Vital Role of Non-Flag State Actors in the Pursuit of Safer Shipping. *Ocean Development and International Law*, 32(1), 27-42.

Wan et al., 2016. Pollution: Three steps to a green shipping industry. *Nature*, 530(7590), pp.275–7.

Wan et al., 2018. Decarbonizing the international shipping industry: Solutions and policy recommendations. *Marine Pollution Bulletin*, 126, pp.428–435.

WCED (World Commission on Environment Development), 1987. *Our common future*, Oxford: Oxford Univ. Press.

Winkel et al., 2016. Shore Side Electricity in Europe: Potential and environmental benefits. *Energy Policy*, 88, pp.584–593.

Wolf, J., 2014. The relationship between sustainable supply chain management, stakeholder pressure and corporate sustainability performance. *Journal of business ethics: JOBE*, 119(3), pp.317–328.

Wong et al., 2009. Complementarities and alignment of information systems management and supply chain management. *International Journal of Shipping and Transport Logistics*, 1(2), 156-171.

Woo, J.-K. & Moon, D.S.-H., 2014. The effects of slow steaming on the environmental performance in liner shipping. *Maritime Policy & Management*, 41(2), pp.176–191.

Worthington, I., 2013. *Greening Business: Research, Theory, and Practice*. Oxford University Press.

Yang, C.-S., 2018. An analysis of institutional pressures, green supply chain management, and green performance in the container shipping context. *Transportation Research Part D*, 61, pp.246–260.

Yang et al., 2009. Assessing resources, logistics service capabilities, innovation capabilities and the performance of container shipping services in Taiwan. *International Journal of Production Economics*, 122(1), pp.4–20.

Yliskylä-Peuralahti, J. & Gritsenko, D., 2014. Binding rules or voluntary actions? A conceptual framework for CSR in shipping. *WMU Journal of Maritime Affairs*, 13(2), pp.251–268.

Yuen et al., 2016. The effect of continuous improvement capacity on the relationship between of corporate social performance and business performance in maritime transport in Singapore. *Transportation Research Part E*, 95, pp.62–75.

Yuen, Thai & Wong, 2017. Corporate social responsibility and classical competitive strategies of maritime transport firms: A contingency-fit perspective. *Transportation Research Part A*, 98, pp.1–13.

Yuen et al., 2017. Antecedents and outcomes of sustainable shipping practices: The integration of stakeholder and behavioural theories. *Transportation Research Part E*, 108, pp.18–35.

Zhu, Q. & Sarkis, J., 2007. The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research*, 45(18-19), pp.4333–4355.

## Appendix

### Questionnaire:

#### Demographics

1. What is your position in the firm?
2. What is the maritime segment the firm belongs to?
3. What type of ships comprise the firm's fleet?
4. What is the average fleet age?
5. What is the fleet size?
6. Have you any new ships under order?
7. Where would you choose to build your new ships? Why?

#### Inquiry

8. How do you perceive the term sustainability in your business?
9. What green shipping initiatives (regulations, policies, measures incentives), are you familiar with?
  - EEDI
  - SEEMP:
    - Trim optimization
    - Weather routing
    - Slow steaming
  - Alternative fuels:
    - Heavy fuel oil (HFO)
    - Marine Diesel Oil (MDO)
    - Liquefied natural gas (LNG)
    - Methanol, Liquid Hydrogen (LH<sub>2</sub>)
    - Bio-diesel, Straight vegetable oil (SVO)
    - Bio-LNG
  - Alternative energy sources:
    - Onshore power supply (OPS)/Cold ironing/ Shore-side electricity
    - Wind: soft sails, kites, wind sails, wind turbines, flettner rotors

- Solar: photovoltaic systems
  - Nuclear
- Market-based mechanisms:
    - Global Emission Trading System (ETS)
    - GHG Fund
    - Port State Leverage (PSL)
    - Rebate Mechanism (RM)

10. What green shipping measures are you currently implementing?
11. What are the reasons for that?
12. What would be the impact of those measures in your firm?
13. How would you reach compliance with the 2020 regulation for sulphur emissions?
14. How would you reach compliance with the 2025 directive for emissions at berth?
15. What are the prohibiting reasons for not adopting other measures?
16. What kind of incentives would you consider as to expand your adopted measures?
17. What would you consider the most cost-effective measure/s? Why/How?
18. What do you consider as the most environmentally friendly measure? Why/How?
19. What would you recommend as an overall measure/ set of measures that ensure/s sustainability and decarbonization of the industry in a holistic perspective?
20. Who do you identify as stakeholders in your line of business and why?
21. What is the impact of the regulatory framework in the firm?
22. Hypothetically there is no obligatory regulatory framework for adopting a certain measure, what would be the measure/s of your choice and why?
23. Do you think that total decarbonization is feasible or infeasible in the near future?
24. How would that be possible?
25. Could you recommend any other person or firm to further aid in this research?

## List of Figures

Figure 1: Thesis disposition. Developed by the author.....	4
Figure 2: Onshore Power Supply (OPS).....	15
Figure 3: Conceptual Framework Model. Developed by the author .....	19
Figure 4: Ratio of Greek-Global fleet. Developed by the author .....	20
Figure 5: Ship type analysis of the Greek-owned fleet in dtw. Developed by the author .....	21

## List of Tables

Table 1: Main Demographic Results .....	31
Table 2: Findings on implementation and compliance .....	33
Table 3: Notions on barriers, incentives, stakeholders and sustainability .....	36
Table 4: Brief clustered presentation of responses .....	39