Cyprus University of Technology
Faculty of Management and Economics

Doctoral Dissertation

Green Supply Chain Management in the Shipping Industry

Stelios Alexandrou

Limassol, October 2018

CYPRUS UNIVERSITY OF TECHNOLOGY

FACULTY OF MANAGEMENT AND ECONOMICS

DEPARTMENT OF COMMERCE FINANCE AND SHIPPING

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Approval Form

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ABSTRACT

The thesis provides a detailed empirical examination on GSCM in the context of the shipping industry, by conducting three innovative empirical studies: (i) resources and capabilities as drivers of proactive GSCM strategy, based on the NRBV theory, and resulting performance and competitive advantage implications, (ii) proactive GSCM strategy implementation and its relationship to financial performance, and (iii) the moderating effect of managerial propensity for risk-taking on the relationship between proactive GSCM strategy and performance.

In chapter two, building on the natural resource-based view (NRBV) theory, I develop a model that examines the drivers of proactive green supply chain management (GSCM) strategy. We then examine the outcome of such strategy on the performance and competitive advantage of shipping firms. I collect data from a global sample of 289 shipping firms, including private and listed companies, and we apply structural equation modelling (SEM) to test the research hypotheses. Resources and capabilities emerge as drivers of GSCM strategy. Furthermore, I find support to the thesis that proactive GSCM strategy affects the environmental and economic performance of shipping firms positively, which in turn enhances competitive advantage. The associations revealed in this study can improve environmental management decisions and provide fruitful managerial and theoretical implications.

In chapter three, this thesis empirically examines the relationship between levels of GSCM strategy adoption and the financial performance of shipping firms. I apply cluster analysis and analysis of variance (ANOVA), to test the research hypotheses. This study is able to cluster shipping firms according to their level of adoption of GSCM strategy, ranging from reactive to more proactive shipping companies. Furthermore, the study shows that shipping firms with a proactive GSCM strategy can achieve better financial performance. The findings of this thesis can improve the environmental management strategy decisions of shipping firms and support the elimination of environmental problems, while improving the financial performance of shipping firms.

Chapter four investigates the moderating role of managerial propensity towards risk on the relationship between proactive GSCM strategy and environmental and economic performance. The study applies structural equation modelling (SEM) to test the research hypotheses. Results show that proactive GSCM strategy is beneficial to both the environmental and economic performance of shipping firms. The positive effects of a proactive GSCM strategy on environmental performance are stronger when managers are highly risk averse, while their level of risk aversion has no moderating effect on shipping firms' economic performance.

Several practical and managerial implications are discussed in this thesis that can assist shipping firms to enhance their performance and competitiveness. This thesis also identifies and discusses the limitations of each study and proposes ideas for future research.

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ABBREVIATIONS

ANOVA	Analysis of Variance
AVE	Average Variance Extracted
C1	Chapter 1
C2	Chapter 2
C3	Chapter 3
CA	Competitive Advantage
CC	Collaboration with Customers
CEO	Chief Executive Officer
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CITC	Corrected Item Total Correlation
CLF	Common Latent Factor
CMB	Common Method Bias
CMIN	Chi-square
CO_2	Carbon Dioxide
CP	Collaboration with Partners
CPP	Company Policy and Procedure
CR	Construct Reliability
C.R.	Critical Ratios
CS	Collaboration with Suppliers
DF	Degrees of Freedom
ECP	Economic Performance
EFA	Exploratory Factor Analysis
EP	Environmental Performance
ER	Experiential Resources
FP	Financial Performance
FR	Financial Resources
GHG	Green-House Gases
GM	Green Marketing

GSC	Green Supply Chain
GSCM	Green Supply Chain Management
GSPs	Green Shipping Practices
HR	Human Resources
IEP	Internal Environmental Proactivity
IFI	Incremental Fit Index
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
KMO	Kaiser-Mayer-Olkin test
MARPOL	International Convention for the Prevention of Pollution from Ships
MEPC	Marine Environment Protection Committee
MSA	Measure of Sampling Adequacy
NGOs	Non-Governmental Organizations
NO_X	Nitrogen Oxides
NRBV	Natural Resource-Based View Theory
OECD	Organisation for Economic Co-operation and Development
OCIMF	Oil Companies International Marine Forum
PCFI	Parsimony Comparative Fit Index
PRATIO	Parsimony Ratio
RBV	Resource-Based View Theory
RMR	Root Means Square Residuals
RMSEA	Root Mean Square Error of Approximation
ROI	Return on Investment
RT	Risk Taking
SC	Shipper Cooperation
SDC	Shipping Design for Compliance
SM	Stakeholder Management
SEM	Structural Equation Model
SMEs	Small Medium Enterprises
SOLAS	Safety of Life at Sea
SO_X	Sulphur Oxides
SP	Strategic Proactivity

SRMR	Standardized Root Mean Square Residuals
SSI	Sustainable Shipping Initiatives
SV	Shared Vision
TMSA	Tanker Management Self-Assessment
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development

DEFINITIONS

- **GSCM** is defined as a proactive environmental management strategy that includes the adoption of internal and external green supply chain management practices aiming at pollution prevention.
- **Economic performance** is defined as the reductions in various costs, such as decrease of cost for energy consumption, and decrease of fine for pollution, as a result of the successful implementation of proactive GSCM practices.
- **Financial performance** in this thesis represents the financial profits gained through the adoption of GSCM practices, such as sales increase, and increase of profitability.
- **Competitive advantage** refers to a firm's advantages that are the result of successfully implementing a proactive GSCM strategy facilitating cost reductions, market opportunities, and neutralisation of risks and competitive threats.

CHAPTER 1: INTRODUCTION

INTRODUCTION

Global warming is on the rise, with a new record set in 2017 indicating a 1.5 Celsius degree increase compared to the pre-industrial period (Sustainable Development Goals Report, UN 2017)[1]. More than 1.6 million people have died from global weather phenomena in the period 1990 – 2015 (Sustainable Development Goals Report, UN 2017), which highlights the ever-increasing need to tackle climate change and the related hazards and natural disasters. Almost three quarters of the planet's surface is water. Oceans are the largest part of our ecosystem, and a key source of environmental benefit to humans. They generate half the oxygen we breathe and act as a climate regulator. In recent years, pollution levels have radically increased due GHG emissions, waste and human need for fossil fuels, such as oil used in ship operations. While shipping is the least environmentally damaging mode of transport, it remains a significant contributor to marine pollution. As we have seen the size of ships, and the global fleet, increase, with a corresponding rise in marine pollution, we have also witnessed a rise in pressure from stakeholders, such as shipping industry clients, governments and NGOs, for the implementation of stricter regulations in order to protect and preserve the environment. The Marine Environment Protection Committee that operates under the International Maritime Organization (IMO) has responded by developing and ratifying more regulations under the International Convention for the Prevention of Pollution from Ships (MARPOL). Thus, the implementation of much needed environmental management practices and the adoption of a proactive environmental culture have become important elements in shipping firm strategy-making.

Maritime transportation constitutes a key pillar of the global supply chain, which facilitates international trade, contributes to global growth and creates value in the world economy. Globalisation has not only driven international economic growth, but also the way industries, such as shipping, operate. In an effort to meet the increasing demand for goods and services, the global fleet has swelled [2] and ships have become larger. This has had the dual effect of increasing competition in the shipping industry as well as the concerns and pressure exerted by various stakeholders regarding the impact of ship operations on the environment.

Shipping companies must respond to stakeholder needs in order to remain competitive and profitable, by integrating environmental issues into their supply chain management, otherwise known as green supply chain management (GSCM).

1.1. Environmental management and supply chain management – Green Supply Chain Management (GSCM)

Environmental management concerns firm activities such as processes and practices geared to achieve environmental objectives. It is the management of organisational strategies, such as internal green practices, that aim to reduce the environmental impact of their operations. Supply chain management, meanwhile, is responsible for the flow of materials, whether tangible or

[1] For more information, please see: https://unstats.un.org/sdgs/files/report/2017/TheSustainableDevelopmentGoalsReport2017.pdf

[2] The global fleet has increased from 26,772 vessels in the late 1980s to 94,543 in September 2017. For more information: World Fleet Monitor, Volume 8, and No 9. September 2017, Clarksons.

intangible, which are necessary to produce goods or services, through the supply chain, from initial supplier to the end customer.

Due to the abundance in choice of products and services, industry competition is no longer hinged upon the products themselves, but rather on the supply chain effectiveness and value (Boyer et al. 2004). Supply chain value is the most valuable success factor for organisations, as it increases the services offered, which is directly related to customer satisfaction. Therefore, companies need to integrate their supply chain (both internally and externally) in order to increase their value and competitiveness, as well as the value of the overall chain, while also satisfying stakeholders, who demand high quality services delivered in an environmentally friendly manner. This is the one-way road that favours the increase of the overall supply chain value.

While firms need to incorporate environmental issues into their own strategy, they must also share these issues with their supply chain members, via green supply chain integration. The implementation of GSCM practices, which include internal and external green practices, can thus lead to supply chain integration and eventually to competitiveness and economic performance improvements (Rao and Holt, 2005).

GSCM has been given a variety of definitions in the literature (Zhu and Sarkis, 2004). Shrivastava (2007) defines GSCM as the integration of environmental thinking into supply chain management. In another study, GSCM is defined as the integration of environmental concerns into inter-organisational practices (Sarkis et al., 2011). According to Wong et al. (2015), "GSCM is the inter-organizational efforts in managing supply chain activities to lower the negative environmental impact". The authors believe this applies from the sourcing of raw materials to the service provided to the end user.

In this study, GSCM is defined as an innovative integrated green strategy that includes internal environmental management practices, as well as external green collaborative management practices with supply chain members, both of which must be adopted by companies.

Internal green management practices refer to the internal day-to-day green operations within a firm (Azevedo et al., 2011), while external green management practices refer to a firm's collaborative practices with their supply chain members to achieve common environmental goals. Firms collaborate directly with their chain members to plan, develop and manage environmental management strategies, in order to reduce the environmental impact from their activities (Vachon and Klassen, 2008).

GSCM is an environmental strategy with a proactive philosophy in preventing pollution. Such strategy allows companies to operate with an environmentally oriented philosophy and, at the same time, remain profitable and competitive (Rao and Holt, 2005). According to Zhu et al. (2005), GSCM can be seen "as an important new archetype for enterprises to achieve profit and market share objectives, by lowering their environmental risks and impacts and while raising their ecological efficiency". Thus, GSCM strategy helps companies to respond positively to the interplay between business and the environment.

GSCM integration allows companies to increase their supply chain value, an important driver of business success. Srivastava (2007) asserts that GSCM is a business value driver that increases the profitability of supply chain members, as well as the overall chain itself.

The popularity of the concept of GSCM can be seen from the proliferation of publications on this topic in leading environmental, operations, and supply chain management journals (Sarkis et al., 2011). There is a substantial body of literature that examines the topic of GSCM as it relates to company performance. Most studies, however, limit their examination of the relationship to the manufacturing sector in Asia (Azevedo et al., 2011; Zhu and Sarkis, 2004; Zhu et al., 2007, 2010).

Studies on GSCM in the service sector, such as the shipping industry, are limited. No detailed studies exist on GSCM within the shipping industry. Thus far, the role of proactive GSCM strategy in the global shipping industry has not been examined. The aim of this thesis is to contribute to the GSCM literature by studying three innovative empirical models with regards to the topic of GSCM in the global shipping industry.

1.2. Shipping and the environment

Responsible for more than 80% of global trade volume, shipping constitutes the principal mode of transport for raw materials, semi-manufactured and manufactured products. Sea-trade constitutes the most important pillar of globalisation. Without the shipping industry, goods and services would have been limited due to trade being cost prohibitive.

No other mode of transport is more efficient and environmentally friendly—given the tons of cargo that can be transported via ships—than the shipping trade. There are growing concerns about the environmental impact caused by shipping activities in international trade (Lun et al., 2014). The global fleet and the size of the ships are increasing, accompanying concerns relating to environmental problems, such as pollution. Stakeholders thus pressure shipping firms to add environmental thinking in their strategies and to adopt green practices to become more environmentally friendly. So, protecting the environment is the biggest sustainability challenge for international shipping companies today.

Since the early 1970s, ecological issues, especially the issue of pollution, has been the subject of increased attention both within the shipping industry and for academics as well (Leonidou et al., 2013). An example is the adoption of the International Convention for the Prevention of Pollution from Ships by the IMO[3] in 1973, known as MARPOL[4]. With the intensification of ecological problems caused by shipping operations, such as oil pollution, hazardous / harmful / toxic materials, noise pollution, greenhouse gases, and waste, stakeholders have become more aware of environmental issues and increased pressure on shipping firms to take the necessary actions, such as adopting internal and external green practices, in order to protect and sustain the environment.

[3] IMO is the United Nations specialized agency charged with developing and adopting global regulations on the safety, security and efficiency of ships and on the protection of the environment – both marine and atmospheric – from shipping operations (IMO, 2011).

[4] The MARPOL Convention addresses pollution from ships by oil; by noxious liquid substances carried in bulk; harmful substances carried by sea in packaged form; sewage; garbage; and the prevention of air pollution from ships' (Marine Environment report, IMO 2018).

Environmental practices also put pressure on shipping companies in other ways as well. The shipping industry has a lot of competition, as companies provide similar services. Shippers have more choice, so companies compete on the basis of their supply chain's effectiveness and value. Green supply chain integration can increase the overall supply chain value, i.e. companies greening their practices, whilst collaborating and working with their supply-chain members in order to reduce environmental impact and improve the environmental performance of the overall supply-chain (Vachon and Klassen, 2008). By adopting GSCM practices, firms can achieve supply chain integration that leads to improved competitiveness and economic performance (Rao and Holt, 2005).

A critical question for companies, and shipping firms in particular is: Will adopting proactive environmental management strategy, such as GSCM, increase performance and competitive advantage? According to Zhu and Sarkis (2004), improved performance is an important driver for firms to adopt GSCM practices. Especially for shipping firms, investment in green technologies and systems—in other words, green practices—holds even greater importance, as it's an industry comprised of assets that cost hundreds of millions and is also characterised by intense competition and uncertainty. While important studies have already examined the topic of GSCM in the manufacturing sector, there is a lack of corresponding empirical investigation in the shipping sector.

This thesis aims to fill the gap by carrying out three different but closely related empirical studies, presented in chapters two, three, and four, on GSCM in the shipping industry, which is a topic of ongoing research both in academia and industry.

The thesis contributes to the literature by being the first to empirically examine the following in the context of the global shipping industry: i) resources and capabilities as drivers of proactive GSCM strategy, based on the NRBV theory, and the performance and competitive advantage implications, ii) proactive GSCM strategy implementation and its relationship to financial performance, and iii) the moderating effect of managerial propensity towards risk-taking on the relationship between proactive GSCM strategy and performance.

1.3. Objectives and contributions of the thesis

The main objective of the current thesis is to conduct a detailed empirical examination of proactive GSCM strategy in the context of the global shipping industry. This thesis contributes to the academic literature in several ways. Chapter two examines, for the first time, the resources and capabilities acting as drivers of proactive GSCM strategy, based on the NRBV theory, and the performance and competitive advantage implications of such strategy on shipping firms. Chapter three goes a step further by also being the first to conduct an empirical examination of the impact of varying levels of GSCM strategy adoption, and the resulting improvement in financial performance for shipping firms. Chapter four focuses on a similarly innovative examination of the moderating effects of managerial propensity towards risk-taking on the relationship between proactive GSCM strategy and performance.

1.3.1. Drivers and consequences of GSCM in shipping

Chapter two of this thesis performs an empirical assessment of the drivers of shipping firms' proactive GSCM strategy, and the resulting improvement on their performance and competitive advantage. No other study seems to have performed such an examination in the context of the global shipping industry. This thesis does so in chapter two via a study of 10 research hypotheses, which are outlined in the following paragraph.

H1: Shipping firms' quality of human resources is positively associated with the development of a proactive GSCM strategy. H2: Shipping firms' financial resources are positively associated with their proactive GSCM strategy. H3: Shipping firms' experiential resources are positively associated with the development of proactive GSCM strategy. H4: Shipping firms' capability of shared vision is positively associated with the development of a proactive GSCM strategy. H5: Shipping firms' stakeholder management is positively associated with the development of a proactive GSCM strategy. H6: Shipping firms' capability of strategic proactivity is positively associated with the development of a proactive GSCM strategy. H7: Shipping firms' proactive GSCM strategy is positively associated with improved environmental performance. H8: Shipping firms' proactive GSCM strategy is positively associated with improved economic performance. H9: Shipping firms' environmental performance positively affects their competitive advantage. H10: Economic performance positively affects the competitive advantage of shipping firms.

Chapter two performs structural equation modelling to examine the above hypotheses and it contributes to the literature in several ways, which will be explained in more detail in subsection 2.1. For now, a general outline of the contribution is as follows:

First, this is the first study that uses the NRBV theory in order to examine internal drivers, specifically, resources and capabilities, in relation to GSCM strategy and the resulting effect on the performance and competitive advantage of shipping firms.

Second, consensus has yet to be reached in GSCM literature regarding the relationship between proactive environmental strategy, such as GSCM, and economic performance.

Third, this study takes into account every segment in shipping, thus providing a comprehensive image of the industry. In addition, this study's sample is significantly larger than those used in prior GSCM studies.

The results from this study may benefit shipping managers by guiding them regarding the key drivers for the successful and effective implementation of a profitable and competitive proactive GSCM strategy.

1.3.2. GSCM and financial performance

Chapter three includes an innovative empirical study of GSCM strategy preferences and the resulting effects on the financial performance of shipping firms. Two hypotheses are examined in this chapter, namely, H1: Shipping firms can be clustered according to their strategic choices around GSCM, and H2: Shipping firms that implement more proactive GSCM strategies will have better financial performance. For the significance test of these hypotheses, firstly, a K-means cluster analysis was performed to examine whether shipping firms can be clustered according to

their strategic choices around GSCM. After the cluster analysis, One-Way Anova and Kruskal Wallis tests were used to find the differences in financial performance among the clusters on the basis of a Tukey Post-Hoc analysis, and a Mann-Whitney test, respectively.

Chapter three contributes to the GSCM literature in several ways which will be explained in more detail in subsection 3.1. For now, a general outline of the contribution is as follows:

First, it seems this is the first study to support GSCM as a proactive environmental strategy for shipping firms, which includes innovative green practices with the aim to prevent pollution and to integrate the green supply chain. Furthermore, this is the first study to examine the implementation of proactive GSCM strategy and its relationship to improved financial performance in the shipping industry.

Second, consensus has yet to be reached in the general environmental management literature on the relationship between proactive environmental strategy and financial performance, and more importantly, this is the first study to examine that relationship in the context of the shipping industry.

1.3.3. The moderating effect of managerial propensity for risk-taking on the relationship between proactive GSCM strategy and performance

Chapter four of this thesis provides an empirical study of the relationship between proactive GSCM strategy and performance in the context of the shipping industry. The study is the first to provide an empirical assessment of the moderating effect of managerial propensity for risk-taking on the relationship between GSCM strategy and two performance measures, namely environmental and economic.

Four research hypotheses are examined in this study. H1: Proactive GSCM strategy is positively associated with environmental performance for shipping firms. H2: Proactive GSCM strategy is positively associated with economic performance for shipping firms. $H3_a$: Managerial aversion to risk has a positive moderating effect on the relationship between proactive GSCM strategy and environmental performance, and $H3_b$: Managerial aversion to risk has a positive moderating effect on the relationship between proactive GSCM strategy and economic performance. Structural equation modelling is used to test the research hypotheses. A multi-group analysis is conducted in the examination of the moderating effects of managerial propensity for risk-taking on the relationship between GSCM strategy and performance. The chapter also includes discussion on the data analysis strategy and the results.

This study contributes to the relevant literature in several ways, which will be explained in more detail in subsection 4.1. For now, a general outline of the contribution is as follows:

The study presents a unique causal model that seeks to empirically examine how proactive GSCM strategy relates to the environmental and economic performance of shipping firms. In addition, an innovative aspect of this study is the facts that this is the first study to take into account the risk-taking propensity of shipping industry managers and empirically examines the moderating effects of their risk aversion on the relationship between proactive GSCM strategy and two performance measures, namely environmental and economic. This study's results provide empirical evidence

of the performance impacts of a proactive GSCM strategy with high and low managers' aversion to risk.

As already mentioned, consensus has not yet been reached in environmental management literature on the relationship between GSCM and economic performance; some studies show a positive relationship (Azevedo et al. 2011; Zhu et al. 2007; Zhu et al. 2012; Zhu and Sarkis, 2004), some show none (Zhu et al. 2005; Zhu et al. 2013).

More importantly, this is the first study which upholds GSCM as a proactive environmental strategy, and empirically examines the causal relationship between this proactive environmental strategy and performance in the context of the shipping industry.

1.4. Structure of the thesis

This thesis contains five chapters. Chapter one discusses environmental management and supply chain management, and the integration of the former into the latter, otherwise known as the concept of green supply chain management (GSCM), in the global shipping industry. Chapter one also provides a methodology and an estimation strategy, as well as the key objectives and critical contributions of this thesis.

Chapter two provides an empirical examination of the drivers and effects of implementing a proactive GSCM strategy. An important contribution of this study is the use of NRBV theory in the aforementioned examination, in the context of an industry with unique characteristics such as shipping. Examining GSCM in the shipping industry thus constitutes a distinct contribution to GSCM literature.

Chapter three contains an innovative empirical examination of GSCM strategy implementation and the resulting improvement in financial performance.

Chapter four focuses on the relevant literature, looking at the moderating effect of managerial propensity for risk-taking on the relationship between proactive GSCM strategy and performance, still in the context of shipping firms.

The structure of the studies presented in chapters two, three, and four, follows that of an academic paper, that is to say, it has an introduction, a brief literature review, development of hypotheses, description of methodology, a discussion of the results, followed by a conclusion, containing a discussion of the implications and limitations of the study, and finally recommendations for future research.

CHAPTER 2: DRIVERS AND CONSEQUENCES OF GREEN SUPPLY CHAIN MANAGEMENT IN SHIPPING

2.1. Introductions

Carrying more than 80% of the global trade volume (UNCTAD, 2017), maritime transportation is a dominant mode of transport that facilitates international trade and contributes to global development and prosperity. Globalisation and heightened competition have changed the way that shipping companies operate (Yang et al., 2013). The shipping industry now faces a higher trade volume and an increasing number of larger vessels, with a corresponding rise in merchant fleet capacity. One result of this growth is the impact on the environment from ship operations, such as GHG,[5] waste, noise, operational pollution and oil spills that continue to aggravate the concerns of stakeholders.

The intensification of the ecological problems resulting from pollution[6] has led charterers, shippers, governments, NGOs and other stakeholders, to increase the pressure on shipping firms to take environmental protection measures. For instance, oil majors have introduced strict requirements for tanker chartering in the TMSA,[7] a standard that has become a market-imposed regulation primarily aimed at safety, environmental protection and pollution prevention. In addition, the Marine Environment Protection Committee that sits under the International Maritime Organization (IMO), the specialised agency of the UN, continues to develop and ratify regulations (e.g. MARPOL, the Ballast Water Management Convention, the sulphur cap) targeted towards pollution prevention (Review of Maritime Transport, 2017)). Stakeholder concern and pressure is what drives shipping companies and the industry as a whole to focus on environmental issues. For example, Maersk, a major liner shipping company, was among the first to build energy efficient ships with particular environmental performance attributes and a cradle to cradle passport (in effect, ships that are recyclable). The adoption of green management practices has become an integral part of the environmental strategy of shipping companies due to the belief that it may ultimately contribute to a competitive advantage (Yang et al. 2013).

Shipping companies presently constitute an integral part of global supply chains, which are made up of a range of stakeholders and partners, from raw material traders to shippers, consignees and wholesalers. Supply chain partners view green supply chain management practices as essential for competitiveness. This has encouraged shipping firms to 'green' their own practices in line with those of supply chain partners. Shipping firms are increasingly sharing resources, skills and knowledge to collaborate with their supply chain members towards common environmental goals, specifically, reducing their environmental impact and improving the environmental performance of the overall supply chain. This strategy is known as Green Supply Chain Management (GSCM) and refers to shipping companies including the environmental perspective in the management of their supply chain, for example, by adopting proactive internal and external practices to prevent

[5] 'Maritime transport emits around 1,000 million tonnes of CO2 annually and is responsible for about 2.5% of global greenhouse gas emissions (3rd IMO GHG study)'. (https://ec.europa.eu/clima/policies/transport/shipping_en).

[6] The recent UN report (Review of Maritime Transport, 2018) showed that global warming is rising dramatically (http://unctad.org/en/PublicationsLibrary/rmt2017_en.pdf). In recent years, pollution caused by elements such as GHG emissions, have been on the rise, causing disastrous outcomes for ecosystems.

[7] TMSA refers to the Tanker Management Self-Assessment, which is a programme that encourages shipping firms to assess their safety management systems against key performance indicators. This programme provides companies with a means to improve and measure their environmental performance (https://www.ocimf.org/sire/about-tmsa.aspx).

pollution. Some authors argue that implementing GSCM practices not only leads to green supply chain integration, but also an eventual improvement in performance and competitiveness (Rao and Holt, 2005; Yang et al., 2013).

Research into GSCM is mostly being performed in the manufacturing sector. Empirical research on the topic, including its impact on the performance and competitiveness of shipping firms remains inadequate (Lai et al., 2013). At the same time, increasing pressure and regulation make the adoption of GSCM practices crucial for the competitiveness of shipping firms. These green practices require internal coordination, as well as external collaboration with customers and suppliers. As the adoption of green supply chain management practices becomes more important, it is necessary to further examine the topic of GSCM in the global shipping industry.
Most studies have focused on the relationship between GSCM and performance (e.g. Vachon and Klassen, 2008; Zhu and Sarkis, 2004; Zhu et al., 2012, 2010), however, few have examined the causal relationship between GSCM, performance and competitive advantage (Rao and Holt, 2005; Yang et al., 2013). One important gap is that studies have neglected the antecedents and factors that contribute to the successful implementation of proactive GSCM strategy (internal factors as indicated by Fahiminia et al., 2015), which can lead to improvement in performance and competitiveness.

Only a handful of credible studies examine green issues within the service industry. For instance, Lai et al. (2013) and Chang and Danao (2017) examine green shipping practices (GSPs) in the shipping industry. In another study, Leonidou et al. (2013) examine resources and capabilities as drivers of green marketing strategy, as well as the latter's effect on Greek hotels, specifically their competitive advantage, their market and their financial performance. These studies are nevertheless limited by their scope: they focus on specific internal green management practices, such as GSPs or green marketing. In contrast, our study contributes to the literature by developing a unique conceptual model that considers the entirety of the supply chain of shipping firms and examines whether resources and capabilities act as drivers to the development and successful implementation of a proactive GSCM strategy. Our model includes the adoption of internal and external green supply chain management practices, and we look into the extent to which these may lead to improved performance and competitiveness for shipping firms.

This study seeks to identify and examine antecedents based on the theoretical principles of the resource-based view (RBV) and the natural resource-based view (NRBV). Based on NRBV theory, valuable resources and capabilities are key to the successful implementation of a proactive environmental management strategy that leads to improved performance and a sustainable competitive advantage (Amit and Schoemaker, 1993; Leonidou et al, 2017).

Departing from the majority of prior studies that have examined the concept in manufacturing supply chains, this study seeks to be the first to examine it in the context of transportation supply chains in the shipping industry.

The present study contributes to GSCM literature in several ways. Firstly, as already mentioned, this is the first study to use NRBV theory in order to examine the effect of internal drivers, such as resources and capabilities, on proactive GSCM strategy implementation, and the effects of such

a strategy upon the performance and competitive advantage of shipping firms. The few existing studies have focused on the examination of the relationship between antecedents, especially external factors, and GSCM adoption (e.g. Zhu et al, 2011; Zhu and Sarkis, 2006). There are also a few studies that have examined the internal drivers of GSCM, and of those, most have focused on factors such as company policy, management support and commitment (Lee, 2008; Liu et al., 2012; Wu et al., 2012; Zhu and Sarkis, 2006; Zhu et al., 2008). Thus, we have identified a significant gap in the literature in terms of causal models that examine internal drivers, and the performance and competitive implications of a proactive GSCM strategy.

Secondly, there is no consensus in environmental management literature regarding the relationship between proactive environmental strategies, such as GSCM, and economic performance. While some studies show a positive relationship (Rao and Holt, 2005; Yang et al., 2013), others find none (Bowen et al., 2001; Zhu et al., 2013, 2005). This may have been due to differences and variations in the sampled firms across the industries examined in each study, or due to the omission of variables that may have been important to the mechanism between GSCM and economic performance (Shang et al. 2010; Yang et al. 2013). By focusing on the shipping industry, this study aims to depart from prior studies that have focused solely on mixed samples from manufacturing industries. The main objective of shipping firms is to provide a high-quality service with lower costs. Thus, it is important to further examine whether the adoption of proactive GSCM practices leads to improved economic performance for shipping firms.

This study will address the gap, in the context of the shipping industry, by developing a unique conceptual model, which not only considers the antecedents and consequences of proactive GSCM strategy in a relevant and idiosyncratic industry, but also provides ample opportunity for generalised results.

Thirdly, this study takes into account every segment across the shipping industry, such as bulk, liner and specialised shipping, contrary to previous studies that have examined GSCM only in relation to a specific segment of shipping. For example, Yang's et al. (2013) study focuses on container shipping. Focusing on a larger global sample of shipping firms than any preceding study, and taking into account the diverse, but closely related, segments in the shipping industry facilitates a wider generalisation of results and addresses issues that may apply beyond the shipping industry.

Fourthly, this study contributes to the GSCM literature by focusing solely on the shipping industry, which is notable in market uncertainty, freight volatility, and capital intensity; characteristics that influence strategy, competitiveness and performance (Andreou et al., 2014).

The study is comprised of the following sections: An introductory section; section two, which provides a detailed review of prior studies on environmental and GSCM strategy; section three provides the conceptual framework and the development of 10 research hypotheses. Section four discusses the methodology, including the survey development, sample characteristics, and the data analysis methods; section five discusses the results of the empirical analysis performed through structural equation modelling, including robustness and validity and reliability tests; and section

six concludes by discussing the implications for the shipping industry and provides suggestions for future research.

2.2. Literature review

In-depth empirical studies on the topic of GSCM are limited. Most have been conducted within the context of the manufacturing industry, examining diverse areas such as i) the extent to which GSCM practices have been adopted (Zhu and Sarkis, 2004), ii) the motives and drivers of GSCM practices (Wu et al., 2012; Zhu and Sarkis, 2006) and iii) GSCM practices and their impact on performance (Zhu and Sarkis 2004; Zhu et al., 2013, 2005).

A limited number of studies examine environmental management practices within the shipping industry. Specifically, Lai et al. (2013), found that shipping design of compliance (SDC), a green shipping practice, has had a positive influence on the financial performance of 107 shipping firms, leading them to conclude that SDC is beneficial for the financial and service performance of shipping firms. They also report that shipper cooperation and company policy and procedure have a moderately positive effect on the relationship between SDC and service performance. In a recent study, Chang and Danao (2017), examine the factors that drive green shipping practices (GSPs) and the effects of such practices on the environmental and productivity performance of shipping firms. They show that shipping firms are motivated to adopt GSPs by external drivers such as industrial norms set by institutional associations and customer demand to protect the environment, as well as by internal drivers, such as the value firms place on their image.

The studies that have focused on the shipping industry suffer from two main limitations; first, they tend to focus on internal management practices, such as GSPs, and second, their samples being relatively small, they do not examine a wide spectrum of shipping firms.

In contrast, Yang et al. (2013), have examined and found GSCM to have a positive effect on the green performance and competitiveness of container shipping firms in Taiwan. The study did not, however, examine drivers that influence the adoption of those GSCM practices. Yang's more recent study (2017) provided a conceptual model that examines institutional pressure as a driver for the adoption of internal and external green management practices and the effect of GSCM, specifically on the green performance of 129 container shipping firms in Taiwan. The findings revealed that institutional pressure has a positive influence on the adoption of internal green practices, but not on external green collaborative practices. The findings also revealed that GSCM practices positively influenced the green performance of the firms. We note, however, that the study omitted internal factors that were perhaps crucial for the adoption of GSCM practices, and was narrow in its scope, focusing only on container shipping firms in Taiwan.

Walker et al. (2008), argue that organisations are more likely to be influenced by external rather than internal drivers to adopt GSCM practices. Zhu and Sarkis (2006), identify a range of drivers; for example, Chinese manufacturers are influenced by stakeholder pressure. This is supported by Zhu et al. (2011), who conclude that Chinese manufacturers can be categorised based on GSCM practice adoption levels. They also noted the significance of regulatory pressure as an external driver of GSCM adoption for manufacturing firms in China. This is consistent with the findings of Wu et al. (2012), that show that regulatory pressure has a positive moderating effect on the

relationship between GSCM drivers and the adoption of GSCM practices in manufacturing firms in Taiwan. They also support that the internal driver of organisational support has a positive effect on GSCM practices.

This is also consistent with the findings of Zhu et al. (2008), who found that organisational learning and management support, two internal drivers, have a significantly positive effect on the level of GSCM practice adoption. In contrast, Liu et al. (2012) report no positive relationship between management support and level of GSCM adoption. These conflicting findings may be due to the variability in the study samples, and therefore highlight the need to further examine internal drivers of GSCM practices.

A significant gap in these studies is that they did not examine the effect that the implementation of GSCM practices has on performance. Testa and Irado (2010) addressed this gap by examining the relationship between strategic internal motivation that encourages managers to adopt GSCM practices, and profitability and competitiveness. They prove that reputation, innovation and imitation-led approaches influence the adoption of GSCM practices. They also report that organisations that encourage their suppliers to adopt environmental measures, improve their environmental performance. Nevertheless, their study fails to support the existence of a positive relationship between adopting GSCM practices, profitability and competitiveness.

Zhu et al. (2005), found that stakeholder pressure to adopt and implement GSCM practices improves the environmental and operational performance of Chinese manufacturers. However, the study fails to provide evidence as to a positive relationship between GSCM practices and economic performance. In a later study, Zhu et al. (2013) went on to examine external drivers of GSCM practices, such as institutional pressure, and the effect of these practices on the performance of 396 Chinese manufacturers. They concluded that i) institutional pressure has driven the adoption of internal GSCM practices, which have in turn had a positive association with adopting external GSCM practices, and ii) there is only an indirect positive effect between GSCM and economic performance. In contrast to the latter finding, studies by Rao and Holt (2005), and Yang et al. (2013), demonstrated a positive relationship between adoption of GSCM, competitiveness and economic performance.

The conflicting findings in the literature highlight the need for an empirical examination of external as well as internal drivers of GSCM practices, as well as the relation between GSCM practices, performance, and competitive advantage.

Prior studies on GSCM (e.g. Chiou et al. 2011; Rao and Holt, 2005; Testa and Iraldo, 2010; Yang et al. 2013; Zhu et al. 2013) have neglected to explore company resources and capabilities: these crucial internal drivers may be the key in enabling companies to sustain their competitive advantage. Proactive GSCM strategy requires investment in innovative green technologies, systems, ideas, and practices, which entails the supply of funds, knowledge, skills and abilities for coordination and collaboration. Valuable resources and capabilities are very important for shipping firms because these constitute key sources of performance improvements and sustainable competitive advantage (Barney, 1991; Hart, 1995). These resources and capabilities act as key

drivers of the development and successful implementation of firms' proactive environmental strategy, which are necessary for improved performance and competitiveness (Sharma and Vredenburg, 1998; Sharma, 2000). In this context, NRBV theory is an appropriate theoretical context in which to examine the relationships.

We note two additional issues concerning prior studies on GSCM drivers, practices, and implications. Most studies carry out either a case study analysis (i.e. Azevedo et al. 2011), or an exploratory form of analysis that is not predictive in nature. For example, Walker et al. (2008), perform an exploratory case study analysis of seven organisations to examine the drivers and barriers of GSCM practices. In another study, Zhu et al. (2005) perform an exploratory research to examine the drivers of GSCM adoption and associated improvement in performance. The predictive power of this study is bolstered by the development of a hybrid model that aims to examine the causal effects and the hypothesised relations between the various latent variables.

Furthermore, GSCM has almost always been analysed in the context of a single industry, i.e. manufacturing, in a certain region, i.e. Asian countries such as China, and in a limited context, i.e. using a relatively small sample. For instance, Wu et al. (2012), used a sample of 104 manufacturing firms in Taiwan to examine the relationship between the GSCM drivers and the adoption of GSCM practices. Lee (2008) explored the factors driving SME suppliers to participate in green supply chain initiatives using a sample of 142 suppliers in South Korea. Liu et al. (2012), who investigated the internal and external drivers for the adoption of GSCM practices, used a sample of 165 manufacturing firms in China. Zhu and Sarkis (2006) performed an exploratory research to compare the drivers and practices of GSCM in three types of manufacturing in China using a sample of 118 manufacturing firms.

Using the NRBV theory (Hart, 1995), our study contributes to the abovementioned studies by empirically examining resources and capabilities as internal drivers of a proactive GSCM strategy, and the effects of such strategy on the performance and competitive advantage of shipping firms on a global level.

2.3. Conceptual framework and development of hypotheses

Proactive environmental strategy refers to a firm taking voluntary action to reduce the environmental impact of its operations. Through such strategies, managers search for and adopt innovative practices to reduce the risk of pollution. At the same time, such strategies provide a leverage for positive outputs in relation to the environment, economic performance as well as competitiveness.

In this study, GSCM is a proactive environmental strategy that includes adopting innovative internal and external green supply chain management practices that are required for green supply chain integration, which may also lead to improved competitiveness and performance (Rao and Holt, 2005).

2.3.1. The RBV and NRBV theories

The resource-based view (RBV) is one of the most valued theories in strategic management literature (Newbert, 2007). The RBV considers organisational resources and capabilities as drivers that contribute to organisational performance and competitive advantage. Firm resources, which include tangible and intangible firm assets (Wernfeld, 1984), act as key drivers of competitive advantage and higher performance for firms (Amit and Schoemaker, 1993). The RBV theory also argues, as suggested by Barney (1991) and Schroeder et al. (2002), that firms with valuable, rare, inimitable, and non-substitutable resources, have the ability to develop and adopt strategies which lead to competitive advantages and performance improvements. For a firm to sustain the resulting competitive advantage they must also deploy the necessary capabilities that will assemble, integrate and manage their resources to meet and overcome volatile market demands (Russo and Fouts, 1997).

Proactive GSCM strategy requires investment in innovative green technologies and practices, which require shipping firms to supply funds, knowledge, skills, and abilities for coordination and collaboration. The successful implementation of proactive green strategy enables shipping firms to differentiate their activities from their reactive counterparts and to achieve a competitive advantage (Eisenhardt and Martin, 2000).

Hart (1995) expands the RBV theory by incorporating the environmental factor in management strategy, resulting in a 'theory of competitive advantage based upon the firm's relationship to the natural environment' (Hart, 1995), also known as the natural resource-based view (NRBV).

The RBV/NRBV, which we adopt as the theoretical framework for our model, both attribute competitive advantage to the effective deployment of resources and capabilities when developing a proactive green strategy (Barney, 2001; Hart, 1995).

Judge and Douglas (1998), and Chan (2005), are in line with the above view, stating that firms that take environmental issues into account when formulating strategy develop capabilities that, combined with their resources, enhance the interplay between their operations and the environment, leading to improved performance and a competitive advantage.

The main objective for shipping firms in implementing a proactive GSCM strategy is to achieve competitive advantage and improve performance. Based on the NRBV theory and the literature, the required resources are defined as human, financial, and experiential, and the required capabilities as shared vision, stakeholder management and integration, and strategic proactivity (Christmann, 2000; Sharma and Vredenburg, 1998; Leonidou et al., 2013; Lin and Ho, 2008; Morgan et al., 2004).

Resources and capabilities, as discussed above, are valuable due to the fact they are tacit/skill based, socially complex, and difficult to acquire and replicate (Aragón-Correa and Sharma, 2000; Hart, 1995). They are also crucial in the development and implementation of a proactive green strategy aiming to have a positive impact on performance and competitiveness (Aragón-Correa et al., 2008; Barney, 2001; Hart, 1995).

2.3.2. Human resources and GSCM strategy

The quality of employees, their knowledge, commitment, skills, and their desire for continued growth constitute important human capital resources that can contribute to the successful implementation of a firm's strategies and goals (Jabbour and De Sousa Jabbour, 2016).

For an organisation aiming to integrate environmental issues into their supply chain management strategy and seeking to design, develop, and implement GSCM practices, it is necessary to maintain the relevant human resources (Daily and Huang, 2001). Innovative environmental practices and initiatives tend to depend heavily on employee skills (Youndt et al., 1996). Lee (2008) found that companies with high-quality human resources are far more likely to take part in GSC initiatives[8].

The retention of the key resource of high-quality human capital is essential to mitigate the environmental risks that are inherent to the shipping industry. Employees must be equipped with environmental knowledge and training, enabling them to integrate the environmental perspective into their daily operations and performance. Some studies have concluded that inadequate human capital constitutes an important obstacle to the adoption of GSCM practices (Lin and Ho, 2008; Wu et al. 2012).

Regarding external GSCM practices, high-quality human resources allow shipping firms to better collaborate with their supply chain members on environmental risks and responsibilities, in order to reduce their environmental impact, resolve GSCM-related problems, and to achieve common environmental goals (Vachon and Klassen, 2008; Yang et al., 2013). Teixeira et al. (2016), indicate that green human resource management has a positive impact in adopting GSCM practices.

Hypothesis 1. Shipping firms' quality of human resources is positively associated with the development of a proactive GSCM strategy.

2.3.3. Financial resources and GSCM strategy

Proactive environmental strategies, such as GSCM, require investment in new technologies, and innovative ideas and practices within supply chain management (Zhu et al., 2012). The successful adoption of such strategies often depends on financial investment in innovative green technologies (Leonidou et al., 2013). Financial investment is particularly crucial for shipping companies: Internal green supply chain management practices and pollution prevention technologies are costly. Financial resources are also required for green marketing practices (Leonidou et al., 2013), as well as external green practices, such as collaboration with supply chain members (Wu et al., 2012).

Hypothesis 2. Shipping firms' financial resources are positively associated with their proactive GSCM strategy.

[8] GSC initiatives are green management programmes which firms deploy in order to encourage their supply chain members to adopt green management practices, so that that overall supply chain can improve its environmental performance (Lee, 2008).

2.3.4. Experiential resources and GSCM strategy

Like human resources, experiential resources are an intangible organisational asset. They encompass employee experience and knowledge gained from participation in environmental operations and related activities. Experiential resources also include knowledge-based skills gained through environmental operations, practices, industry information, and other sources, making them complex and difficult to imitate, especially by competitors (Barney, 1991; Darnall and Edwards, 2006).

The experience gained from these activities can help organisations to improve their 'internal operations, achieve greater efficiencies and create opportunities for improving their strategic value' (Darnall and Edwards, 2006). Thus, experiential resources are not only necessary for the implementation of internal green practices, but also for successful collaboration between the company and its supply chain members.

Experiential knowledge and environmental teamwork provide the opportunity for the members of a supply chain to solve complex environmental issues and to adopt required pollution prevention programmes. Using the experience and knowledge of each member, as well as benefiting from potential win-win opportunities, leads to improved environmental performance (Hart, 1995; Jabbour and De Sousa Jabbour, 2016).

Learning gained from participation in environmental operations and activities is a driving factor for the successful implementation of proactive environmental practices in a complex service industry such as shipping. Firms that focus on learning tend to consistently seek to upgrade their existing practices.

Hypothesis 3. Shipping firms' experiential resources are positively associated with the development of proactive GSCM strategy.

2.3.5. Shared vision and GSCM strategy

The organisational capability of shared vision presupposes employees' mutual understanding and beliefs around firm strategies and objectives (Aragón-Correa et al., 2008). The organisation members must all believe in the importance of the firm's objectives and goals, as well as share their knowledge and collaborate to develop and achieve those objectives (Aragón-Correa et al., 2008).

Shared vision has the potential of positively influencing GSCM practices by reducing isolation and promoting integrative collaboration to meet the firm's objective to improve environmental performance. A high level of internal communication and collaborative capabilities can enhance a company's capability to collaborate and solve environmental problems with their supply chain members. This is supported by the empirical analysis of Yang et al. (2013), who state that internal green practices, including internal coordination and collaboration, are associated with external green collaboration. In addition, sharing capabilities and improving communication and collaborative practices allows shipping firms to design and develop their proactive strategies and practices, such as green marketing strategy, in the most productive and profitable way. This is

supported by Leonidou et al. (2013), who prove that shared vision is a capability that positively influences the development of a profitable and competitive environmental marketing strategy.

By sharing a vision, organisational members share their knowledge, creativity and willingness to promote their firm's environmental objectives (Ramus and Steger, 2000), factors which are critical for the successful implementation of a proactive GSCM strategy. According to Hart (1995), firms with this capability are able to develop their proactive environmental strategy, such as GSCM, quicker than firms without it (see also Aragón-Correa et al., 2008). Based on the above, we propose that:

Hypothesis 4. Shipping firms' capability of shared vision is positively associated with the development of a proactive GSCM strategy.

2.3.6. Stakeholder management and GSCM strategy

The ability to build close, collaborative, confidence-based relationships between a variety of stakeholders constitutes an extremely important capability in implementing a firm's proactive environmental strategy (Sharma and Vredenburg, 1998). Several studies have shown the contribution of stakeholder pressure in the adoption of GSCM practices (Lee, 2008; Sarkis et al., 2010; Zhu et al., 2013). The pressure is increasing, especially for shipping firms. Thus, shipping firms need to integrate stakeholder perspectives into their strategic design and development (Hart, 1995).

Liu et al. (2012), argue that the level of a company's GSCM adoption, including internal and external GSCM practices, is significantly and positively associated with stakeholder pressure. Accordingly, relationship-building could be beneficial as it assists shipping companies to better understand the needs and demands of their stakeholders regarding environmental issues. Henriques and Sadorsky (1999) showed that firms with proactive environmental strategies have prioritised the views of their stakeholders and integrated the concerns of the latter into their management strategy. This is also supported by Aragón-Correa et al. (2008), who reveal that stakeholder management capability is positively associated with the development of proactive environmental strategy.

Due to the shipping industry's highly competitive environment, shipping firms with strong stakeholder management capabilities can better recognise and understand their stakeholders' environmental requirements. Shipping firms can use stakeholder management to efficiently respond to stakeholder concerns through implementing GSCM practices.

Hypothesis 5. Shipping firms' stakeholder management is positively associated with the development of a proactive GSCM strategy.

2.3.7. Strategic proactivity and GSCM strategy

Strategic proactivity is the capability of firms to update, design and develop policies and strategies in a proactive manner (Miles et al., 1978; Sharma, 2000). Proactive firms invest in innovative technologies and strategies, to make their internal and external GSCM practices and operations more environmentally friendly.

Strategic proactivity is a capability that allows shipping companies to invest in flexible processes with a focus on sustained green development. Shipping firms with this orientation interpret environmental issues and practices as opportunities rather than as threats; they pursue and adopt proactive strategies that go beyond basic compliance with legislation and regulation.

Hypothesis 6. Shipping firms' capability of strategic proactivity is positively associated with the development of a proactive GSCM strategy.

2.3.8. GSCM strategy and environmental performance

Shipping firms that promote green collaboration and coordination internally, as well as in the context of their supply chain, are better equipped to deal with environmental issues. In addition, by collaborating and sharing knowledge with their supply chain partners, shipping firms can enhance their ability to solve problems and overcome barriers related to environmental issues, thus improving their environmental performance. Companies have been shown to improve their performance by adopting internal and external GSCM practices (Zhu et al., 2013). Vachon and Klassen (2008) also support this position, with their study that proves the positive association between green collaboration with supply chain members and improved performance. Yang et al. (2013) also provide evidence of the positive association between internal green practices and external green collaboration, and improved green performance for container shipping firms in Taiwan. Zhu and Sarkis (2004), prove that manufacturing firms with enhanced internal and external, i.e. collaborative, GSCM practices have a better environmental performance.

Hypothesis 7. Shipping firms' proactive GSCM strategy is positively associated with improved environmental performance.

2.3.9. GSCM strategy and economic performance

Several studies investigating GSCM practices highlight the significant relationship between the implementation of such practices and economic performance. Zhu and Sarkis (2004) propose that high levels of GSCM adoption correspond to improved economic performance for enterprises. Rao and Holt (2005) indicate that greening different phases of the supply chain, i.e. integrating internal and external GSCM practices, can lead to improved economic performance. Nevertheless, some studies failed to find a relationship between GSCM practices and economic performance (Bowen et al., 2001; Zhu et al., 2013, 2005). It follows that the relationship between GSCM implementation and improved economic performance remains inconclusive (Schaltegger and Synnestvedt, 2002; Zhu et al., 2005).

In our study, we support the argument that shipping firms who are proactive in adopting GSCM practices as part of their sustainability strategy see a positive influence on their environmental performance as well as their economic performance in line with the studies of Yang et al., (2013) and Rao and Holt (2005).

Hypothesis 8. Shipping firms' proactive GSCM strategy is positively associated with improved economic performance.

2.3.10. Performance and competitive advantage

Competitive advantage refers to a firm's gains that are the result of successfully implementing a proactive strategy facilitating cost reductions, market opportunities, and neutralisation of risks and competitive threats (Barney, 1991). Performance refers to the outcome of the strategy implementation.

Various studies acknowledge the positive effects of GSCM practices on performance (Testa and Iraldo, 2010; Zhu and Sarkis, 2004; Zhu et al., 2013, 2007, 2005), but few have examined the extent to which their implementation results in a competitive advantage.

Competitive advantage may be gained on the basis of cost and differentiation. Proactive environmental supply chain management practices may reduce costs and provide service differentiation through improved environmental performance (see also Larran Jorge et al., 2015; Russo and Fouts, 1997). By implementing a proactive GSCM strategy, shipping firms signal their improved environmental performance to their stakeholders, which is a fundamental step in establishing a valued reputation. Larran Jorge et al. (2015) agree that improved environmental performance encourages a more positive company image and increased competitiveness.

Similarly, shipping firms may look to improve their competitive advantage by integrating green initiatives and practices, such as internal environmental proactivity (IEP), green shipping practices (GSPs) and green marketing (GM) and adopting collaborative activities with suppliers, partners, and customers (Yang et al., 2013).

Shipping firms can also drive their competitive advantage via cost and risk reductions, improving their image and the environmental quality performance of their services (Shang et al., 2010), such as reduction of GHG, waste and accidents. Shipping firms that implement proactive GSCM practices can add to their maritime transport services, which are also provided by their reactive counterparts, by improving how they deal with quality and cost. This is supported by Yang et al. (2013), who found a positive association between green performance and competitiveness in the context of container shipping firms in Taiwan. Proactive shipping firms offer high-quality maritime transport services that focus on safety and respect the environment. This can lead to service differentiation and competitive advantage.

Hypothesis 9. Shipping firms' environmental performance positively affects their competitive advantage.

Hypothesis 10. Shipping firms' economic performance positively affects their competitive advantage.

Our study's conceptual model is shown below in Figure 1.

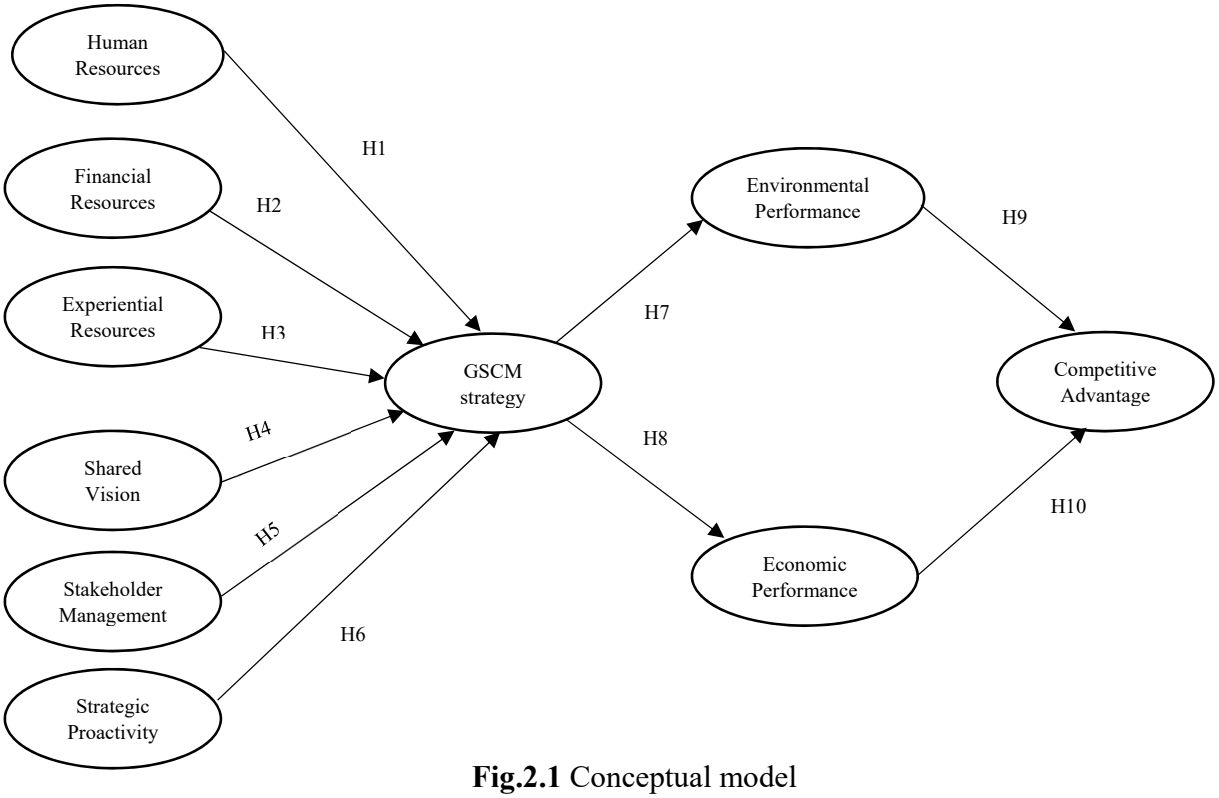

Fig.2.1 Conceptual model

2.4. Methodology

2.4.1. Questionnaire development

The main goal of this study is to examine the extent to which shipping firms' resources and capabilities act as drivers of GSCM strategy, and how this proactive strategy can influence their environmental and economic performance and competitive advantage. To test the research hypotheses, a questionnaire was developed and administered to a global sample of shipping firms. The items were primarily derived from the literature. Due to the unique nature of this study, we developed a new measurement tool that combines theories and variables from a variety of studies and thematic areas, which is presented in more detail in section 2.4.3. To finalise the questionnaire, academic, governmental and shipping industry experts were asked to provide comments and suggestions relating to the items and scales. This process ensured the following: that the questionnaire was comprehensive in its scope, that the questions were made clear for the respondents and that the main variables of the study were being accurately measured.

2.4.2. Data and sample characteristics

The global sample for this study consisted of ship owning and ship operating companies. The choice of companies was based on their representation of integral parts of the supply chain and the level of their contribution to the environmental profile of the supply chain.

By adopting the key informant technique (Kumar and Dillon, 1990), the study identified and surveyed respondents in high-ranking positions (e.g. managers, directors and CEOs) who were deemed knowledgeable on the issues. The technique was adopted to ensure the reliability and validity of the data collected.

The questionnaire was delivered in one of two ways: it was emailed or dropped off by hand. The sample was selected randomly from Lloyd's List Maritime Intelligence Informa, an online global maritime directory that categorises maritime firms by industry sector.

The survey was administered to 570 shipping firms, addressed to the highest ranking managerial official as identified by the company (CEO, managing director, manager, or general manager). From the 570 questionnaires, 47 were delivered and collected by hand. The 523 email questionnaires garnered 217 responses. Four weeks post-dissemination, reminder emails and phone calls were deployed, resulting in an additional 35 responses. From the 299 responses, 10 were not usable, e.g. due to lack of completeness. Thus, the total number of usable responses was 289, giving an overall response rate of 51%, which is considered exceptional for studies of this nature. The relatively high response rate was achieved through a combination of hand-delivering a number of the questionnaires (across three European countries) and the effort put into the follow up to prompt responses.

2.4.3. Measures

The study utilised ten constructs that were mainly derived from the related literature. This included nine first order factors, namely human resources, financial resources, experiential resources, the capabilities of shared vision, stakeholder management and strategic proactivity, environmental and economic performance, and competitive advantage; and one second order factor, namely proactive GSCM strategy, which includes the practices of internal environmental proactivity, green shipping, green marketing, green collaboration with suppliers,[9] green collaboration with customers,[10] and green collaboration with partners.[11]

In order to select measurement items, an in-depth and extensive exploratory research was performed on relevant theories, including the NRBV theory and stakeholder theory. In addition, an in-depth study on GSCM was undertaken by considering research papers, books and case studies related to transportation, supply chain management, environmental management and strategy. When the measurement items were selected, the questionnaire was developed and shaped according to the feedback provided by experienced academics and shipping practitioners.

Our approach supports the content validity of this study. In addition, we performed a number of tests to verify the construct validity and reliability of the resulting items (see section 2.5.3.).

Appendix 1 shows the measurement items used for constructing the variables of interest as expounded in the relevant literature (Aragón-Correa et al., 2008; Banerjee et al., 2003;

[9] Suppliers such as fuel or shipbuilding companies.
10 Customers such as oil companies, shippers, or forwarders.
11 Partners such as stevedoring companies, terminal operators, trucking companies, marine insurance companies, or banks.

Bowen et al., 2001; Lai et al., 2011; Leonidou et al., 2013; Lin and Ho, 2008; Morgan et al., 2004; Sarkis et al., 2010; Shang et al., 2010; Sharma et al., 2007; Vachon and Klassen, 2008; Yang et al., 2013; Zhu et al., 2007).

The items in Appendix 1 were mainly extracted from the literature, while others were slightly modified to reflect the context of this study e.g. X1.5b, X1.6a, X16.b, X1.8, X1.10 (see Appendix 1), as per the suggestion of academics and shipping industry practitioners.

Appendix 1 presents the finalised measurement items used for evaluating resources, capabilities, GSCM practices, environmental and economic performance, and competitive advantage. The measurement items were scored based on a five-point Likert scale (1= strongly disagree to 5= strongly agree).

2.4.4. Pre-test analysis

We followed the suggestion by Armstrong and Overton and performed a comparison of early (first wave) and late (second wave) respondents to test for non-response bias by t-test analysis. This was to reveal any significant differences in the responses between the two groups (Armstrong and Overton, 1977).

First, we divided the 289 survey respondents into two groups, namely early (n=207) and late (n=82) respondents. We performed an independent sample t-test[12] to examine whether a non-response bias problem appears from the data of the two groups. At a 5% significance level, we concluded that there are no significant differences between the two groups of respondents. In addition, from the t-test analysis, we concluded that there is no statistically significant difference in the responses of the two groups, since late responses appear to be in line with those provided by early respondents (Yang et al., 2013). Thus, both the t-test analysis and the high response rate suggest that non-response bias was not a problem in this study.

2.4.5. Data analysis strategy

Guided by the methodological characteristics and the objectives of this study, the multivariate statistical analysis technique of structural equation modelling (SEM) was deemed to be the most appropriate for testing the research hypotheses. SEM can manage many endogenous and exogenous variables, as well as latent variables, thus allowing researchers to test more complicated hypotheses between latent variables. An exploratory factor analysis was performed to identify and extract the key dimensions (factors) for the variables: resources, capabilities, GSCM practices, environmental and economic performance, and competitive advantage. This approach was first introduced by Anderson and Gerbing (1988) and was adopted across many studies that followed (Shang et al. 2010; Yang et al., 2013; Zhu and Sarkis, 2004; Zhu et al. 2011). Following the exploratory factor analysis (EFA), a two-step method suggested by Anderson and Gerbing (1988), was used to analyse the data. In the first step, confirmatory factor analysis was performed to verify the factor structure of a set of observed variables. Once the measurement model was validated, the second step estimated the structural model, using SEM, from the latent variables, to determine

12 A t-test was performed on the data, regarding the agreement level of two groups on the various resources, capabilities, GSCM practices, environmental and economic performance, and competitive advantage variables.

whether significant relationships exist between the constructs. The results and a discussion of the empirical analysis are presented in the following sections.

2.5. Results of empirical analysis

2.5.1. Profile of the respondents

Table 2.1 presents the characteristics of firms that responded to the questionnaire, as well as respondent bios. More than 30% of firms had a 100 or more shore-based employees, while 29.1%, 27.3%, and 12.5% had between 21-50, 1-20, and 51-100 shore-based employees respectively. Almost 70% of firms had more than 100 employees at sea. More than 32% of the responding firms had been founded over 31 years ago, which is a key finding for the quality and the validity of the survey results.

Table 2.1
Demographics

Characteristics of respondents	Frequency	%
Company information		
Ownership		
Local firm	149	51.6
Foreign firm	128	44.3
Others	12	4.1
Numbers of employee (shore based)		
1-20	79	27.3
21-50	84	29.1
51-100	36	12.5
>100	90	31.1
Numbers of employee (at sea)		
1-20	10	3.5
21-50	25	8.7
51-100	52	18
>100	202	69.9
Headquarters		
EU registered	168	58
Non-EU registered	121	42
Establishment (in years)		
1-10	29	10
11-20	101	34.9
21-30	65	22.5
>31	94	32.5
Biographical information		
Job title		
CEO	16	5.5
Managing director	48	16.6
Department manager/Department director	214	74
Others	11	3.8
Gender		
Male	251	86.9
Female	38	13.1
Education		
Under graduate	20	6.9
Master's degree	197	68.2
Doctorate degree	14	4.8
Others	58	20.1
Age (in years)		

Under 30	5	1.7
30-40	65	22.5
41-50	101	34.9
Above 50	118	40.8
Industry Experience (in years)		
Under 5	3	1
5-10	18	6.2
11-15	28	9.7
16-20	50	17.3
21-25	65	22.5
Above 25	125	43.3
Managerial Experience (in years)		
Under 5	25	8.7
5-10	60	20.8
11-15	71	24.6
16-20	43	14.9
21-25	32	11.1
Above 25	58	20.1

Regarding respondent bios, results show that 5.5% of the questionnaire respondents were CEOs, while 16.6%, and 74% were managing directors and department managers/department directors respectively. Furthermore, respondents were asked to indicate their industry and managerial experience. Over 83% of respondents have more than 10 years of experience in shipping, while over 70% of respondents have more than 10 years of managerial experience. Overall, the sample profile shows that 96% of questionnaire respondents were department managers/department directors or above, leading to further confirmation of the validity and reliability of the survey findings.

2.5.2. Exploratory factor analysis

Factor analysis is a dimension reduction technique that aims to find a smaller set of underlying factors from the original variables with a minimal loss of information (Hair et al., 2006). We used principal component analysis with varimax rotation in our exploratory factor analysis (EFA), to further confirm and validate the underlying factors, as our items had been selected from a variety of sources. The approach was employed to identify and extract key dimensions for the variables: resources, capabilities, GSCM practices, environmental and economic performance, and competitive advantage. The results are indicated in Appendix 2.

Various tests were performed to determine the adequacy of the analysed data. The Kaiser-Mayer-Olkin (KMO) test for sampling adequacy was 0.928, well above the 0.5 threshold suggested by Hair et al. (2006). Bartlett's sphericity test was also significant (see Appendix 3). Only variables with a factor loading greater than 0.50 were extracted, a conservative criterion based on Hair et al. (2006)[13]. Two internal green items (X5b and X6b), did not meet this criterion and were eliminated from the research.

Based on the Kaiser's eigenvalue greater or equal to one criterion, the principal component analysis yielded a fifteen-factor solution, namely human, financial, and experiential resources, capabilities of shared vision, stakeholder management and strategic proactivity, internal environmental proactivity, green shipping practices, and green marketing, collaboration with

[13] According to Hair et al. (2006), 'the larger the absolute size of the factor loading, the more important the loading in interpreting the factor matrix'.

suppliers, partners and customers, environmental performance, economic performance, and competitive advantage (see Appendix 2). The cumulative variance of the fifteen factors is 67.208%. The percentage of variance and the cumulative variance for each of the fifteen factors are shown in Appendix 4.

As mentioned above, content validity was supported by using existing literature and the executive interviews that contributed to the development of the questionnaire. Following data collection, further analysis was performed to confirm construct validity and reliability.

The above EFA results showed that all measurement items had strong loading on the construct.

2.5.3. Construct Validity and Reliability test

We adopted the recommended process for developing and validating the questionnaire. The validity and reliability of the constructs were tested using Cronbach's alpha.

Table 2.2 shows the results of the reliability tests. The lower threshold for Cronbach's alpha is 0.60 (Flynn et al., 1990; Nunnally and Bernstein, 1994), but the agreed lower acceptable limit is 0.70 (Flynn et al., 1990). Cronbach's alpha for the fifteen factors is well above 0.78, and therefore well above the limit of 0.70. Cronbach's alpha values confirms the reliability of the constructs in this study.

Table 2.2
Reliability test

Measures	Items	Mean	S.D.	Cronbach α	CITC range
4. **Human resources**	4	3.292	1.331	0.834	0.573-0.855
5. **Financial resources**	4	3.268	1.341	0.818	0.557-0.847
6. **Experiential resources**	2	3.303	1.338	0.816	0.696
7. **Shared vision**	3	3.300	1.332	0.787	0.526-0.793
8. **Stakeholder management**	4	3.320	1.338	0.850	0.626-0.846
9. **Strategic proactivity**	3	3.303	1.306	0.923	0.671-0.895
10. **Internal environmental proactivity**	8	3.333	1.369	0.892	0.582-0.931
11. **Green shipping practices**	5	3.198	1.334	0.845	0.560-0.874
12. **Green marketing**	6	3.273	1.370	0.878	0.632-0.916
13. **Collaboration with suppliers**	5	3.298	1.371	0.847	0.590-0.881
14. **Collaboration with partners**	5	3.316	1.298	0.817	0.539-0.874
15. **Collaboration with customers**	5	3.229	1.370	0.867	0.618-0.886
16. **Environmental performance**	6	3.182	1.344	0.859	0.571-0.904
17. **Economic performance**	5	3.224	1.360	0.851	0.612-0.888
18. **Competitive advantage**	7	3.431	1.420	0.860	0.572-0.890

In addition to Cronbach's alpha, we performed the corrected item-total correlation (CITC) reliability test (Kerlinger, 1986), to further ensure the constructs' internal consistency and validity. The CITC is basically the correlation between an item, or indicator, and the composite score of the rest of the items in the set (Shang et al., 2010).

The lower agreed limit of CITC is 0.30 (Ferketich, 1991), while Nunnaly (1978) suggests excluding items with total correlation values below 0.40. The CITC values for the fifteen factors were larger than 0.50. Specifically, the CITC of all items ranged from 0.539 to 0.931, all well above the limit of 0.30. Based on Cronbach's alpha and CITC values, we confirm the validity and reliability of the constructs.

2.5.4. Confirmatory factor analysis

Prior to evaluating the structural equation model, we conducted a confirmatory factor analysis (CFA) using the maximum likelihood estimation with SPSS AMOS 21 to assess the unidimensionality of the study's constructs. We performed the CFA to verify the factor structure of a set of observed variables produced by the EFA and to establish that our theoretical model fit well with the sample data.

The results of confirmatory factor analysis showed a good fit in accordance to established criteria such as those by Hu and Bentler (1999) and Kline (1998). The results are summarised in Table 2.3. Based on the results of the absolute fit indices, and incremental fit indices of the measurement model, we achieved a good fit (Hu and Bentler, 1999). More specifically, a value of root mean square error of approximation (RMSEA) less than 0.06 (Hu and Bentler, 1999), and a value of CMIN/DF less than 3 (Kline, 1998), were indicative of acceptable model fit.

Table 2.3
Measurement model

	Fit indices	
X^2 / d.f. =1.109, RMSEA = 0.019	SRMR = 0.04, CFI = 0.979, IFI = 0.979	PRATIO = 0.937, PCFI = 0.917

With respect to absolute fit indices, both the RMSEA value of 0.019 and the CMIN/DF (x^2/df) value of 1.109 are well below the acceptable value. In addition, incremental fit indices, such as comparative fit index (CFI[14]) and incremental fit index (IFI) are both 0.979, scores well above the acceptable value of 0.90 (Hair et al., 2010).
Moreover, parsimonious fit indices of PRATIO = 0.937 and PCFI = 0.917 both indicate an acceptable fit. Furthermore, the value of root means square residuals (RMR[15]) is 0.083, and the standardised root mean square residuals (SRMR) is 0.04, which is below the recommended threshold value of 0.10. Overall, the results indicate that our measurement model is acceptable, further confirming reliability and unidimensionality.

2.5.5. Construct validity

The construct validity was further examined by testing for convergent and discriminant validity. Convergent validity "relates to the degree to which multiple methods of measuring a variable provide the same results" (Yang et al., 2013). Discriminant validity refers to the degree to which measures of different variables are unrelated or unique (Kline, 2011). Regarding convergent validity in our measurement model, all the t-values in the Amos output are statistically significant - critical ratios (C.R.) > 1.96 - and all the factor loadings of the model were above 0.50 (Kline, 2011); convergent validity is thus satisfied. In addition, the average variance extracted (AVE), of the model was 0.5842, a value that exceeds the recommended acceptable limit of AVE > 0.50 (Bagozzi and Yi, 1988). Moreover, construct reliability scores (CR) were above 0.82, all well above the minimum threshold of 0.70 (Nunnally and Bernstein, 1994); consequently, convergent validity is achieved.

[14] According to Hu and Bentler (1999), a CFI value of 0.95 or higher is an indicator of good fit.
[15] According to Kline (1998), the minimum acceptable value of RMR is 0.10.

In addition, the average variance extracted (AVE) values for all constructs were larger compared to the corresponding squared correlation for each pair of constructs (Fornell and Larcker, 1981), thus indicating discriminant validity. The results are shown in Table 2.4.

Table 2.4
Convergent validity

Item codes	HR	FR	ER	SV	SM	SP	IEP	GSP	GM	CS	CP	CC	EP	ECP	CA
							GSCM								
HR1	0.998														
HR2	0.693														
HR3	0.706														
HR4	0.655														
FR1		0.984													
FR2		0.681													
FR3		0.663													
FR4		0.676													
ER1			0.708												
ER2			0.669												
SV1				0.998											
SV2				0.616											
SV3				0.698											
SM1					0.974										
SM2					0.705										
SM3					0.720										
SM4					0.706										
SP1						0.811									
SP2						0.994									
SP3						0.680									
SP4						0.827									
SP5						0.643									
SP6						0.817									
IEP1							0.998								
IEP2							0.658								
IEP3							0.627								
IEP4							0.681								
IEP5							0.672								
IEP6							0.702								
IEP7							0.713								
IEP8							0.716								
GSP1								0.998							
GSP2								0.644							
GSP3								0.660							
GSP4								0.671							
GSP5								0.696							
GM1									0.993						
GM2									0.730						
GM3									0.696						
GM4									0.670						
GM5									0.735						
GM6									0.686						
CS1										0.998					
CS2										0.662					
CS3										0.707					
CS4										0.651					
CS5										0.679					
CP1											0.997				
CP2											0.631				
CP3											0.666				
CP4											0.614				
CP5											0.656				
CC1												0.990			
CC2												0.728			
CC3												0.717			
CC4												0.698			
CC5												0.671			
EP1													0.998		
EP2													0.628		
EP3													0.707		
EP4													0.646		
EP5													0.699		
EP6														0.998	
ECP1														0.685	
ECP2														0.676	
ECP3														0.651	
ECP4														0.722	
ECP5															0.988
CA1															0.652
CA2															0.626
CA3															0.643
CA4															0.657
CA5															0.625
CA6															0.653
CA7															
Variance extracted	60.09%	58.21%	74.09%	62.09%	61.56%	64.55%	53.14%	55.62%	57.72%	56.38%	52.86%	59.23%	54.08%	57.35%	49.36%
Construct reliability	85.37%	84.37%	84.72%	82.46%	86.25%	91.46%	89.87%	85.85%	88.91%	86.24%	84.35%	87.65%	87.28%	86.72%	86.88%

Note: Model's AVE = 0.5842

After completing the analysis of the measurement model and the various validity and reliability tests, we then tested our hypothesised structural model to examine whether our hypotheses are supported. Prior to the estimation of SEM, we tested for common method bias.

2.5.6. Common method bias

One of the main sources of measurement error, and consequently result invalidity, is method variance (Podsakoff et al., 2003), which arises from having a common rater to provide the measure for both independent and dependent variables. As this study used one rater per company to answer the questionnaire, it was liable to common method variance (Podsakoff et al., 2003). To mitigate this risk, our study used both the 'procedural' remedies suggested by Podsakoff et al.[16], as well as the statistical approach of Hartman's single factor test, both of which control and mitigate common method bias (Podsakoff, 1986).

In this study, we protected the confidentiality of the firms and that of the respondents. Respondents were assured of the anonymity as well as the confidentiality of the study, based on the procedural remedy by Podsakoff et al. (2003). Furthermore, respondents were told that there were no right or wrong answers and that 'they should answer questions as honestly as possible' (Podsakoff et al., 2003). In addition, 96% of the questionnaire respondents were department managers / department directors or above, with more than 10 years of experience in the shipping industry and in managerial positions, which we believe made them best placed to answer the questionnaire.

Adopting another procedural remedy recommended by Podsakoff et al., (2003), we carried out an in-depth and extensive exploratory research of the GSCM literature. We also constructed the items carefully, providing examples, keeping questions simple and specific and avoiding complicated syntax in the selection and development of the scale items.

In line with prior environmental management studies (Lai et al., 2013; Leonidou et al., 2013), we performed Hartman's single factor test in order to detect if any single factor accounts for the majority of the covariance between the dependent and independent variables (Podsakoff, 1986). The results of the single factor test show that no factor explains more than 33% of the variance. In addition, we performed the common latent factor (CLF) test using the Amos software and the results showed that the common variance was 2%. Furthermore, the results show that with the addition of the marker variable, a variable not related to any other variable in the model, the common variance decreased to less than 0.1%. We also tested to see if there is a relationship between the marker variable and the variables in the model (Lai et al., 2013). We found no significant relationship with any of the variables in the model. Results of the common method bias tests and applied procedural remedies indicate that common method bias was unlikely to be a problem in this study.

[16] Podsakoff et al. (2003) introduced various ways to control the common method bias problem. The two primary ways are a) procedural remedies and b) statistical remedies.

2.5.7. Hypotheses testing

Following the assessment of the measurement model, we developed a structural model, using structural equation modelling (SEM), to test our hypotheses using the variables 'firm size' and 'stakeholder pressures', as control variables.

The overall fit of the final structural model is good, with $x^2/df = 1.167$, CFI = 0.980, IFI = 0.980, SRMR = 0.06, PRATIO = 0.920, PCFI = 0.901, RMSEA = 0.024.

Table 2.5
SEM results

Measures	Standardize path coefficients	P-value	Results
H1: Human resources → GSCM strategy	0.218	0.000	Supported
H2: Financial resources → GSCM strategy	0.139	0.000	Supported
H3: Experiential resources → GSCM strategy	0.152	0.000	Supported
H4: Shared vision → GSCM strategy	0.252	0.000	Supported
H5: Stakeholder management → GSCM strategy	0.180	0.000	Supported
H6: Strategic proactivity → GSCM strategy	0.173	0.000	Supported
H7: GSCM strategy → Environmental performance	0.649	0.000	Supported
H8: GSCM strategy → Economic performance	0.708	0.000	Supported
H9: Environmental performance → Competitive advantage	0.147	0.018	Supported
H10: Economic performance → Competitive advantage	0.318	0.000	Supported

The results of the various hypotheses are shown in Table 2.5. Figure 2.2 shows the causal relationships of the model and the standardised path coefficients, as well as the significance of the hypothesised relationships. Findings suggest that all ten hypotheses are supported.

The standardised path coefficients indicate that, out of ten hypotheses, nine (H_1, H_2, H_3, H_4, H_5, H_6, H_7, H_8, H_{10}) are statistically significant at 0.001 level, and one hypothesis (H_9), is significant at 0.05 level. More specifically, H_1-H_3 are supported due to positive associations revealed between human resources and GSCM strategy (H_1, $\hat{a}_1 = 0.218$, $P < 0.001$), financial resources and GSCM strategy (H_2, $\hat{a}_2 = 0.139$, $P < 0.001$), and experiential resources and GSCM strategy (H_3, $\hat{a}_3 = 0.152$, $P < 0.001$). Similarly, $H_4 – H_6$ can also be supported due to positive associations revealed between the capabilities of shared vision and GSCM strategy (H_4, $\hat{a}_4 = 0.252$, $P < 0.001$), stakeholder management and GSCM strategy (H_5, $\hat{a}_5 = 0.180$, $P < 0.001$), and strategic proactivity and GSCM strategy (H_6, $\hat{a}_6 = 0.175$, $P < 0.001$).

Similarly, H_7 and H_8 are also supported, due to the positive associations between GSCM strategy and environmental performance (H_7, $\hat{a}_7 = 0.649$, $P < 0.001$), and GSCM strategy and economic performance (H_8, $\hat{a}_8 = 0.708$, $P < 0.001$). In addition, H_9 and H_{10} are also supported due to positive associations between environmental performance and competitive advantage (H_9, $\hat{a}_9 = 0.147$, $P < 0.05$), and economic performance and competitive advantage (H_{10}, $\hat{a}_{10} = 0.318$, $P < 0.001$).

The results of the study support all our research hypotheses and confirm the validity of the hypothesised causal model. In effect, the results support that the resources and capabilities of shipping companies act as drivers of proactive GSCM strategy, and that with the implementation

of such a proactive environmental strategy, shipping firms can positively influence environmental and economic performance that can, in turn, lead to a competitive advantage.

Finally, as shown in Figure 2.2, we control for two variables, namely, firm size and stakeholder pressure. Findings revealed that stakeholder pressure has a significant positive association with GSCM strategy. This provides further support to the findings of prior studies in the literature (Zhu et al., 2013, 2005). However, firm size was not found to have any significant association with environmental and economic performance.

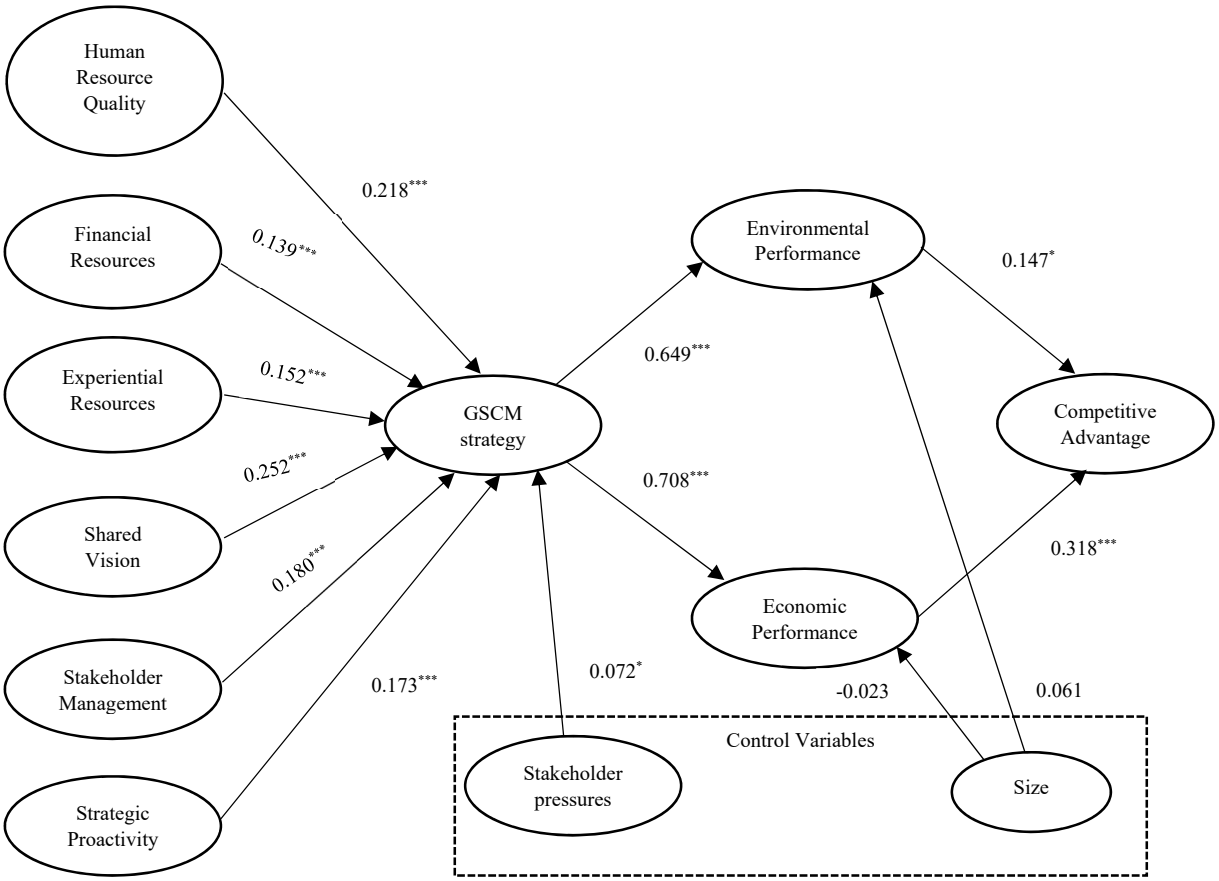

Fig. 2.2. Estimated SEM model with control variables.
Notes: *Correlation is significant at the 0.05 level, **correlation is significant at 0.01 level, ***correlation is significant at 0.001 level.

2.6. Discussion and Conclusion

Shipping firms are increasingly looking to enhance their environmental profile, having recognised that their partners and customers in the supply chain regard environmental issues to be of importance. In fact, environmental issues have reached a level of importance where they are being used as key criteria for business partnering, in addition to developing the regulatory framework. In this context, we must tackle the empirical question around the drivers of a proactive green supply chain management strategy as well as the environmental, economic and competitive implications that may arise from such strategy.

This study was the first to empirically examine ten research hypotheses, which were supported theoretically and developed as part of a causal model. The hypotheses examined the antecedents and consequences of shipping firm GSCM strategy; these were grounded in a natural resource-based view theory, which indicates that resources and capabilities can be drivers of a proactive green strategy that aims to improve performance and competitiveness. The findings underscore the critical role of organisational resources and capabilities in the pursuit of a green supply chain management strategy. Key resources found to have a positive influence on GSCM were human resource quality (supporting findings by Daily and Huang, 2001, Lee, 2008 and Teixeira et al., 2016), financial resources (in support of Leonidou et al. 2013[17]; Wu et al. 2012), and experiential resources[18]. The study also reveals the positive impact of capabilities on GSCM strategy, including shared vision (supporting findings from Aragón-Correa et al. 2008; Hart, 1995; Leonidou et al. 2013), stakeholder management (as in Aragón-Correa et al. 2008; Henriques and Sadorsky, 1999; Leonidou et al. 2013) and strategic proactivity (Aragón-Correa et al. 2008). The implementation of a proactive green supply chain management strategy was found to influence environmental as well as economic performance positively, which were consequently found to be conducive to heightened competitive advantage.

The study makes several contributions to the theory, as well as providing several practical implications. First, the study injects a theoretical perspective into a field characterised by scant contributions of this type, by underlining the key role of organisational resources and capabilities in the development of green supply chain management strategy. Our examination of the antecedents and consequences of GSCM strategy, which had hitherto been unexamined in a single causal model, represents a significant contribution to the field.

The study emphasises the role of green supply chain management strategy in the achievement of key business objectives, such as environmental performance, economic performance and ultimately competitive advantage, for shipping firms. Managers and maritime companies are therefore encouraged to adopt green strategies in their supply chain management practices. Such strategies need to go beyond the regulatory requirements and be proactive in nature. What is also very important, as evidenced by this study, is to go beyond organisational boundaries and set common environmental goals and objectives with customers, suppliers and partners in the supply chain.

The study has supported that organisational resources and capabilities are both vital for the development and implementation of an environmental supply chain management strategy. This suggests that managers must allocate resources, including experiential, financial, human and technical, to support green supply chain strategy initiatives. It is also important for managers to develop strategic capabilities such as shared vision, stakeholder management and strategic proactivity.

[17] The key distinction between our study and that of Leonidou et al. (2013), is the former examines financial resources as a driver of proactive GSCM strategy, whilst the latter examines financial resources as a driver of environmental marketing strategy.

[18] This is the first study that examines and proves the importance of experiential resources as drivers of GSCM strategy.

It should also be recognised that certain factors, such as increasing environmental protection regulations (e.g. regulations under MARPOL[19], Ballast Water Management, and the SOLAS [20] conventions), growing market and public pressure for better environmental protections, and intensifying competition, make the adoption of proactive green supply chain management strategies critical for shipping firms to differentiate their activities from their rivals, as well as to improve their performance and competitiveness. However, to successfully implement green supply chain strategies, it is essential for shipping firms to include proactive steps, such as implementing environmental training programmes, securing environmental certification, adopting green shipping practices, as well as external green collaborative practices, and establishing green marketing practices.

The results of this study do not imply that these are the sole valid models for the antecedents and consequences of a green supply chain strategy in shipping firms, although the model hypothesised in this study provides a good fit to the data.

From a methodological perspective, it would be helpful to consider alternative methodological approaches to test the relationships between the variables. A hierarchical regression analysis might also be a good method to identify the role of mediation on the relationship between independent and dependent variables. In line with the majority of past empirical studies, this study also examines a 'snapshot image' of the issues under scrutiny. Since some time has to elapse before resources/capabilities can be incorporated in green supply chain strategies and result in enhanced performance and competitive advantage, it is also important to embark on longitudinal studies. A more qualitative analysis in the form of case studies would also help more in-depth understanding on the interconnection of the constructs used in this study.
Future research using the longitudinal approach may also be conducted to investigate the short- and long-term effects of green supply chain management strategy and practices by shipping firms and the impact on their performance and on their competitiveness.

Moreover, the heterogeneous nature of shipping firms (e.g. dry bulk, wet bulk, container liner) makes it necessary to identify differences in the green supply chain strategies of these companies according to their sector.

The potential of other factors having a moderating role in the strategy-competitiveness link may also be examined. Such factors include the firm's proactive or reactive approach to environmental issues (Aragón-Correa et al. 2008).

The examination of other internal factors, such as managerial sensitivity to green issues, leadership style, and owner demographic characteristics, could also lead to a better understanding of the mechanism of linking organisational resources/capabilities to green supply chain strategy formulation.

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[19] The International Convention for the Prevention of Pollution from Ships. For more info please see: (http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx).

[20] The International Convention for the Safety of Life at Sea. For more info please see: (http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx).

CHAPTER 3: GREEN SUPPLY CHAIN MANAGEMENT STRATEGY AND FINANCIAL PERFORMANCE IN THE SHIPPING INDUSTRY

3.1.Introduction

Shipping is a dominant mode of transport, as well as one of the most important pillars of globalisation and global development facilitating international trading. Seaborne trade accounts for more than 80% of the global trade volume (UNCTAD, 2017), creating increasing demand for shipping services and the global fleet. The resulting expansion of the global fleet[21] has led to concerns about the impact of shipping operations (Gavronski et al., 2011), and has highlighted the need for environmental protection to be addressed by the shipping industry (Lun et al., 2014). Over the last few decades, shipping has left its indelible mark on the environment, with marine pollution contributing significantly to global warming. Due to increased trade volume, firms' desire to benefit from economies of scale and the development of technology, ships are getting bigger and the maritime sector continues to grow, which only intensifies concerns in relation to the harmful effects that come hand-in-hand with ship operations (Yang et al., 2013), such as GHG emissions[22], waste, noise pollution and toxic materials.

Shipping companies are faced with intensified competition as well as environmental regulation, forcing them to adopt practices to keep them competitive and performing well.
Stakeholders, such as clients, suppliers, NGOs and governments, exert pressure on shipping firms to be environmentally responsible. As a result, many firms have started to introduce environmental management practices in their sustainability strategies. Shipping companies are part of global supply chains and manage the interaction between their supply chains and the environment. The link between supply chains and environmental management, called green supply chain management (GSCM) [23], has therefore become increasingly important in shipping company strategies. This is a concept that is gaining in popularity (Yang et al., 2013), specifically, as a strategy that includes practices which are crucial for the mechanism between the environment and financial performance.
Given the significance of environmental management in the shipping industry, and due to the increasing concerns about the impact of shipping operations to the environment[24], there is a major need to further examine the topic of GSCM in the shipping sector. In an era of ongoing challenges in the global economy, shipping firms are increasingly looking towards new strategic options that would provide them with advantages in the market place. Proactive GSCM strategy provides the opportunity for shipping firms to differentiate their activities from those of their competitors, by

[21] The global fleet has been growing rapidly since the 1980s: from 26,772 vessels in the late 1980s, to 94,543 vessels in September 2017 (for more information, see World Fleet Monitor, Volume 8, and No 9. September 2017, Clarksons).
[22] GHG stands for greenhouse gases. IMO's Marine Environment Protection Committee (MPEC) has been energetically pursuing a reduction of GHG emissions in the shipping industry. (For more info see: http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/GHG-Emissions.aspx).
[23] GSCM is defined, as the way that companies add the environmental thinking into supply chain management.
[24] 'Maritime transport emits around 1,000 million tons of CO_2 annually and is responsible for about 2.5% of global greenhouse gas emissions (3rd IMO GHG study)', (see also https://ec.europa.eu/clima/policies/transport/shipping_en) contributing in this way to the dramatic increase in global warming. Stricter regulations have thus been put in place, for example the IMO's recent implementation of a global limit of 0.5% of sulphur in ship fuel oil (Review of Maritime Transport, 2017). GSCM strategies also include practices such as the development and implementation of energy efficient systems, e.g. waste heat recovery systems, energy-efficient engines and scrubbers.

offering high-quality environmental maritime services that respect and safeguard the environment, and that also have the potential to improve performance and competitiveness (Yang et al., 2013).

GSCM is now regarded as a core management concept when developing an organisation's environmental responsibility. While a number of GSCM studies have been carried out over the years, especially in the manufacturing sector in Asia, there is a dearth of studies that relate to GSCM practices and financial performance in specialised sectors, such as the shipping industry. This gap in the literature will be addressed here through an empirical investigation. While shipping is the safest, most efficient and economic mode of transport, it is mired by increasing concerns about its impact on the environment (e.g. emissions and sea waste), therefore it is important for companies to become more environmentally friendly. This study extends this rationale further by focussing on the interrelation between GSCM practices and financial performance. It argues that companies that adopt proactive GSCM practices perform better financially, which in turn enhances their environmental conservation efforts.

The main motivation behind this study is today's great attention towards environmental awareness by organizations, especially for shipping operations, and the long-debated question whether the adoption of environmental practices by firms results in a positive performance output.

The study focuses on the shipping industry due to the latter's importance in the global supply chain, and to the environment as well. While ships are a relatively environmentally-friendly mode of transport, in relation to the tons carried, when an accident occurs, the damage to the environment tends to be direct, observable, and significant. This makes it vital to study the topic of GSCM in the context of the shipping industry.

Because of the necessity of environmentally friendly shipping and the increasing concerns about the environmental impacts of ship-related activities (Gavronski et al., 2011), and with the scanty research on GSCM adoption (Lai et al., 2011), this study aims to contribute to the green supply chain management literature by examining the GSCM strategic choice and the effects of that choice on the shipping firms' financial performance.

This study is driven by the unique characteristics of the shipping industry, such as capital intensity—billions are invested in high value assets like new buildings and second-hand ships (Andreou et al., 2014)—highly leveraged assets, freight volatility and a risky, uncertain, and competitive environment. In such an uncertain and risky environment, it is crucial for shipping firms to have a good understanding of the real effects of a proactive green management strategy on their financial performance since the effects of such relationship remains an open question in the literature. This study has therefore chosen to focus on the shipping industry and will provide an empirical investigation of (i) the extent to which GSCM strategy has been adopted by shipping firms, and (ii) the effects of such adoption on their financial performance.

The growing attention paid to GSCM and its importance is evidenced by the increasing number of publications in relation to this concept in leading management journals (see, among others, Rao and Holt, 2005; Rao, 2002; Zhu and Sarkis, 2004; Zhu et al., 2007, 2008). These studies have nevertheless left many empirical questions unanswered, especially when it comes to the relationship between green strategy and financial performance. Further research on the topic of

GSCM and its potential effects on business performance is needed, a fact also recognised in the literature (e.g. Sarkis et al., 2011). While most environmental management studies agree that firms with robust environmental strategies experience improved performance (Aragón-Correa et al., 2008; Menguc et al., 2010; Russo and Fouts, 1997), others report mixed evidence (Christmann, 2000; Salzmann et al., 2005; Walker and Wan, 2012). As a result, there is no consensus in the literature as to the relationship between proactive environmental strategy, such as GSCM, and financial performance. The results of prior studies may have varied due to the omission of important elements, for example due to the data chosen to be analysed (Schaltegger and Synnestvedt, 2002), which may have been collected from too small a sample (Zhu and Sarkis, 2004).

Green marketing tends to also be widely overlooked in studies that examine the relationship between proactive environmental strategy and financial performance. Green marketing is the promotion of products or services using environmental claims either about their attributes or about the practices, systems, policies and processes of the firms that produce or sell the former (Prakash, 2002). Green marketing is also a key GSCM variable promoting a firm's image and success. For example, firms can inform their stakeholders about environmental strategies and practices, thus reducing the information asymmetry[25] with their stakeholders. In an intensely competitive industry such as shipping, reputation is an important issue. With the adoption of green marketing practices, shipping firms can bolster their reputation, which may in turn enhance future profits (Roberts and Dowling, 2002).

As stakeholders increase pressure on shipping firms to enhance their environmental performance, the latter must signal[26] their engagement in environmental actions. These signals are made possible via green marketing strategy; green marketing practices are implemented by companies to show stakeholders that they hold an environmentally oriented philosophy and are good corporate citizens.

Further, proactive GSCM practices may help reduce agency costs[27]. A transparent environmental footprint, which signals environmentally conscious practices, policies and principles, may reduce monitoring costs, which in turn may boost sales and reduce agency costs, resulting in better financial performance. Hence, it is important to take into account the crucial parameter of green marketing when providing a clear picture of the relationship between proactive GSCM strategy and financial performance. Proactive green practices can also lead to first-mover advantages (Hart, 1995). A good example is BMW's 'design-for-disassembly' process, in which BMW gained cost advantages over competitors by being a first mover. Similarly, innovative GSCM practices can

[25] Information asymmetry occurs when there is a variance in the knowledge held by different parties. Due to information being at times private, one party may have more or better information than the other. In short, 'information asymmetries arise between those who hold that information and those who could potentially make better decisions if they had it' (Connelly et al., 2011).

[26] Signalling theory deals with information asymmetry between two parties: 'Typically, one party, the sender, must choose whether and how to communicate (or signal) that information, and the other party, the receiver, must choose how to interpret the signal' (Connelly et al., 2011).

[27] Agency costs are those arising from the difference in priorities between shareholders and their firms' management. Shareholders' priority is to maximise share values in the long-run, whereas management's priority is the short-run profits that maximise personal compensation.

differentiate proactive shipping firms from their competitors, showing that the former is providing high quality environmental services at a lower cost.

After carefully reviewing the relevant literature, it emerged that most key GSCM research has been conducted in the context of the manufacturing industry in Asia (Rao and Holt, 2005; Rao, 2002; Zhu and Sarkis, 2006, 2004; Zhu et al., 2011). This was possibly due to the environmental harms caused by manufacturing industry in Asia and the stricter regulations put in place by governments in order to motivate the implementation of environmental practices in the region (Zhu et al., 2011). We feel that comprehensive research on GSCM must be carried out, which takes into consideration the concept's key mechanisms. This would in turn satisfy our aim to fill the gap in the literature regarding GSCM; namely, how the concept functions within the global shipping industry.

As suggested above, a substantial number of studies provide evidence of the importance of GSCM to firms, especially around environmental and economic performance (Shang et al., 2010; Yang et al., 2013; Zhu and Sarkis, 2004; Zhu et al., 2012). However, there is no strong evidence regarding the influence of proactive GSCM strategy on financial performance, especially in the global shipping industry there is no such research. A few studies have considered the relationship between GSCM and financial performance in the manufacturing industry, with several studies finding a positive relation (Rao and Holt, 2005), while others, none at all (Testa and Iraldo, 2010), thus failing to provide overall strong evidence in relation to the positive financial outcomes of GSCM implementation. Given that improved financial performance constitutes an important motivation for shipping firms to implement environmental management practices (Bowen et al., 2001; Zhu and Sarkis, 2004) the results of this study allows for a better understanding of the mechanisms that are crucial for a successful green strategy, so they can improve their environmental supply chain management practices.

Most GSCM management literature focuses on studies that have used mixed samples from the manufacturing industry, including chemicals, electronics and automotive vehicles. Few studies deal with a single type of industry, such as the study of Yang et al. (2013) which focuses on the examination of the topic of GSCM in container shipping. According to Andreou et al. (2012), "one benefit of focusing on a single industry is the mitigation of possible inter-industry variations that usually tarnish inferences of studies that span several industries". This is the first study that examines the relationship between GSCM and financial performance focusing solely on the shipping industry, which is characterised by uncertainty, volatility, risk, and capital intensity, all of which play an important role in the firms' financial management and performance (Andreou et al., 2014).

The present study contributes to the GSCM literature in several ways. First, to the best of our knowledge, this is the first study which upholds GSCM as a proactive environmental strategy integrating innovative green practices into the supply chain, investigates the level to which shipping firms engage with GSCM practices, ranging from reactive to proactive, and examines the effects of such strategy on the financial performance of shipping firms on a global level.

Second, we introduce a new variable of proactive GSCM strategy, namely internal environmental proactivity (IEP), which can be seen as a part of internal green practices and integration. Further, setting aside the particularly innovative nature of GSCM mentioned above (namely, as a proactive

strategy), there is no consensus in the general environmental management literature on the relationship between proactive environmental strategy and financial performance, a gap we wish to address.

Third, there is no consensus about the positive effects of green supply chain collaboration and firm performance. Some studies assert that firms must focus on supplier collaboration, over customer collaboration, in order to achieve better performance (Huber, 2008; Sarkis et al., 2011); others find that collaboration across the supply chain is a requisite for performance improvements and competitiveness, as was the case for container shipping firms in Taiwan (Yang et al., 2013). Therefore, one of the goals of this study is to provide strong evidence about the impact of green collaboration across the supply chain on the performance of shipping firms.

Fourth, our study contributes to the GSCM literature by focusing on a global sample of shipping firms, which is a larger sample than those of prior studies. Additionally, this study considers a larger number of green practices, which are key to the mechanism between environmental management strategy and financial performance. Overall, this study takes into account significantly different variables than those of prior studies [28].

The study comprises the following sections: The introductory section is followed by section two, which provides a detailed review of prior studies on proactive environmental and green supply chain management strategy. Sections three, four, and five provides the development of the research hypotheses. Section six discusses the methodology, including the survey development, sample characteristics, and the data analysis methods. Sections seven, and eight discusses the results of the empirical analysis. Section nine concludes by discussing the implications drawn from the empirical findings and also provides suggestions for future research.

3.2. Literature review

This research examines two important questions which emerged following a review of the GSCM literature. The first question relates to the differing extents to which shipping firms have adopted GSCM strategies, and the second question concerns the effects of such adoption on their financial performance.

As already mentioned, studies in relation to the effects of a proactive strategies, such as GSCM, on performance in specialised sectors, such as shipping, are extremely limited, both in number, as well as magnitude and depth of investigation. In this section, we review the literature on GSCM and performance in order to provide a clear image and address the main gaps.

Prior to the present study, the majority of previous studies examined GSCM's effect on environmental and economic performance; these studies focused on the Chinese manufacturing industry (Zhu and Sarkis, 2004; Zhu et al., 2012). In contrast, this paper examines the effects of

[28] For example, this study considers ISO 50001, which is the energy management systems standard. This research also develops a new variable, namely internal environmental proactivity (IEP), and incorporates already existing variables, i.e. green marketing, which are necessary to explain the mechanism of proactive GSCM strategy and financial performance.

GSCM strategy to the financial performance of shipping firms globally, thus providing an original contribution to the literature.

Looking at the aforementioned two studies in more detail, Zhu and Sarkis (2004) examined the extent to which 186 Chinese manufacturing enterprises adopted GSCM, and the resulting effect of this adoption on their environmental and economic performance. Those that had adopted GSCM practices extensively were shown to perform better environmentally. When it came to economic performance, on the other hand, the study found mixed results.

In a related study, Zhu et al. (2012) investigated GSCM adoption by 245 Chinese manufacturers, examining their environmental, economic and operational performance. They found three types of adopters: early, followers, and laggards. Chinese manufacturers with extensive GSCM practices had better environmental, economic and operational performance. However, the results showed that the differences in performance between the three diffusion clusters (early, followers, and laggards) are not as large as the differences in the levels of adoption of GSCM practices.

In another study, Azevedo et al. (2011) investigated the influence of GSCM practices on supply chain performance (environmental, economic, and operational) in the context of the automotive industry. Using a case study approach, they showed that green practices have a positive effect on certain supply chain performance indices (quality, customer satisfaction, and efficiency).

As mentioned, there seems to be no consensus with regards to the effects of GSCM practices on financial performance in the manufacturing industry, perhaps due to the diversity of samples examined, or the omission of variables important for the mechanism between GSCM and financial performance, such as green marketing. Testa and Iraldo (2010) were unable to provide strong support regarding the relationship between GSCM practices and profitability in countries belonging to the Organisation for Economic Co-operation and Development (OECD). Conversely, Rao and Holt (2005) found that GSCM practices have a positive influence on the sales and profitability of manufacturing firms in Asia. These conflicting findings highlight the need to further examine the impact of GSCM practices on firm performance.

Bowen et al. (2001) assert that organisations tend to implement environmental practices driven by the promise of enhanced profits. So, the question of whether the implementation of proactive green strategy sustains or even accelerates profitability is of great interest to shipping firms. This study aims to address this question by examining the strategic environmental choices made by shipping firms and the effects of those choices on their financial performance. The research clusters shipping firms according to their commitment to green supply chain management strategies and examines the resulting effects on financial performance. Aragón-Correa et al. (2008), already examined three clusters of automotive SMEs in Spain, namely leaders, proactive, and reactive, with the first two groups achieving improved financial performance. In addition, Zhu et al. (2004) support that, among Chinese manufacturing firms, early adopters of GSCM practices perform better than late adopters. On this basis, we can surmise that leading and proactive shipping firms will achieve better financial performance outcomes.

Studies in relation to GSCM in the shipping industry are, as mentioned, scant. A very limited number of studies on GSCM in shipping exist, but they have chosen very narrow samples of firms,

primarily from Asia. Lai et al. (2013), for example, looked at 107 Hong Kong shipping firms to examine the effect of a single green shipping practice—shipping design for compliance (SDC)—on financial and service performance. They also examined the role of company policy and procedures (CPP) and shipper cooperation (SC) on that relationship. They found that i) SDC is beneficial to the financial and service performance of shipping firms, ii) CPP and SC have positive moderating effects on the relationship between SDC and service performance, but iii) there are no positive moderating effects observed in the relationship between SDC and financial performance.

Yang et al. (2013), investigated the effects of internal and external GSCM practices and integration on environmental and economic performance and competitiveness in the context of container shipping in Taiwan. With a sample of 167 firms, they found that internal green practices and integration, and external green collaboration have a positive impact on the firms' performance and competitiveness. An important contribution emanating from this study is that it takes into consideration internal as well as external green integration, establishing both as important factors in the implementation of green practices and green supply chain integration. This is proved by Rao and Holt (2005), who found that 'greening' different phases of the supply chain leads to an integrated green supply chain, which ultimately leads to competitiveness and economic performance improvements.

The study by Yang et al. (2013) nevertheless has a key limitation, in that it focuses only on container shipping. Had they investigated GSCM across shipping industry sectors, it would have enabled us to generalise the results, and map the differences in terms of green strategic choices over the entire shipping industry.

GSCM strategy in this study includes two main categories extracted from the literature (Bowen et al., 2001; Lai et al., 2011; Shang et al., 2010; Vachon and Klassen, 2008; Yang et al., 2013; Zhu et al., 2007), i) internal GSCM practices, constituted by the following variables: internal environmental proactivity (IEP), green shipping practices (GSPs), and green marketing (GM), and ii) external GSCM practices, constituted by the following variables: green collaboration with suppliers (CS), green collaboration with partners (CP), and green collaboration with customers (CC).

3.3. Proactive green supply chain management practices

It is important at this point to describe each proactive GSCM practice used in this research.

3.3.1. Internal green supply chain management practices

Internal integration of green practices requires the willingness and participation of every individual in the company. The importance of each internal proactive GSCM practice is discussed in the following paragraphs.

3.3.1.1. Internal environmental proactivity

Internal environmental proactivity includes several internal pollution preventing items that has been widely recognized in the literature. The items are key factors for firms to be able to implement proactive GSCM practices (Zhu et al., 2008). Through these, managers contribute to the promotion of innovative ideas within the company, boosting the development and adoption of innovative practices.

According to Sarkis et al. (2010), "for employee commitments to advance, they must have support from management". With commitment and guidance from managers, employees can better understand and address their firm's environmental issues, thus leading to the successful development of proactive environmental strategies (Zhu et al., 2008).

Furthermore, managers committed to green practices provide a good example and an extra motivation for firm employees to get involved in creating more innovative practices. As noted, proactive environmental management in any case requires the involvement and cooperation of everyone within an organisation.

Cooperation in particular, where participants within an organisation work together in the same direction, orientation and cooperative philosophy, is a must for the successful implementation of internal integration. Zhu and Sarkis (2004) found that cross-functional cooperation is significant for the implementation of GSCM practices in the Chinese manufacturing firms. Two other substantial components for the successful implementation of internal integration, namely, coordination and organisation, are achieved through cross-functional cooperation. According to Yang et al. (2013), "internal integration recognizes that different functions within a firm should not act as functional silos, but instead as part of an integrated process". An important ingredient to ensure employee commitment and cross-functional cooperation is knowledge of proactive environmental management philosophy. This knowledge can be boosted with green education and training programmes. Sarkis et al. (2010), stated that companies that implement green training programmes can select the right employees with proactive green management philosophies. Such employees can help the company to effectively manage potential risks, i.e. pollution, collisions, penalties, bad reputation and image and more. Reducing risk by adopting proactive GSCM practices can also result in a better reputation and image for the company.
This leads us to the second important factor of internal green management practices and integration, green marketing.

3.3.1.2. Green marketing

Green marketing is probably one of the most important factors of proactive environmental strategy. According to Baker and Sinkula (2005), the design and implementation of environmental marketing strategies can lead to a competitive advantage, as well as financial performance improvements (Leonidou et al., 2013). The importance of green marketing in proactive environmental management strategies is stressed in the literature.

Banerjee, in particular, introduced the concept of corporate environmentalism, which is defined as "the organization-wide recognition of the legitimacy and importance of the biophysical

environment in the formulation of organization strategy, and the integration of environmental issues into the strategic planning process" (Banerjee, 2002). A core component of this concept is environmental strategy, which includes green marketing strategy (Baker and Sinkula, 2005), by which we mean the environmentally friendly marketing practices that enhance firms' social legitimacy.

Social legitimacy is very important for firms, because it has the ability to lead to greater access to different resources (Walker and Wan, 2012), such as the financial. Firms relay their proactive green actions to stakeholders, leading to reduced information asymmetry and increased social legitimacy, both of which can lead to improved competitiveness and financial performance (Yang et al., 2013).

This research examines the importance of green marketing on GSCM implementation, by taking into account the key factors in the interplay between proactive green strategies and performance. The study supports that green marketing is one of the main practices of a proactive green supply chain management strategy, as it provides the necessary information to stakeholders regarding the shipping firm's environmentally friendly practices, thus reducing information asymmetry and gaining social legitimacy among stakeholders.

3.3.1.3. *Green shipping practices* [29]

Green shipping practices constitute the third and final internal green practice of proactive GSCM strategy. These practices aim to make shipping systems and processes more environmentally friendly, for example, using environmentally friendly equipment, materials (i.e. non-toxic paints) and types of fuel (i.e. low sulphur fuels).

Green shipping practices are a necessary pillar to the environmental strategies of shipping firms. Shipping firms have moved to adopt green practices in response to stakeholder pressure and also to meet their objectives: delivering high-quality services that respect and safeguard the environment, and serving people and markets across the globe with the lowest possible environmental footprint.
Maersk Line is one success story in this regard, who have implemented energy efficiency programmes in an effort to protect the environment. They have reduced the CO_2 emissions from their vessels by 40%, while expecting to grow approximately 80% in volume. At the same time, they have set an objective to reduce CO_2 emissions by 60% (Maersk, 2017). This constitutes an example of a company with proactive environmental strategy, which seeks innovative ways to reduce the environmental impact from its operations, while remaining profitable and competitive.

Such proactive green shipping practices are highly important for operation efficiency and for environmental conservation (Lai et al., 2013), and at the same time those practices favour positive outcomes as well as increased competitiveness for shipping firms (Yang et al., 2013).

[29] Green shipping practices concerns the proactive actions, such as the adoption of environmental technologies and shipping design, in order to reduce the negative impact from ships operations (Lai et al., 2011). Is the ecological modernization concept, which is concerned with implementing innovative green management practices to reduce ecological impacts while reaping operational gains (Lai et al., 2013).

3.3.2. External green supply chain management practices

Due to the important role of supply chain integration in remaining competitive and profitable, companies need to not only manage the internal processes and practices mentioned above, they also need to collaborate with external parties to ensure the ideal outcome from their green supply chain management strategy. Supply chain collaboration is that which takes place between supply chain members so as to achieve common goals (Mentzer et al., 2001). In this research, external proactive green practices mean a firm's collaboration with its supply chain members, namely suppliers [30], customers [31], and partners [32] (Yang et al., 2013).

External green collaboration helps the integration process between internal proactive green management practices and external proactive environmental management practices. The main focus of green collaboration among supply chain members is to achieve more proactive and environmentally sound operations that prevent or limit pollution (Vachon and Klassen, 2008) and improve the overall environmental performance of the supply chain.

It has become increasingly important for shipping firms to collaborate and work together toward common environmental goals with their chain members in order to achieve green supply chain integration (Stank et al., 2001).

For a supply chain to be successful, integrated, and environmentally responsible, every pillar must coordinate and collaborate with the other. According to Cao and Zhang (2011), "supply chain partners work together toward common goals and achieve more mutual benefits than can be achieved by acting alone".
External green collaboration includes, for example, strategic alliances with supply chain members to develop environmentally oriented strategies. Alliances are important for the supply chain integration process, so we are seeing organisations increasingly collaborate through them (Waters, 2003). In the shipping industry, one example of an alliance is the Sustainable Shipping Initiative (SSI) [33], whose objective is to encourage supply chain collaboration towards a sustainable future. Supply chain members work together to implement commercially successful practices that have a positive social and environmental impact. SSI's proactive philosophy goes beyond regulations and established practices, to "tackle some of the shipping sector's greatest opportunities and challenges, a vision of an industry in which sustainability equals success". An important benefit to green supply chain collaboration is the opportunity for firms to exchange information, ideas, knowledge, experience, and skills which favour the development of common environmental goals. Such collaboration increases the potential to reduce environmental risks, cut costs, and prevent pollution, all of which can lead to better performance. The importance of supply chain collaboration (Cao and Zhang, 2011; Stank et al., 2001), and green supply chain collaboration in particular, is evidenced in the literature, where key studies found that the latter constitutes an

[30] For example, fuel and ship-building companies.
[31] For example, oil companies, shippers and forwarders.
[32] For example, stevedoring companies, terminal operators, trucking companies, marine insurance companies and banks.
[33] For an overview of the SSI alliance see (http://www.ssi2040.org/about-the-ssi/#).

extremely important external factor in green supply chain management strategy (Vachon and Klassen, 2008; Yang et al., 2013).

3.4. Financial performance

Financial performance is the profit made through the adoption of proactive environmental strategies, such as the GSCM strategy we focus on in this study.

The literature is at times ambiguous as to the definition of economic performance and financial performance. Seuring and Muller (2008) support that economic and financial performance are one and the same.

In this research, financial performance is not the same as economic performance. We consider financial performance to be the financial gains of a firm resulting from the implementation of proactive GSCM strategy, and not the reduction in costs.

Financial performance measures in this research include the following items: profitability, return on investment (ROI) and sales growth, all of which have been extracted from prior research (Judge and Douglas, 1998; Panayides, 2003).

3.5. Development of hypotheses

3.5.1. GSCM strategies in the shipping industry

Environmental management practices are now as crucial as they are popular. The extent of the adoption of such practices depends on each company's strategic planning. Green management strategies can range from reactive to proactive (Aragón-Correa and Sharma, 2003).

Firms that choose to be proactive in their environmental management, tend to implement green practices, such as innovations aimed at preventing pollution. In contrast, reactive firms tend to comply with existing regulations, such as standard pollution control measures (Sharma and Vredenburg, 1998; Sharma, 2000).

GSCM can be seen as a proactive environmental strategy, as it focuses on innovative green management practices aimed at preventing pollution. However, shipping company policies may differ in their level of adoption of GSCM practices. Some may be more environmentally sensitive, especially with regards to the overall sustainability strategy, as a result such firms will be more proactive rather than reactive in their environmental practices. Some good examples are Maersk and CMA CGM. Over the last decade, Maersk have invested in energy efficiency and worked towards CO_2 reduction[34]. Maersk's 'low impact shipping' strategy has reduced CO_2 emissions by more than 25% per container-kilometre since 2007. Maersk's company policy on vessel recycling is also in place to minimise the company's environmental impact. CMA CGM, on the other hand, has implemented an eco-speed programme that aims for the optimal trade-off between vessel speed and CO_2 emissions (Lai et al., 2011).

[34] A good example is the development of triple E vessels by Maersk. Triple E vessels are designed to improve energy efficiency, economies of scale, and environmental performance. For more information see: https://www.maersk.com/explore/fleet/triple-e

Stakeholder pressure constitutes another important factor for the varying levels of adoption of GSCM strategy. For instance, the ecological regulations and policies enforced differently, according to the ship flags: national registries require stricter regulations in relation to open registers.

Size also represents an important factor in strategic choices. Larger firms experience more pressure to protect the environment, especially listed companies and shipping firms with a major fleet of different types of vessels travelling across the globe. As a result, larger shipping companies seem to have higher levels of adoption of proactive green practices. Zhu and Sarkis (2007) confirm that manufacturers facing higher regulatory pressure tend to implement more GSCM practices.

In examining why leading companies tend to be better at implementing proactive environmental practices (Zhu and Sarkis, 2006), a key factor emerges in that these larger companies have greater access to quality resources compared to the smaller firms (Russo and Fouts, 1997), both financial and in terms of personnel. When certain firms fail to implement the same strategies, one reason could be that they do not have the same strategic resources as larger firms (Barney, 1991).

However, while larger firms are more likely to adopt proactive environmental practices (Aragón-Correa, 1998; Russo and Fouts, 1997; Sharma, 2000), this does not preclude SMEs from doing so as well. According to Aragón-Correa et al. (2008), SMEs with specific characteristics can create organisational capabilities which may favour the adoption of proactive environmental strategy.

Nevertheless, it is predominantly the larger firms, those at a greater risk of seeing their image and reputation tarnished, who make the effort to invest in proactive environmental strategies, implementing innovative green practices in order to prevent, rather than control, events. Investing in a proactive green strategy also helps sustain their competitiveness.

Firms, even when they operate within the same industry and business environment, may follow different strategies (Caves, 1980), based on the strategic environmental philosophy and orientation of their management (Dess and Davis, 1984). According to Porter (1980), firms within the same industry can thus be clustered into different strategic categories, ‘thus the choice of strategy can be viewed as the choice of which strategic group to compete in’.

Whether a firm’s environmental strategy can be categorised as reactive or proactive (Aragón-Correa, 1998; Aragón-Correa et al., 2008; Russo and Fouts, 1997), managers play the most important role, as it is they who set the objectives and strategies for the company to follow. Managerial interpretation of environmental issues as threats or as opportunities (Sharma, 2000), will affect how the firm’s strategy is developed. If a manager interprets GSCM as an opportunity, then they will be supportive and committed to its adoption and vice versa.

Based on the arguments presented above we propose that:

H1: Shipping firms can be clustered according to their strategic GSCM choices.

3.5.2. Proactive GSCM strategy and financial performance

Although GSCM is a relatively new concept in environmental management, a considerable body of literature on the topic of GSCM has been produced examining the relationship between the adoption of GSCM practices and the resulting effect on environmental, operational, and economic performance. Most studies showed a positive link between green practices and environmental and operational performance (Zhu et al., 2007, 2005), while some show mixed results between GSCM and economic performance. Certain authors suggest that GSCM practices are positively related to economic performance (Rao and Holt, 2005; Zhu et al., 2012b), while others find no such relationship (Zhu et al., 2005).

In the shipping context, few studies have looked at GSCM and its relationship to performance (Lai et al., 2013; Lun et al., 2014; Yang et al., 2013).

One of the most important challenges that shipping firms face, is how to make their operations environmentally friendly and at the same time sustain their profitability. Financial performance can therefore be one of the most important factors motivating firms to implement GSCM strategies (Zhu and Sarkis, 2004). The inclusion of environmental issues in a firm's strategic planning may add value to its business programme.

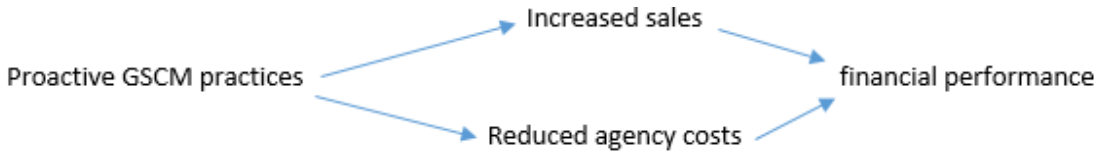
The absence of an empirical investigation of the relationship between a proactive environmental strategy, such as the GSCM, and its effects on shipping firms' financial performance means that the present study is of importance and interest to the shipping industry, as well as GSCM literature in general.

As stated, evidence is mixed as to the effect of a proactive environmental strategy on financial performance (Menguc et al., 2010). While some studies showed a positive relationship (Aragón-Correa et al., 2008; Menguc et al., 2010; Russo and Fouts, 1997), others provide contrary empirical evidence (Christmann, 2000).

Proactive GSCM strategies require the adoption of innovative technologies, aimed at energy efficiency, pollution prevention, waste recycling and green design (Chen, 2008). Key innovative practices, such as green shipping help to control and prevent emissions and effluent; they can include energy savings, shipping equipment reuse, recycling, and recovery in order to reduce the environmental impact of shipping operations (Lai et al., 2013), while also improving environmental and financial performance. Firms which are willing to implement proactive green strategies have been shown to enjoy lower costs and a better reputation (Aragón-Correa et al., 2008; Sharma, 2000), which can also lead to better financial performance.

GSCM includes all the environmental supply chain practices, internal and external, that a company can implement in order to be environmentally conscious and respond to stakeholder concerns. Environmentally proactive firms adopt the strategies needed to reduce the impact of their operations, bolstering their image and reputation as good corporate citizens (Menguc et al.,2010), which can also lead to improved sales and profits. Studies have shown that proactive green management practices, such as green marketing, create a reputational advantage that can lead to financial performance improvements (Miles and Covin, 2000).

The mechanism leading to financial performance improvements is as follows:



Signalling[35] refers to the way in which one party delivers information concerning itself, to the other party (Connelly et al., 2011), for example, when a company presents information related to its environmental activities to a range of stakeholders via its website.

According to Walker and Wan (2012), a company can adopt a range of strategies: from symbolic to substantive actions, from green washing[36] to green highlighting[37] of environmental issues, and through these strategies, signal that it is in line with environmental norms. Shipping is a sector facing a great deal of pressure and scrutiny from stakeholders, so it is difficult for managers to merely greenwash – stakeholders tend to look for substantive actions and public firms are closely monitored for environmental performance.

Another aim that shipping firms have in adopting proactive green practices is to gain legitimacy among stakeholders, which is very important because legitimacy leads to a better reputation and image, leading to increased sales and profits. Walker and Wan (2012), found that green-washing has a negative effect on financial performance, so it is crucial for green actions to be substantive, especially when it comes to the highly competitive environment in which shipping companies operate.

GSCM practices, such as green marketing, and green collaboration with supply chain members, provide the opportunity to shipping firms to send signals to their stakeholders about their proactive environmental programmes and actions, highlighting their commitment to the environment. Thus, green marketing practices can lead to financial performance improvements. This is supported by Shang et al. (2010), who found that green marketing-oriented manufacturing firms in China excelled in performance, with increased sales and market share. In another study, Leonidou et al. (2013) found that environmental marketing strategy leads to a competitive advantage and eventually to financial performance improvements for Greek hotels. Menguc et al. (2010) also

[35] Signalling "is the idea that one party credibly conveys some information about itself to another party" (Connelly et al., 2011). Signalling theory deals with information asymmetry between two parties. *"Typically, one party, the sender, must choose whether and how to communicate (or signal) information, and the other party, the receiver, must choose how to interpret the signal" (Connelly et al., 2011).*

[36] 'Green-washing' is defined by Walker and Wan (2012), 'as symbolic information emanating from within an organization without substantive actions. Or, in other words, discrepancy between the symbolic actions and substantive actions'.

[37] 'Green-highlighting' represents information 'disseminated by an organization so as to present an environmentally responsible public image. Green-highlighting can contain both symbolic and substantive action', (Walker and Wan, 2012).

found that a proactive environmental strategy is positively and significantly related to sales and profit growth.

Furthermore, due to pressure and scrutiny from stakeholders, managers tend to place an emphasis on the company's values and strategies (management support and commitment to green strategies), which helps to reduce agency costs (Berrone and Gomez-Mejia, 2009), and can lead to improved financial performance (Aragón-Correa et al., 2008).

Several studies have found a positive relationship between proactive green practices and performance. Chen (2008), argues that companies should be rated on green innovation performance, specifically, their proactive initiatives that aim to improve the quality of the company's environmental management. In the same study, the author also states that companies with significant investment in their green core competences were likely to see improvement in their green process, their product innovation performance, as well as their image among external stakeholders.
According to Zhu et al. (2012), firms with higher levels of GSCM adoption, more proactive firms, attain better performance. Because of the highly competitive environment in the shipping industry, shipping firms are more sensitive to their image and their social legitimacy. By implementing proactive green management strategies, shipping firms will be more innovative and socially conscious, which make such firms special in the eyes of their customers (Porter and van der Linde, 1995), leading to financial performance improvements (Menguc et al., 2010).

In another study, Aragón-Correa et al. (2008) show that automotive SMEs in Spain with a proactive environmental strategy improved their financial performance. In a related study, Molina-Azorín et al. (2009), empirically examined the relationship between environmental proactivity and firm performance in the context of the Spanish hotel industry and found the same results. A recent study by Sen et al. (2015) also confirmed the same link, in the context of manufacturing firms in India and the UK.

On this basis, in this study we take similar shipping firms that follow different environmental management strategies, ranging from reactive to proactive, and we show the difference in impact on their respective financial performance. Firms with a strong environmental leadership philosophy, i.e. the more environmentally proactive firms, will make more of an effort to respect and safeguard the environment. Commitment to a strategy such as GSCM will lead to improvements in financial performance for 'leaders' and 'proactive' shipping firms, (Dess and Davis, 1984).

Thus, the second proposition in this study is that:

H2: Shipping firms that implement more proactive GSCM strategies perform better financially.

3.6. Methodology

3.6.1. *Survey development*

This study adopted the survey method to collect primary data in order to examine the various hypotheses, since the data needed is not available in any database. In developing the questionnaire,

experts from academia, governmental agencies, and the shipping industry were asked to provide their feedback. This process ensured the comprehensiveness of the items and thus contributed to the quality of the questionnaire's design and content. The items covered the core aspects of GSCM strategy. The questions were also made as clear as possible to the respondents.

The survey made extensive use of a five-point Likert scale (1= strongly disagree to 5= strongly agree) to attain detailed and quantifiable primary data. Once finalised, the survey was sent to the sampled shipping companies.

3.6.2. *Data and sample characteristics*

As the study aims to examine shipping firms' strategic GSCM choices and their resulting financial performance, we used a global sample of shipping firms, including ship-owning and ship management companies.

Quantitatively, this study identified key respondents, including presidents/vice presidents, managers/assistant managers, directors/vice directors who were deemed the most knowledgeable to answer the questionnaire and to provide valid and reliable data.

The questionnaire was delivered in one of two ways: it was emailed or dropped off by hand. The sample was selected randomly from Lloyd's List Maritime Intelligence Informa, an online global maritime directory that categorises maritime firms by industry sector.

The survey was administered to 570 shipping firms globally, asking those in a managerial position to answer all the questions. From the 570 questionnaires, 47 were delivered by hand. The 523 email questionnaires garnered 217 responses. Four weeks post-dissemination, reminder emails and phone calls were deployed, resulting in an additional 35 responses. From the 299 responses, 10 were not usable. Thus, the total number of usable responses was 289, giving an overall response rate of 51%.

3.6.3. *Measures*

An exploratory GSCM research was preliminarily performed in order to select the measurement items in this study. We conducted an in-depth study on GSCM literature, including research papers, books and case studies related to supply chain management, and environmental management and strategy.

Next, we developed the survey, incorporating suggestions from the abovementioned experts such as CEOs, managing directors, managers, and ship captains. The above, along with the literature review support the content validity of this study. In addition, we performed a number of tests to verify the construct validity and reliability of the resulting items (Yang et al., 2013).
Appendix 1, shows the measurement items used to construct the variables of interest, as supported by the literature (Bowen et al., 2001; Judge and Douglas, 1998; Lai et al., 2011; Panayides, 2003; Rao and Holt, 2005; Shang et al., 2010; Vachon and Klassen, 2008; Yang et al., 2013; Zhu et al., 2007).

The measurement scales were selected and developed following an in-depth exploratory research into GSCM literature. Thirty-six items on GSCM and three items on financial performance, as

shown in Appendix 1, were extracted mainly from the literature, while others were slightly modified as per the suggestion of academics and shipping industry practitioners.

Specifically, sixteen items on internal GSCM practices were based on the literature (Bowen et al., 2001; Lai et al., 2013, 2011; Shang et al., 2010; Yang et al., 2013; Zhu et al., 2007), while five items, X1.5b, X1.6a, X16.b, X1.8, X1.10 (see Appendix 1), were based on feedback from academics and shipping industry practitioners.

Fifteen items on external GSCM practices and three items on financial performance were based on the literature (Vachon and Klassen, 2008; Yang et al., 2013), and (Judge and Douglas, 1998; Panayides, 2003; Rao and Holt, 2005), respectively.

Tables 2, 3 and 4, present the final measurement items used for evaluating internal GSCM practices, external GSCM practices and financial performance. The measurement items are based on a five-point Likert scale (1= strongly disagree to 5= strongly agree).

3.6.4. *Pre-test analysis*

Due to survey responses being collected in two batches, we felt the need to address the potential of a non-response bias between the two groups of respondents; we addressed the issue by establishing whether there was a statistically significant difference between the two groups of respondents.

We followed the suggestion by Armstrong and Overton and performed a comparison of early (first wave) and late (second wave) respondents to test for non-response bias by t-test analysis. This was to reveal any significant differences in the responses between the two groups (Armstrong and Overton, 1977).

First, we divided the 289 survey respondents into two groups, namely early (n=207) and late (n=82) respondents. We then performed an independent t-test [38] (the most common statistical method for examining differences between two groups) on the sample in order to examine whether a non-response bias problem would emerge. At the 5% significance level, there were no significant differences between the two groups of respondents. Thus, both the t-test analysis and the high response rate suggest that non-response bias was not a problem in this study.

3.6.5. *Data analysis methods*

This study used the IBM's SPSS version 21 for windows. First, an exploratory factor analysis was performed to identify and extract the key dimensions (factors) for the variables: internal GSCM practices, external GSCM practices, and financial performance. Then, a reliability test was employed to verify the validity and reliability of each construct and item.
Finally, a cluster analysis, a One-Way ANOVA and a Kruskal-Wallis test were employed to check our hypotheses. The results and a discussion around the empirical analysis are presented in the following sections.

[38] A t-test was performed on the data of the agreement level of the two groups on the internal green practices, external green practices, and financial performance.

3.7. Results of empirical analyses

3.7.1. *Demographics*

Table 3.1 presents the characteristics of companies that responded to the questionnaire, as well as respondent bios. Regarding the companies, more than 50% were local, while 44.3% were foreign. In addition, more than 30% were firms with more than 100 shore-based employees while almost 70% of the firms had more than 100 employees at sea. One of the main contributions of this study to GSCM literature, in addition to examining GSCM in shipping, is that we collected data from shipping companies at a global level.

More than 32% were firms had been founded at least 31 years ago, which is a key finding for the quality and the validity of the survey results.

Table 3.1
Demographics

Characteristics of respondents	Frequency	%
Company information		
Ownership		
Local firm	149	51.6
Foreign firm	128	44.3
Others	12	4.1
Numbers of employee (shore based)		
1-20	79	27.3
21-50	84	29.1
51-100	36	12.5
>100	90	31.1
Numbers of employee (at sea)		
1-20	10	3.5
21-50	25	8.7
51-100	52	18
>100	202	69.9
Headquarters		
EU registered	168	58
Non-EU registered	121	42
Establishment (in years)		
1-10	29	10
11-20	101	34.9
21-30	65	22.5
>31	94	32.5
Biographical information		
Job title		
CEO	16	5.5
Managing director	48	16.6
Department manager/Department director	214	74
Others	11	3.8
Gender		
Male	251	86.9
Female	38	13.1
Education		
Under graduate	20	6.9
Master's degree	197	68.2
Doctorate degree	14	4.8
Others	58	20.1
Age (in years)		

Under 30	5	1.7
30-40	65	22.5
41-50	101	34.9
Above 50	118	40.8
Industry Experience (in years)		
Under 5	3	1
5-10	18	6.2
11-15	28	9.7
16-20	50	17.3
21-25	65	22.5
Above 25	125	43.3
Managerial Experience (in years)		
Under 5	25	8.7
5-10	60	20.8
11-15	71	24.6
16-20	43	14.9
21-25	32	11.1
Above 25	58	20.1

Regarding respondent bios, results show that CEOs made up 5.5% of survey respondents, while 16.6%, and 74% were managing directors, and department managers / department directors respectively. Respondents were asked to indicate their industry and managerial experience. Over 83% of respondents had more than 10 years of experience in shipping, while over 70% of respondents had more than 10 years of managerial experience. In sum, the Table 3.1 results reveal that 96% of the questionnaire respondents held the position of department manager / department director or higher, leading to further confirmation of the validity and reliability of the survey findings.

3.7.2. *Exploratory factor analysis*

We performed a factor analysis in order to identify and extract key dimensions for the following variables: internal green practices, external green practices, and financial performance.

Principal component analysis with varimax rotation was employed to identify the key dimensions of 19 internal GSCM practices, 15 external GSCM practices, and 3 types of financial performance. The results of the exploratory factor analysis are indicated in Tables 3.2, 3.3, and 3.4.

The Kaiser-Mayer-Olkin (KMO) test that arises from the exploratory factor analysis of internal green practices, external green practices, and financial performance was 0.896, 0.872, and 0.678 respectively. According to Hair et al. (2006), the KMO measure of sampling adequacy (MSA) must exceed 0.50. The Bartlett's sphericity test was also significant. In short, the conclusion was that our data was appropriate for analysis (Hair et al., 2006).

Factor loadings of 0.50 or greater are considered practically significant (Hair et al., 2006). Therefore, only variables with a factor loading greater than 0.50 were extracted, a conservative criterion based on Hair et al. (2006) [39]. Two internal green items, X5b and X6b, did not meet this criterion and were thus eliminated.

[39] According to Hair et al. (2006), 'the larger the absolute size of the factor loading, the more important the loading in interpreting the factor matrix'.

Based on the Kaiser's eigenvalue greater or equal to one criterion, the principal component analysis yielded a three-factor solution, namely internal environmental proactivity, green shipping practices, and green marketing (see Table 3.2). The cumulative variance of the three factors is 61.322%. The percentage of variance and the cumulative variance for each of the three factors are shown in Table 3.2.

The three internal GSCM components (factors) [40], namely, internal environmental proactivity, green shipping practices, and green marketing are described below (see Table 3.2):

Table 3.2

Exploratory factor analysis of internal GSCM practices

Internal green practices	F1	F2	F3
X1.1. We always attempt to go beyond basic compliance with laws and regulations on environmental issues.	**0.887**	0.281	0.222
X1.2. We commit ourselves to support GSCM.	**0.710**	0.167	0.075
X1.3. In our company cross-functional cooperation effectively supports green operations.	**0.642**	0.204	0.102
X1.4. We provide green education and training.	**0.663**	0.240	0.169
X1.5. We are committed and we have obtain the ISO 14000 certification.	**0.681**	0.067	0.167
X1.6. We are committed and we have obtain the ISO 50001 certification.	**0.707**	0.160	0.174
X1.7. We effectively manage the environmental risks affecting our business.	**0.760**	0.161	0.059
X1.8. It is a priority that the ships we order/trade/operate are environmental friendly (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank).	**0.714**	0.145	0.237
X1.9. We mainly use environmental-friendly materials and equipment (e.g. non-toxic paint, electric deck machine).	0.230	0.290	**0.857**
X1.10. We mainly use environmental-friendly materials and equipment such as Ballast Water Handling System.	0.147	0.177	**0.675**
X1.11. We mainly use clean-burning, low-sulphur fuels for main and auxiliary engines.	0.169	0.137	**0.727**
X1.12. We adopt optimal vessel speed and routing system.	0.138	0.187	**0.732**
X1.13. We promote the environmental-friendly recycling of scrap ships.	0.159	0.168	**0.744**
X1.14. We provide customers with information regarding our environmental-friendly practices through our website or other means.	0.262	**0.876**	0.256
X1.15. We intend to increase the budget allocated on green advertising within next year.	0.214	**0.700**	0.198
X1.16. We adopt the notion of resource and energy conservation in promotion.	0.150	**0.717**	0.186
X1.17. We use environmental friendly arguments in our marketing strategy.	0.267	**0.712**	0.086
X1.18. We regularly update environmental conservation information in our firm's Website.	0.184	**0.737**	0.177
X1.19. We often attract customers with green initiatives and eco-service.	0.117	**0.719**	0.200
Eigenvalues	7.715	2.214	1.722
Percentage variance	40.603	11.654	9.064
Cumulative variance	40.603	52.257	61.322

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 5 iterations.

[40] The items selected to evaluate internal green supply chain management practices were mainly extracted from prior research, specifically, **(a) Internal environmental proactivity** items were mostly extracted from Bowen et al., (2001), Yang et al., (2013) and Zhu et al., (2007); **(b) Green shipping practices** items were mostly extracted from Lai et al., (2011) and Yang et al., (2013); and items from **(c) Green marketing** were mostly extracted from Shang et al., (2010) and Yang et al., (2013).

Table 3.3

Exploratory factor analysis of external GSCM practices

External green practices	F1	F2	F3
X2.1. We achieve common environmental goals collectively with suppliers.	0.256	**0.842**	0.332
X2.2. We develop a mutual understanding of environmental risk and responsibilities with suppliers.	0.199	**0.674**	0.205
X2.3. We work together with suppliers to reduce environmental impact from operations.	0.184	**0.740**	0.154
X2.4. We make plans to resolve GSCM related problems with suppliers.	0.147	**0.740**	0.104
X2.5. We provide resources, skills, and knowledge to strengthen GSCM along with our suppliers.	0.207	**0.718**	0.163
X2.6. We achieve common environmental goals collectively with partners.	0.272	0.246	**0.861**
X2.7. We develop a mutual understanding of environmental risk and responsibilities with partners.	0.168	0.187	**0.677**
X2.8. We work together with partners to reduce environmental impact from operations.	0.085	0.054	**0.763**
X2.9. We make plans to resolve GSCM related problems with partners.	0.139	0.228	**0.651**
X2.10. We provide resources, skills, and knowledge to strengthen GSCM along with our partners.	0.252	0.197	**0.652**
X2.11. We achieve common environmental goals collectively with customers.	**0.857**	0.258	0.285
X2.12. We develop a mutual understanding of environmental risk and responsibilities with customers.	**0.714**	0.240	0.239
X2.13. We work together with customers to reduce environmental impact from operations.	**0.761**	0.158	0.154
X2.14. We make plans to resolve GSCM related problems with customers.	**0.748**	0.231	0.100
X2.15. We provide resources, skills, and knowledge to strengthen GSCM along with our customers.	**0.727**	0.135	0.172
Eigenvalues	6.450	1.569	1.518
Percentage variance	43.002	10.458	10.122
Cumulative variance	43.002	53.461	63.583

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 5 iterations.

Table 3.4

Exploratory factor analysis of performance

Financial performance	F1
Y1. Increase of profitability.	**0.964**
Y2. Sales growth.	**0.902**
Y3. Increase of ROI.	**0.911**
Eigenvalues	2.572
Percentage variance	85.745
Cumulative variance	85.745

Extraction Method: Principal Component Analysis.[a]

a. 1 components extracted.

Table 3.5
Reliability test

Measures	Items	Mean	S.D.	Cronbach α	CITC range
1. Internal environmental proactivity	8	3.333	1.369	0.892	0.582-0.931
2. Green shipping practices	5	3.198	1.334	0.845	0.560-0.874
3. Green marketing	6	3.270	1.370	0.878	0.632-0.916
4. Collaboration with suppliers	5	3.298	1.371	0.847	0.590-0.881
5. Collaboration with partners	5	3.316	1.298	0.817	0.539-0.874
6. Collaboration with customers	5	3.230	1.370	0.867	0.618-0.886
7. Financial performance	3	3.463	1.275	0.915	0.781-0.912

1. The first factor (F1), internal environmental proactivity, consisted of eight items. These items are related to shipping firms' internal environmental proactivity practices. Factor 1 accounted for 40.603% of the total variance. Here, the item with the highest factor loading was: 'we always attempt to go beyond basic compliance with laws and regulations on environmental issues'.
2. The second factor, green marketing, consisted of six items, which are all green marketing related. Factor 2 accounted for 11.654% of the total variance. 'We provide customers with information regarding our environmentally friendly practices through our website or other means', is the item with the highest factor loading here.
3. Factor 3, green shipping practices, comprised five items which are all green shipping related. Factor 3 accounted for 9.064% of the total variance. The item 'we mainly use environmentally friendly materials and equipment', had the highest factor loading.

Table 3.3 shows the results of the exploratory factor analysis (EFA) on the external green practices. The EFA yielded a three-factor solution based on the eigenvalue greater or equal to 1 criterion. All items have factor loadings greater than 0.50, specifically greater to 0.65, so they are considered practically significant (Hair et al., 2006). The cumulative variance of the three factors is 63.583%.

Three external green practices [41] were identified:

1. The first factor, green collaboration with customers, consisted of five items. These items are related to environmental collaboration activities with customers (Yang et al., 2013). Factor 1 accounted for 43.002% of the total variance. The highest loading on this factor had the item 'we achieve common environmental goals collectively with customers'.
2. Factor 2, namely green collaboration with suppliers, comprised five items. These items are related to green collaboration activities with suppliers. Factor 2 accounted for 10.458% of the total variance. The highest loading on this factor had the item 'we achieve common environmental goals collectively with suppliers'.
3. Factor 3, green collaboration with partners, consisted of five items. This factor accounted for 10.122% of the total variance. 'We achieve common environmental goals collectively with partners' had the highest factor loading.

[41] External green supply chain management practices include the supply chain collaboration with **suppliers**, **partners**, and **customers** (Yang et al., 2013), and were extracted mainly from prior research (Vachon and Klassen, 2008; Yang et al., 2013).

Table 3.4 reports the results of the exploratory factor analysis on performance [42]. The EFA yielded a one-factor solution based on the eigenvalue greater or equal to 1 criterion. All items have factor loadings greater than 0.50, specifically, greater than 0.90. The cumulative variance of this factor is 85.745%. The performance factor, namely financial performance, consisted of three items. These items are related to improvements in financial performance. The highest factor loading was related to the item: 'increase of profitability'.

The survey was carefully developed and validated. Content validity was supported using relevant literature as well as expert input. Following data collection, further analysis was performed in order to confirm the construct validity and reliability.
We used principal component analysis with varimax rotation in our exploratory factor analysis (EFA), to further confirm and validate the underlying factors (Yang et al., 2013), as our items had been selected from a variety of sources. The results of the EFA showed that all measurement items had strong loading on the construct.

3.7.3. Reliability test

Further analysis was performed in order to confirm the reliability and validity of the constructs. Reliability analysis is a method used to measure the accuracy, or lack of distortion, of the indicators (Chiou et al., 2011). A reliability test based on Cronbach's alpha was performed to ensure the constructs' internal consistency and validity.

Table 3.5 shows the results of the reliability test. The lower threshold for Cronbach's alpha is 0.60 (Flynn et al., 1990; Nunnally and Bernstein, 1994), but the agreed lower acceptable limit is 0.70 (Flynn et al., 1990). The Cronbach's alpha of all seven factors are well above 0.80, and therefore are well above the limit of 0.70 (Nunnally and Bernstein, 1994). The Cronbach's alpha value confirms the reliability of the constructs in this study.

In addition to Cronbach's alpha, we performed the corrected item-total correlation (CITC) reliability test (Kerlinger, 1986) to further ensure the constructs' internal consistency and validity. The CITC is basically the correlation between an item, or indicator, and the composite score of the rest of the items in the set (Shang et al., 2010).

The lower agreed limit of CITC is 0.30 (Ferketich, 1991), whereas Nunnaly (1978) suggests excluding items with item total correlation values below 0.40. The CITC values of the seven factors were larger than 0.50. Specifically, all items ranged from 0.539 to 0.931. Based on the Cronbach's alpha and CITC values, we were able to confirm the validity and reliability of the constructs.

3.8. Hypotheses testing

First, a K-means cluster analysis was performed to determine whether shipping firms can be clustered along the lines of their strategic choices. Following the cluster analysis, a One-Way

[42] The financial performance items were collected from Judge and Douglas (1998), Panayides (2003) and Rao and Holt (2005).

ANOVA and a Kruskal Wallis test was used to test differences in financial performance among the different groups on the basis of Tukey Post-Hoc analysis, and Mann-Whitney tests respectively.

3.8.1. Cluster analysis

Appendix 2 shows the final cluster centres, which are computed as the mean for each variable within each final cluster. The final cluster centres reflect the characteristics of the typical case for each cluster. Note that cluster 1 has the highest values across all variables, followed by cluster 2 and, finally, cluster 3.

Table 3.6
Distances between final cluster centers.

Cluster	1	2	3
1		5.873	9.940
2	5.873		5.487
3	9.940	5.487	

Table 3.6 shows the Euclidean distances between the final cluster centres. Note that greater distances between clusters indicate greater dissimilarities. Moreover, clusters 1 and 3 are most different, while clusters 2 and 3 are less so. Based on the above tables and the corresponding comments, we conclude that shipping firms can be placed into three different clusters: cluster 1 contains the "leaders", cluster 2, the "proactive" firms and cluster 3 the "reactive" firms. These groups are labelled according to terminology used by Aragón-Correa et al. (2008). Shipping firms with reactive strategies aim to merely meet existing environmental regulations, while firms with a more proactive green philosophy aim to go over and above, by voluntarily adopting additional proactive green strategies aimed at preventing pollution.
Shipping firms with environmental leadership strategies make an effort to re-design their business models to include the proactive internal and external green supply chain management practices that go beyond the regulatory requirements. The result is a minimised environmental footprint and differentiated, high-quality transport services that respect and safeguard the environment.

Thus, hypothesis 1 is supported.

Table 3.7
Number of cases in each cluster.

Cluster	Number of cases
Leaders	140
Proactive	62
Reactive	87

Table 3.7 shows the number of cases in each cluster. About half (48.44%) are in cluster 1 (leaders), 21.45% belong to cluster 2 (proactive), while 30.10% belong to cluster 3 (reactive).

3.8.2. One Way Analysis of Variance

To see whether there are differences in the mean values of the variables "Increase of profitability", "Sales growth" and "Increase of ROI" relative to "cluster", we will use the One-Way ANOVA if the variables are normally distributed and the variances are homogeneous or the Kruskal-Wallis test if they are not.

If the significance value of the One-Way ANOVA test is less than 0.05 and homogeneity of variances occurs, we will perform Tukey Post-Hoc Analysis. Post-Hoc tests consist of pairwise comparisons that are designed to compare all the possible combinations of clusters. Otherwise, if we apply the Kruskal-Wallis test and the significance value is less than 0.05, we will use Mann-Whitney tests, by applying the Bonferroni correction, in order to identify which of the three pairwise comparisons ("leaders" vs "proactive", "leaders" vs "reactive", "proactive" vs "reactive") caused this result.

Based on the results of the Kolmogorov-Smirnov test and the Levene test of homogeneity of variances, we cannot use One-Way ANOVA for the variables "Increase of profitability" and "Increase of ROI", because the significance levels of the former two are all smaller than the cut-off value of 0.05 (see Appendix 3 and 4).
Appendix 5 shows the summary statistics for the variables "Increase of profitability", "Sales growth" and "Increase of ROI".

The results of the One-Way ANOVA and Kruskal Wallis tests are shown in Table 3.8.

Table 3.8
Results of One-Way ANOVA and Kruskal Wallis tests

Financial performance	Group 1 'Leader'	Group 2 'Proactive'	Group 3 'Reactive'	ANOVA F	Kruskal-Wallis $X^2(2)$	Group Comparisons
N	140	62	87			
Increase of profitability	4.250	3.823	2.115		169.419*	1 > 2 > 3
Sales growth	4.079	3.774	2.195	105.019*		1 > 3, 2 > 3
Increase of ROI	4.107	3.742	2.092		123.043*	1 > 2 > 3

*p < 0.05.

i) For the variable "Increase of profitability", from the Kruskal-Wallis test, we find a significant difference between the means of the three clusters ($X^2(2) = 169.419$, $p = 0.000 < 0.05$). Furthermore, for the three Mann-Whitney tests ("leaders" vs "proactive", "leaders" vs "reactive", "proactive" vs "reactive"), and following a Bonferroni correction, with p value = 0.05/3 = 0.0167, revealed a significant difference between clusters 1 and 2 ($p = 0.001 < 0.0167$), between clusters 1 and 3 ($p = 0.000 < 0.0167$) and between clusters 2 and 3 ($p = 0.000 < 0.0167$). Note that the highest mean value in this variable has the "leaders" cluster, while the smallest has the "reactive" cluster.

ii) For the variable "Sales growth", from the One-Way ANOVA test, we find a significant difference between the means of the three clusters ($F(2, 286) = 105.019$, $p = 0.000 < 0.05$). Furthermore, the Tukey Post-Hoc analysis revealed that there is a significant difference between clusters 1 and 3 ($p = 0.000 < 0.0167$) and between clusters 2 and 3 ($p = 0.000 <$

0.0167), while there is no difference between clusters 1 and 2 ($p = 0.102 > 0.0167$). Note that the highest mean value in this variable has the "leaders" cluster, while the smallest has the "reactive" cluster. The difference in the mean values between clusters 1 and 2 (leaders vs proactive) is too small.

iii) For the variable "Increase of ROI", from the Kruskal-Wallis test, we find a significant difference between the means of the three clusters ($X^2(2) = 123.043$, $p = 0.000 < 0.05$). Furthermore, the three Mann-Whitney tests ("leaders" vs "proactive", "leaders" vs "reactive", "proactive" vs "reactive"), following a Bonferroni correction, with p value = 0.05/3 = 0.0167, revealed that there is a significant difference between clusters 1 and 2 ($p = 0.012 < 0.0167$), between clusters 1 and 3 ($p = 0.000 < 0.0167$) and between clusters 2 and 3 ($p = 0.000 < 0.0167$). Note that the highest mean value in this variable has the "leaders" cluster, while the smallest has the "reactive" cluster.

Overall, the "leader" firms experience the highest financial performance, followed by the "proactive" group of firms, and finally, the "reactive" firms trail into last place.

Thus, hypothesis 2 is also supported.

3.9. Conclusion and discussion

Growing awareness of the importance of environmental conservation, and the corresponding rise in environmental management within shipping firms, are the key factors that underpin the value of this study. The study contributes towards a better understanding of the practices required to achieve green operations, as well as the impact that such green practices have on firm performance.

The main objective of this study is to contribute to shipping management literature by examining the concept of GSCM specifically in the shipping industry, by categorising shipping firms into clusters according to their strategic green options, and proving that proactive strategic green choices lead to superior financial performance.

This study provides an empirical assessment of the levels of proactive internal and external GSCM practice adoption in the shipping industry. It examines and analyses the way that different adoption levels influence the shipping firms' financial performance. To do so, this study provides evidence to shed light upon the oft-contested relationship between proactive environmental strategy and financial performance.

Our statistical analysis supports the hypotheses that shipping firms may be grouped into different GSCM strategy adoption clusters, and that shipping firms which implement more proactive GSCM practices attain better financial performance.

Using a survey to collect shipping industry data, we performed a factor analysis in order to identify the key dimensions of internal green practices, external green practices, and financial performance. Seven factors emanated from the principal component analysis with varimax rotation. Namely, internal environmental proactivity, green shipping practices, green marketing, green collaboration with suppliers, partners, and customers, and finally the financial performance factor.

Following a series of tests to check the validity and reliability of the constructs, cluster analysis, One-Way ANOVA, and Kruskal-Wallis tests were employed to test the research hypotheses. The findings of the cluster analysis indicate the existence of three groups of shipping firms, namely the "leaders", "proactive" firms, and "reactive" firms, supporting our first hypothesis. While most studies in the management literature state that reactive firms outnumber proactive firms and leaders (Aragón-Correa et al., 2008; Zhu et al., 2011), especially in the manufacturing sector, this is not the case in the shipping industry.

Due to the shipping industry's unique characteristics, namely, intense competition, high capital investment and highly leveraged assets, freight volatility, uncertainty and risk, as well as strict environmental regulations and penalties, shipping firms are more likely to adopt proactive green supply chain management strategies and practices in order to reduce their risks and to remain competitive and profitable.
Proactive GSCM strategy includes all the innovative internal and external green practices that a company requires in order to be environmentally conscious, and adequately respond to stakeholder concerns.

The findings of the One-Way Anova and Kruskal-Wallis tests indicate that shipping firms considered to be "leaders" or "proactive", outperform the "reactive" group from a financial perspective. This means that shipping firms who have implemented proactive GSCM practices to a larger extent experience better financial performance.

Comparing the results of this study with prior research, it seems that the results from studies that examined green strategies in the manufacturing sector, partially apply to the shipping industry as well, for example, overall findings showed that firms that adopt proactive environmental strategies, such as GSCM, achieve better financial performance (Aragón-Correa et al., 2008; Menguc et al., 2010). Nevertheless, prior studies did not examine the differences in financial performance in the three diffusion clusters of shipping firms (early, followers, and laggards), nor did they show that these are as large as the differences in levels of adopting GSCM practices (Zhu et al., 2012). In this study, we found significant differences in the financial performance measures between the leaders, proactive and reactive groups. One explanation could be that, the studies on manufacturing firms in China included early adopters, who are still at the consideration stage, and have not yet implemented external GSCM practices. Our study, in contrast, found that most shipping companies have successfully implemented external green practices, such as green collaboration with supply chain members, and that leaders and proactive shipping firms with higher levels of collaborative green supply chain practices are those that perform better.

Green collaboration with supply chain members constitutes an important modern capability for shipping firms. As concern, pressure, regulation, risk, and uncertainty grow, shipping must share resources, skills and knowledge with supply chain members in order to achieve common environmental goals, and to overcome potential environmental obstacles and issues in a more integrated way. The main objective is to achieve green supply chain integration in order to improve both the performance and the service value of the overall supply chain.

Another possible explanation for the gap identified in prior studies in finding significant differences in relation to the GSCM adoption and performance improvements, is the omission of important variables (i.e. green marketing) in the mechanism between GSCM and performance.

The results of this study show that the adoption of proactive GSCM strategies by shipping firms is a win-win situation. By implementing proactive GSCM practices, such as green marketing, shipping firms can send signals to stakeholders about their environmental programmes. These signals contribute to firms' positive financial outcomes. Furthermore, by collaborating with their supply chain members, shipping firms' environmental performance, productivity, and the quality of their services is improved. This, in turn, increases the overall supply chain value, which is a key objective in today's competitive environment (Song and Panayides, 2012), and results in a win-win situation for both shipping companies and their stakeholders. An integrated green supply chain not only increases the firm's service value, it also increases the value of the overall supply chain, factors that are necessary for improved competitiveness and performance.

3.9.1. Study implication

We now discuss the theoretical contribution and practical implications of the results of this study in relation to shipping firms, their managers, as well as organisations that invest in shipping firms. Regarding the theoretical contribution, this study is innovative in the area of GSCM; it adds to the relevant literature by being the first to examine the range of approaches that shipping companies deploy in adopting GSCM strategies. It also highlights the importance of proactively adopting GSCM strategy in order to achieve a key goal: improved financial performance.
As for investors, the results clearly show that environmentally proactive shipping firms are a good investment, as they offer high quality transport services that respect and safeguard the environment. Turning to shipping firms, due to the intense competition characterising the shipping industry, as well as the growing global concern and attention to environmental conservation, shipping firms' competitiveness is strongly affected by their commitment to take on green strategies and practices (Yang et al., 2013). As Rao and Holt (2005) showed, GSCM practices lead to improvement in both competitiveness and performance; this study supports these arguments by establishing groups of shipping firms with a superior strategic approach regarding GSCM.

This study highlights the green practices necessary for a shipping firm's successful implementation of a proactive GSCM strategy that can lead to improvements in overall supply chain value and financial performance. By implementing these practices, shipping firm managers can contribute to the financial performance of their organisation. The internal and external GSCM practices examined in this study can help shipping firms offer high quality services that respect and safeguard the environment, increasing in that way the value of the overall supply chain. This contributes to competitiveness and better financial performance outcomes.

3.9.2. Limitations and future research

The present study has some limitations that should be taken into account in future research. First, the data collected in the present study provides evidence around research hypotheses in a specific industry, i.e. shipping. As such, studies on GSCM strategy and its effect on financial performance

should also be performed in the context of other service industries with similar characteristics (e.g. other transport industries or hospitality). Research on GSCM in the service industry in general remains inadequate. Accordingly, a different or bigger sample should be employed to further verify our findings.

In addition, this study limits the examination to the adoption of GSCM strategy by shipping firms and its effects on financial performance. Other factors that have different effects can be examined in the future (e.g. internal factors, such as manager characteristics or managerial interpretations and preferences towards strategic options, or external factors, such as stakeholder pressure). These might have moderating effects on the relationship between proactive GSCM strategy and financial performance of shipping firms. Accordingly, alternative methodologies should be used in order to examine various causal relationships between green practices and performance. Structural equation modelling that estimates the multiple and interrelated dependence in a single analysis, would be an appropriate method to examine the direct, mediate, and even moderate effects of factors influencing the relationship between GSCM practices and the performance of shipping firms.

Finally, it would be ideal to identify the preferred GSCM strategies in the different—albeit closely related—sectors within the shipping industry (bulk, liner, specialised), and to examine and illustrate the effect of those strategic preferences on financial performance.

CHAPTER 4: THE MODERATING EFFECTS OF MANAGERS' RISK-TAKING PROPENSITY ON THE RELATIONSHIP BETWEEN GREEN SUPPLY CHAIN MANAGEMENT STRATEGY AND PERFORMANCE IN SHIPPING

4.1.Introduction

Globalisation promotes the enhancement of worldwide integration through the exchange of ideas, goods and services in the light of a unified market structured on competition, in relation to the idea of supply and demand. Therefore, globalisation is viewed as an agent of economic enhancement, which empowers the industry to function. The shipping industry constitutes one of the most important components of globalisation. Through industrial modernisation, the supply of goods and services has increased, resulting in the creation of global prosperity. One of the most important aspects of economic prosperity is constituted by global transport, especially maritime transportation. Shipping is the main mode of transport, carrying more than 80% of the global trade volume (UNCTAD, 2017), providing the opportunity for countries to import and export their products around the world in the most efficient, safe, economic, and environmentally friendly way. Indeed, shipping constitutes the most efficient, safe, economic, and environmentally friendly mode of transport, due to the tons of cargo that ships can carry. Accordingly, shipping is the most important pillar of the transport chain, acting as the main moderator between the suppliers, producers, and final customers. Simultaneously, the impacts and concerns in relation to the natural environment have increased with the rise of globalisation and the increase in production and trading. There is an increasing trend around concerns connected to the environmental impacts of different firms' operations, and especially concerns for the environmental impacts of the shipping-related activities.

In recent years, the pace of industrial modernisation and the increase in production and trading has led to greater impacts on the natural environment, including gas emissions, waste, oil pollution, toxic pollution and more. Several different factors, including the global economic crisis, have affected the shipping industry significantly, thus the minimisation of costs and maximisation of profits is increasingly necessary. Simultaneously, there is an increasing trend regarding concerns connected to the environmental impacts generated from firms' activities. Shipping firms, in order to serve the worlds' increasing demands for maritime transport, have, as a consequence, increased their fleet, in both numbers and in scale. Such growth has led to greater impacts on the natural environment generated from shipping-related activities. With the intensification of ecological problems resulting from pollution,[43] various stakeholder groups, including clients, governments and NGOs, have increased pressure on shipping firms to take action to prevent pollution and to protect the environment. They put pressure on shipping firms, through regulatory pressure connected to stricter regulations regarding air pollution,[44] or competitive pressure connected to the

[43] The recent report of the UN (Review of maritime transport, 2017), shows that the dramatic increase of global warming is continuous: a record was set in 2017 with 1.5 degrees Celsius above the pre-industrial period (IPCC report, 2018), nonetheless a continuous increase is illustrated in connection to the natural hazards and the disastrous outcomes connected to and attached with, more than 1.6 million people died from international natural hazards from the periods 1990 – 2015 (The Sustainable Development Goals Report, UN 2017), an increasing and more prominent effort is required for diminishing the impact on climate change and the related hazards and natural disasters.

[44] 'Maritime transport emits around 1000 million tons of CO2 annually and is responsible for about 2.5% of global greenhouse gas emissions (3rd IMO GHG study)'. (https://ec.europa.eu/clima/policies/transport/shipping_en), contributing in this way to the dramatic increase of global warming. Thus, with the intensification of ecological problems resulting from pollution, various shipping industry stakeholders have increased their pressures on shipping firms in order to reduce their pollution and to improve their environmental performance. An example are the stricter

stricter environmental requirements that charterers have introduced for vessel chartering, in order to adopt more proactive green practices and improve their environmental performance. Since environmental performance is a major concern and the supply chain is an ultimate driver for the shipping operations, the GSCM strategy is considered crucial within the shipping industry. The main objective constitutes the preservation of the natural environment, the improvement of performance and the service value of the overall supply chain. This is an illustration of the need for shipping firms to implement the necessary green supply chain management practices.

One of the main characteristics of the shipping industry is intense competition. This forces companies to select and adopt strategies that will provide them with the opportunity to differentiate their activities, and to improve their performance, both of which are very important. An example of such strategy is the GSCM. The GSCM strategy refers to the way in which shipping companies include environmental issues and thinking into their supply chain management.

Nowadays, shipping firms aim to strengthen their environmental profile, recognising that their supply chain members consider the environmental performance of shipping firms to be a crucial factor when choosing possible partners. Because maritime transportation constitutes one of the most important pillars of international supply chains, shipping firms must achieve internal green integration, by adopting internal green management practices in line with those of their supply chain partners, as well as any external green collaboration, by working together with their supply chain members in an effort to reduce the environmental impact from their operations, and remain competitive and profitable. The main objective for shipping firms is to provide a high-quality service that respects the natural environment at a low cost. In an effort to succeed, they need to achieve green supply chain integration. GSCM is the strategy adopted by shipping firms that incorporates all the internal and external collaborative green practices aiming at pollution prevention from firms' operations. With the successful implementation of a proactive GSCM strategy, shipping firms will offer a high-quality service that respects the safety and the natural environment, whilst increasing, in that manner, the value of the overall supply chain that leads to performance and competitive improvements (Rao and Holt, 2005).

Providing that the manufacturing and shipping sectors continue to develop, further management practices are expected to balance economic growth and environmental damage. As concerns and pressures regarding environmental issues are increasing, both manufacturing and shipping companies have realised that in order to remain competitive it is important to develop a mutual understanding of environmental risks and responsibilities with their supply chain members. They have also found it necessary to adopt the necessary green practices in order to reduce the environmental impact of their products and services (Zhu and Geng, 2013).

Although GSCM has received strong attention in environmental management literature, the majority of previous studies have focused solely on the manufacturing sector. The empirical examination of the topic of GSCM in a service sector, such as the shipping industry, is lacking. Indeed, studies in relation to the topic of GSCM in the shipping industry are scant and focus on a

regulations set up by IMO in order to reduce pollution, such as the recent implementation of a global limit of 0.5% on Sulphur in fuel oil used on board ships (Review of maritime transport, 2017).

very narrow sample of firms, on small samples, and on Asian countries, for instance (Lai et al., 2013; Yang et al., 2013). A possible explanation for this may relate to the environmental harms caused by the manufacturing industry in Asia and the stricter regulations put in force by Asian governments in order to motivate the implementation of environmental practices (Zhu et al., 2011). More specifically, the area that requires particular focus, is whether GSCM leads to improved organisational performance, and if it brings additional benefits. These advantages relate to the relationship between GSCM strategy and the environmental and economic performance for shipping firms.

By reviewing the relevant literature, we realise that although the majority of previous studies show a positive relationship between GSCM and environmental performance, with regards to economic performance, the findings are conflicting (Rao and Holt, 2005; Zhu et al., 2013, 2005). This may be due to the differentiation in the manufacturing industries examined in each study. According to Andreou et al. (2012), "one benefit of focusing on a single industry is the mitigation of possible inter-industry variations that usually tarnish inferences of studies that span several industries". In this study, we focus solely on the shipping industry. Further reasons for the varying results may be related to the data utilised in each analysis (Schaltegger and Synnestvedt, 2002), such as the small sample size. Alternatively, this may occur due to the definitions of performance that have been operationalised (e.g. measuring economic performance with financial performance measures).

A main challenge for firms is how to be environmentally friendly whilst remaining profitable and competitive. Thus, it is important to further examine the relationship between GSCM adoption and performance improvements. The performance improvements constitute an important motivation for the implementation of environmental supply chain management practices by firms (Bowen et al., 2001; Zhu and Sarkis, 2004), especially for the shipping industry which is characterised by intense competition, high leverage assets, volatility in freight rates, and risks that influence their strategy and performance. Thus, there is a significant interest in examining the effects of GSCM practices on the performance of shipping firms. On this basis, the results of this study will give the opportunity for shipping firms to better understand the mechanisms that are crucial for a successful green strategy and that enable a shipping firm to seek better environmental supply chain management practices. Furthermore, since managers are the ones responsible for the selection and adoption of firms' strategies, it is important to examine, empirically, the role that managers have on the mechanism between GSCM strategy and performance.

There is almost no empirical research connected to the factors that strengthen such a relationship, especially in relation to the shipping industry. Several studies examine the moderating effects on the relationship between GSCM and performance, but they only take into account external factors as moderators, and again they only focus on the manufacturing industry (Zhu and Sarkis, 2007). The empirical examination of internal factors on the relationship between GSCM and performance is not evident, especially regarding internal factors such as the role of managers' in the process of GSCM adoption and performance in a service sector such as the shipping industry. The managers' role in this relationship seems to be important (Wu et al., 2012; Zhu and Sarkis, 2004), since managers are the ones responsible for deciding upon the policies and strategies that a company

follows. Thus, their priorities when considering the strategies and their commitments play an important role in the mechanism between the adoption of GSCM and performance. Previous studies showed the importance of the support and commitment of managers to GSCM implementation and the performance of firms (Wu et al., 2012; Yang et al., 2013; Zhu and Sarkis, 2004). Since the strategies that managers' implement, support and commit, relate to their risk preferences (Kohli and Jaworski, 1990), it is crucial to examine the interactional effects of the risk-taking preferences of managers on the relationship between GSCM adoption and performance. Managers' strategic preferences are largely based on their risk preferences. Hence, their preferences in relation to risk may have a significant impact on the mechanism between GSCM practices and performance. For example, when managers who are environmentally oriented are risk averse and opposed to taking environmental related risks (Stone and Wakefield, 2000). This will promote an environmental oriented philosophy within the company and may further strengthen the GSCM adoption and performance mechanism.

The present study will focus on the empirical examination of the role of the manager in this process, especially managers' aversion to risk, in order to measure the relationship between this management trend, with the moderating effect on the relationship between the GSCM strategy and the environmental and economic performance. To the best of our knowledge, this is the first study that takes into account managers' risk-taking propensity and examines the effects of their aversion to risk on the relationship between proactive GSCM strategy and performance measures in the context of the global shipping industry.

In addition to the need to examine the existing gaps in literature, as the study shows, the mere characteristics of the shipping industry, accompanied for example with the need for examining the internal moderators, makes it important to investigate the GSCM strategy of shipping firms.

The study is organised as follows; section one comprises the introduction (as shown above). Section two provides a detailed review of previous studies that conducted an environmental and green supply chain management strategy, and the development of hypotheses. Four research hypotheses and the conceptual model are presented in section two. Section three provides the methodology, including the survey development, sample characteristics, and the analysis strategy. Section four discusses the results of the empirical analysis, such as the descriptive statistics, exploratory factor analysis, results of validity and reliability tests, confirmatory factor analysis, and the results of the structural equation modelling. Section five discusses the conclusion and the implications for the shipping industry, drawn from the empirical findings. It further provides suggestions for future research. The appendices are presented in the final section.

4.2. Literature review and hypotheses development

The conceptual model of the present study is comprised of two direct hypothesised associations between key constructs, and two moderating hypotheses on the relationship between proactive GSCM and performance measures. This section provides a brief outline of the literature which has provided the basis for this research. Specifically, in this section we discuss the previous research conducted on GSCM practices and its performance implications as well as the interaction effects on that relationship, accompanied by the relevant hypotheses development.

4.2.1. Green supply chain management strategy and performance

The main goal of companies is the minimisation of costs and the increase of profit. At this stage, it is crucial to emphasise the existing literature, in order to reiterate the importance of the hypothesis development. As concerns, pressures, and regulations regarding environmental issues are increasing, firms have started to incorporate the environmental issues in their strategic formulation. A major concern facing firms - especially shipping firms - is whether the implementation of green practices will improve their performance and competitiveness.

Examples in the literature place emphasis on the manufacturing firms Zhu et al. (2005; 2013) and show that firms in China with higher adoption levels of GSCM achieve better environmental performance. However, they have not found a positive relationship between GSCM practices and economic performance improvements. A similar study conducted by Zhu and Sarkis (2004), reveals that Chinese manufacturers with early an adoption of GSCM practices have environmental performance improvements. Nevertheless, conflicting findings regarding economic performance were presented in their study. Although a strong relationship between GSCM practices and environmental performance was evident in the study of Zhu et al. (2007; 2012), they have not found strong evidence for the relationship between GSCM and economic performance for manufacturing firms in China.

In contrast, Zhu et al. (2010), based on comparative analysis, support that large Japanese manufacturers with higher levels of implementation of GSCM practices achieve better environmental and economic performance when compared with Chinese manufacturers. Azevedo et al. (2011) provide evidence that GSCM practices improve environmental, operational and economic performance by reducing green related costs.

In another study, Chiou et al. (2011), using a sample of 124 manufacturing firms in Taiwan examined the impact of GSCM on the environmental performance and competitive advantage. Their study indicates that greening the supplier and green internal innovative practices improve both the environmental performance and competitive advantage of manufacturing firms. In a related study, Rao and Holt (2005), show that greening the different phases of the supply chain leads to an integrated green supply chain that improves competitiveness and economic performance for manufacturing firms in South East Asia.

Only few studies have considered green management practices and the performance implications in a service sector such as the shipping industry. More specifically, the study of Yang et al. (2013) has examined the impact of GSCM practices on the performance and competitiveness of container shipping companies in Taiwan. Using a sample of 163 container shipping firms in Taiwan they argue that internal green practices, such as green policy, green shipping practices, and green marketing, positively influence external green practices, such as collaboration with supply chain members. In addition, they have indicated that these internal and external GSCM practices positively influence green performance, i.e. environmental and economic performance, which in turn helps to enhance the competitiveness of container shipping firms in Taiwan.

The importance of green shipping management practices on the performance of shipping firms is evident in the study of Lai et al. (2013), which uses a sample of 107 shipping firms in Hong Kong

to show that the green shipping practice of shipping design compliance is beneficial for the performance of shipping firms.

A proactive GSCM strategy includes all the internal and external green practices aimed at pollution prevention. The main objective for the implementation of a proactive GSCM strategy by shipping firms, is to increase their profitability and competitiveness by performing in a more environmentally friendly way that leads to reductions in green costs. In order to achieve this goal and to remain competitive in today's intense competition, shipping firms must achieve green supply chain integration, internal green integration and external green integration, by collaborating with supply chain members. As already mentioned, greening the different phases of the supply chain leads to supply chain integration and eventually to performance improvements and competitive advantages for firms.

Various difficulties and obstacles within an organisation are overstepped with internal integration and collaboration, while different departments work as an integrated team, aiming to meet the firm's goals and the requirements of their stakeholders. This also assists the creation of an efficient coordination and collaboration with the members of the firm's supply chain, as the ultimate goal is to improve the environmental performance of the overall supply chain.

By collaborating and sharing knowledge with their supply chain partners, shipping firms will favour their ability to solve problems and overcome barriers related to environmental issues in a better way, while also improving their environmental and economic performance. Thus, companies can gain performance benefits by adopting internal and external GSCM practices (Zhu et al., 2013). This is supported by the study of Vachon and Klassen (2008), which also found that green collaboration with supply chain members is positively associated with performance improvements. Thus, we support the argument that shipping firms with proactive GSCM practices adoption in their sustainability strategy may also benefit their environmental performance as well as their economic performance. This would create a win-win situation for the environmentally oriented shipping firms, as well as the natural environment.

The successful implementation of a proactive GSCM strategy will improve the environmental performance of shipping firms by making their systems and operations more environmentally friendly. This will favour a decrease in green costs, and thus, the improvements in economic performance. For example, by adopting internal environmental proactive practices, such as the energy management systems, i.e. firms with ISO 50001 certification - the energy management systems standard - firms have the ability to become more environmentally friendly and, in addition, save money in regard to energy, such as the decrease of cost for energy consumption, reductions in fuel costs, and more. Using energy efficiently helps organisations save money, as well as helping to conserve resources and tackle climate change.

Based on the above, it is purported that GSCM contributes towards higher economic and environmental performance through cost savings and the reduced negative impact on the environment. Consequently, the following hypotheses are proposed:

H1: Proactive GSCM (green supply chain management) strategy is positively associated with environmental performance for shipping firms.

H2: Proactive GSCM (green supply chain management) strategy is positively associated with economic performance for shipping firms.

4.2.2. Managers' risk aversion and the relationship between proactive GSCM strategy and performance

It is important at this point to discuss the previous studies on GSCM literature, as this will enhance our argument and equip us to develop further our hypothesis. Examining factors acting as moderators on the GSCM and performance link will enable us to emphasise the existing gaps within the existing literature and illustrate the input of our hypothesis to the literature. Few studies exist in connection to the GSCM literature that have examined moderating factors on the relationship between GSCM and performance. Most of these previous studies have only considered external factors acting as moderators, and these studies also have the limitation of using samples that mainly come from manufacturing industries in Asia.

Specifically, Zhu and Sarkis (2007), examined the moderating effects of institutional pressures on the relationship between GSCM practices and organisational performance for Chinese manufacturing firms. They have found that the different moderating effects of institutional pressures can encourage a performance measure such as environmental performance, but can cause the decrease of another, like economic performance. Although market pressures positively moderate the relationship between GSCM and environmental performance, with the existence of market pressure and the implementation of eco-design practices, the economic performance tends to deteriorate. The results of this study reveal that 'none of the institutional pressures contribute to or lessens possible win-win situations' for Chinese organisations (Zhu and Sarkis, 2007). In a related study, Dubey et al. (2015), found that institutional pressures act as moderators on the relationship between supplier relationship management, and total quality management and environmental performance, in the framework of green supply chain. In another study, Wu et al. (2012), also consider the institutional pressures as interacting factors, with the only difference being, that in this study, the moderating effects of institutional pressures was tested on the relationship between GSCM drivers and GSCM practices. Using a sample of 104 manufacturing firms in Taiwan, they support that market pressure has no moderating effects on most of the relationships between GSCM drivers and GSCM practices; regulatory pressure has positive moderating effects on most of the relationships between GSCM drivers and GSCM practices; and competitive pressure has negative moderating effects on most of the relationships between GSCM drivers and GSCM practices. In another study, Chan et al. (2012), identified that competitive intensity strengthens the positive effect of a GSCM practice, namely customer cooperation, on corporate performance.

With regards to the internal factors acting as moderators within the GSCM literature, the study of Zhu and Sarkis (2004) examined the variables of quality management (QM) and just-in time (JIT) acting as moderators in the relationship between GSCM practices and firm performance. They fail to provide strong supporting evidence with regards to the interaction effects between the two internal management operations philosophies of QM and JIT, and on the relationship between GSCM and performance in the context of the Chinese manufacturing industry. In another study, Choi and Hwang (2015) show that collaborative capability strengthens the relationship between

GSCM practices and performance. This is shown in factors such as eco-design and investment recovery, and the financial performance of Chinese manufacturers. In a related study, Zhu et al. (2017), fail to provide strong supporting evidence with regards to the positive interaction effects of customer relational governance on the relationship between GSCM practices and environmental and economic performance. These findings are complimentary to the argument that there is a need for further examination of the internal factors that strengthen the positive relationship between GSCM strategy and performance, especially for the shipping industry - an aspect that has never been researched on this level.

Managerial characteristics are important within the shipping industry as they play an important role between strategy and performance. A study on the manager's role in the mechanism between GSCM and performance is needed, as managers hold an important influence on the design, development, implementation and support within shipping firms, in connection to ideas and strategies regarding the environment. The internal characteristics, such as managers' support and commitment to environmental policies and strategies; managerial interpretations on environmental issues, and managers' risk aversion, are important for the mechanism between proactive environmental strategy, such as GSCM, and performance. This is obvious from a variety of papers, despite the limited number of those engaging with GSCM.

According to Stone and Wakefield (2000), managerial involvement, support and commitment has been found to be a crucial factor in the formulation and implementation of firms' strategies and values. Managers play the most important role in designing, implementing and supporting the values, ideas, and strategies that firms follow. Managers' support and commitment was found to be a critical factor in the successful implementation of GSCM practices (Wu et al., 2012). Thus, the successful implementation of a proactive GSCM strategy by shipping firms, depends primarily on the emphasis, support, and commitment on the various environmental issues that managers give.

Several studies provide empirical evidence regarding the importance of top management emphasis, support and commitment to the successful implementation of GSCM practices that leads to environmental and economic performance improvements (Wu et al., 2012; Zhu and Sarkis, 2004, and more). Specifically, Wu et al. (2012), prove that managers' support and commitment, positively influence the development and implementation of GSCM practices for the manufacturing firms in Taiwan. This is also supported by the study of Zhu et al. (2008), who prove that management support constitutes an important driver for the GSCM adoption of manufacturing firms in China. Such commitment and support to green supply chain management practices constitutes an important internal factor for the mechanism between GSCM and performance. This is evident in the study of Zhu et al. (2007), whose findings indicated that Chinese manufacturers with higher GSCM practices - including internal management support and commitment to GSCM practices - leads to performance improvements. In another study, Sharma (2000) argued that if managers interpret the environmental issues as opportunities, the greater the likelihood of adoption of proactive green strategies. Proactive environmental strategies, such as the GSCM, lead to performance improvements (Aragon Correa et al., 2013). Thus, managerial characteristics may play a significant role on the relationship between GSCM and performance. Such a relationship

may be strengthened by a factor called managers' risk-taking propensity, i.e. whether managers are risk averse or risk lovers.

According to Kohli and Jaworski (1990), top management emphasis and risk aversion are related. If top management in shipping is sensitive on issues related to the natural environment, and places emphasis on environmental conservation, it is likely for managers to also be risk averse and opposed to taking environmental risks. In contrast, the lack of management emphasis on environmental related issues may facilitate environmental risk taking (Stone and Wakefield, 2000). This is supported by the study of Stone and Wakefield (2000), which shows that top management emphasis on environmental issues positively influences top management risk aversion. This illustrates that risk-averse managers tend to place more emphasis on environmental related issues and adopt more proactive GSCM strategies and practices to prevent pollution and perform in a more environmentally friendly way. Accordingly, the relationship between proactive GSCM strategy and performance may be strengthened by a factor called managers' risk aversion. Managers' with a high aversion to risk, and opposed to taking environmental risks, may strengthen the relationship between proactive GSCM strategy and performance measures, such as environmental and economic, by adopting more proactive green practices aiming at pollution prevention and green cost reductions.

In the manufacturing industry, Zhu et al (2012) identify three different clusters of industrial manufacturers in China; early – late and laggards, based on their adoption level of GSCM practices. They support that most of the Chinese manufacturers, who are within the lowest GSCM adoption groups (i.e. laggards), have adopted a minimum, up to nil, GSCM practices. They have argued that a possible reason for this might be the managers' risk aversion to green innovations. However, in the shipping industry, the position may be different. In this study, we support the view that the more risk averse a manager is, the greener the innovative practices become established.

It is crucial when examining such risks, that the interrelation between managerial actions/choices and the risk-taking culture within the shipping is analysed. The companies' strategic choices are dependent upon the interpretations of managers' in connection to their environmental strategies, specifically, whether they interpret the environmental practices as opportunities or as threats (Sharma., 2000). If a manager of a shipping firm interprets the GSCM strategies as opportunities, they will be more willing to adopt more proactive practices. This argument is supported by the study of Sharma and Nguan (1999). Due to the increasing focus towards environmental conservation that prevails within the shipping industry, the adoption of a green supply chain in management practices becomes increasingly important. The supply chain partners of shipping firms consider environmental issues to have a particular importance. Thus, supply chain partners have specific demands, including green supply chain management practices, whereby it is important for their own competitiveness within the industry. Therefore, shipping firms, in order to remain competitive, must adopt GSCM practices. Therefore, the various incorporated risks emanating from the non-adoption of GSCM practices are crucial. Such risks are risks associated with competitiveness, reputation and image, fines associated with pollution, insurance costs, costs from energy consumption, detention risks, and more. These risks have an impact on companies' performance outcomes, and because the risk behaviour of managers is relevant to the organisational strategy (Sharma and Nguan., 1999), these will, in turn, influence the GSCM strategy and performance link. To summarise, defining the risk is an entirely subjective term which

largely depends on the managers' preferences. Different actions hinder different risks. Nevertheless, the shipping industry is an industry which entails several risks in its nature (*viz.* freight volatility, intense competition); thus, managers are hesitant towards taking further risks, especially environmental related risks. For this reason, the more environmentally risk averse a manager is, the more proactive towards environmental practices they can be considered, which in turn enables them to remain competitive.

Therefore, because of the increasing uncertainty and the risk that characterises the shipping industry, ship managers tend to be more careful in their choices and the strategies that follow, especially strategies which affect the natural environment. Particularly, if these green practices are not being properly adopted, risks attached to non-compliance will remain a threat. Thus, preventative measures must be adopted for the minimisation of environmental accidents as well as pollution. Disregarding such actions may prove catastrophic for a shipping firms' image and reputation, whilst it will impact sustainability in general. This is also attached to the fact that environmental fines incurred from environmental accidents, are high in number, extending to millions of dollars (amongst these are the Exxon Valdez, and Deepwater Horizon oil spill).[45]

In this study, we support the view that being proactive to GSCM practices does not equate to being a risk-taker. In this study, we argue that managers who are averse to risk – especially to environmental related risks – will be more proactive in the adoption of GSCM practices', and this will in turn positively influence the relationship between proactive GSCM strategy and performance. As Zhu and Sarkis (2004) argued, GSCM is a strategy that assists companies to achieve their objectives (*viz.* performance and competitive), whilst decreasing environmental related risks. As the pressure increases from various stakeholders, on shipping firms, to perform in a more environmentally friendly way, a high amount of risk results from the non-adoption of green practices. For example, costs related to reputation and image, detention costs, insurance costs (in case of pollution and the risks involved). Further examples of pressures include the strict environmental requirements from customers. These may be oil majors chartering a vessel, or the increasing regulations coming from IMO and Flag-States, regarding pollution prevention. All these constitute risks that greatly impact the competitiveness and performance of shipping firms. Therefore, considering the above, we conclude that managers of shipping firms, need to be averse to risks, especially environmentally related risks. They must adopt more proactive GSCM practices that evidently drive into performance and competitive improvements for shipping firms (Yang et al., 2013).

Elaborating more on the reputational aspect, shipping firms are concerned with their reputation, image and are generally focused on avoiding the possible costs of any negative publicity. As regulations relating to environmental issues are increasing, the need to adopt green practices becomes more relevant. Thus, managers of shipping companies that are more risk averse are more likely to be sensitive towards environmental issues, implementing, in that way, more proactive

[45] For further information please see:

- 'The New York Times' <https://www.nytimes.com/1991/03/13/us/exxon-to-pay-100-million-fine-and-plead-guilty-in-valdez-spill.html> accessed April 2018.
- 'The Guardian' <https://www.theguardian.com/business/2016/jul/14/bp-fined-further-25bn-over-deeepwater-horizon-spill> accessed April 2018.

environmental practices. That in turn, positively influences the mechanism between proactive GSCM strategy and performance improvements. The more averse to risky projects the managers are, and especially to projects that harm the natural environment, the bigger emphasis they will place on environmental conservation and adopt proactive green practices. This will also favour the positive relationship between proactive GSCM implementation and performance improvements. Environmentally risk-averse managers are committed to and support environmental conservation and they enter into more green initiatives, thereby increasing the positive relationship between proactive GSCM strategy and performance improvements, such as environmental and economic performance.

Therefore, these aspects constitute sufficient justifications on how risk aversion influences the strategy-performance relationship and, in theory, further justify the role of risk aversion in environment strategy and performance.

Based on the above, the following hypotheses are proposed:

H3a: The managers' aversion to risk has a positive moderating effect on the relationship between proactive GSCM strategy and environmental performance.

H3b: The managers' aversion to risk has a positive moderating effect on the relationship between proactive GSCM strategy and economic performance.

The conceptual model of this study is shown in figure 4.1.

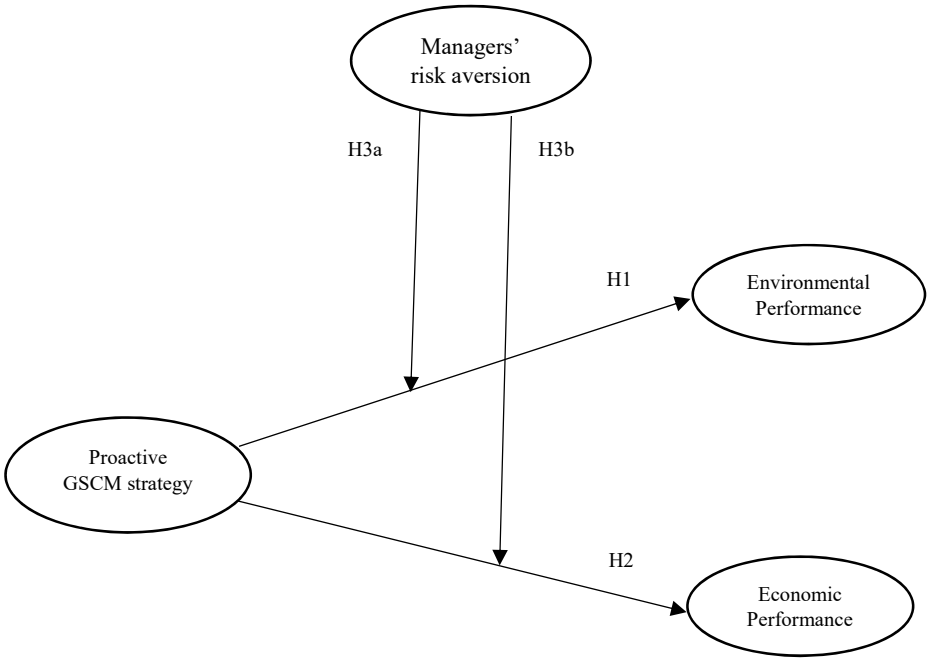


Fig. 4.1. Conceptual model.

4.3. Methodology

4.3.1. Questionnaire development

A survey instrument was developed for collecting data to operationalise the conceptual model. A survey questionnaire is the most appropriate method for collecting this type of data which is not available in any external database.

The survey items of the questionnaire were primarily sourced from the literature. The specific purpose and objectives of the study, however, necessitated the development of a new measurement tool that combines variables from different studies, as presented in section 4.3.3. To examine the scientific validity and reliability of the survey instrument, a draft of the questionnaire was sent to experts from academia, governmental agencies, and the shipping industry who were asked to read and to provide comments and suggestions relating to the measurement items used.

With the completion of the evaluation and improvement process of the questionnaire, the final questionnaire was administered via email to managers/key informants of the sampled shipping companies.

4.3.2. Data and sample characteristics

For the sourcing of more valid and reliable data, the study initially identified and conducted interviews with key persons (key informants), including the president, directors and managers of companies in the shipping industry, and maritime academics who are responsible for and aware of, companies' green strategies. The questionnaire was administered to key informants including president/vice president, manager/assistant manager, director/vice director of companies, who constitute the most knowledgeable parties to answer the questionnaire, and to provide valid and reliable data.

The questionnaire was delivered in one of two ways: it was emailed or dropped off by hand. The sample was selected randomly from Lloyd's List Maritime Intelligence Informa, an online global maritime directory that categorises maritime firms by industry sector.

The survey was administered to a global sample of 570 shipping firms. From the 570 questionnaires, 47 were delivered and collected by hand. From the 523 email questionnaires, the initial email extracted 217 responses. Four weeks later, a second email was sent with a follow-up phone call, asking them to respond to the survey, resulting in 35 additional responses. From the overall 299 responses, 10 were not useable. Thus, the total number of usable responses was 289, giving an overall response rate of 51%.

4.3.3. Measures

This study utilised four constructs that were derived mainly from the related literature. It includes one second order factor, namely the proactive GSCM strategy, which encompasses the practices of internal environmental proactivity, green shipping practices and green marketing, in collaboration with suppliers, customers, and partners. It further includes, two first order factors, namely environmental and economic performance, and finally, one first order factor; namely managers' risk-taking propensity.

For the selection of measurement items used in this study, a primary in-depth and extensive exploratory research was performed on the subject of GSCM. Furthermore, an in-depth study of relevant research papers, books and case studies related to transportation, supply chain management, strategic management, environmental management and strategy, and particularly to GSCM literature, was undertaken. After the selection of the measurement items, the survey questionnaire was constructed by selecting and dropping items, with the help of suggestions and feedback from experienced academics and shipping practitioners. This approach was adopted in order to improve the content validity of this study. In addition, by performing various tests we validated the resulting items to verify their construct validity and reliability (see section 4.4.3).

All the measurement items used in this study for constructing the variables of interest, as shown in Appendix 1, were mainly extracted from the literature (Bowen et al., 2001; Covin and Slevin., 1989; Lai et al., 2011; Shang et al., 2010; Vachon and Klassen, 2008; Yang et al., 2013; Zhu et al., 2007), while some other items used and some changes made on the items, e.g. X1.5b, X1.6a, X16.b, X1.8, X1.10 (see Appendix 1), came mainly from the suggestions of academics and shipping industry's practitioners.

The final measurement items used for evaluating, proactive GSCM practices, environmental and economic performance and managers' risk-taking propensity, (presented in Appendix 1), were scored based on a five-point Likert scale (1= strongly disagree to 5= strongly agree).

4.3.4. Pre-test analysis

After completing the data collection, the next important step was examination of whether there was a non-response bias problem. The responses of the survey came in two waves, thus, there is a need to identify whether there is any indication of a non-response bias between the two groups of respondents.
A comparison of early respondents (first wave of respondents) and late respondents (second wave of respondents), as suggested by Armstrong and Overton (1977), was performed in connection with the test for non-response bias by t-test analysis, in order to be assured that there are no significant differences in the responses between the two groups (Armstrong and Overton, 1977).

Firstly, we divided the 289 survey respondents into two groups, namely, early (n=207), and late (n=82) respondents. Then, we performed an independent sample t-test [46] in order to examine whether a non-response bias problem appears from the data of the two groups.

At the 5% significance level, there were no significant differences between the two groups of respondents. Therefore, the results indicate that non-response bias was not a problem in this study. Accordingly, from the t-test analysis we conclude that there is no statistically significant difference in the responses of the two groups of respondents. Thus, both from the t-test analysis and due to the high response rate, non-response bias was not a problem in our study.

[46] T-test was performed on the data of the agreement level of two groups of the various GSCM practices, environmental and economic performances, and risk-taking variables.

4.3.5. Data Analysis strategy

Structural equation modeling was used to test the various research hypotheses. Firstly, using SPSS 21 for windows, an exploratory factor analysis was performed to identify and extract the key dimensions (components) for the variables GSCM practices, environmental and economic performance, and managers' risk-taking propensity. This is an approach which was first introduced by Anderson and Gerbing, (1988) and since adopted by numerous studies (Yang et al. 2013; Zhu and Sarkis, 2004 and more). Upon completion with the EFA, a two-step method, suggested by Anderson and Gerbing (1988), was used to analyse the data. In the first step, confirmatory factor analysis was performed to verify the factor structure of a set of observed variables produced by the EFA. Once the measurement model was validated, the second step involved estimation of the structural model, using SEM, from the latent variables to determine whether relationships exist between the constructs.

Finally, to examine the moderating effects of managers' risk aversion on the relationship between GSCM strategy and performance measures, we conducted a multi-group analysis in SEM. Firstly, we divided the sample into two groups, namely high risk-averse (n=154), and low risk-averse/risk lovers (n= 135). Multi-group comparisons are a special form of moderation in which a dataset was split with respect to values of a grouping variable (for example, the gender, or the risk-taking propensity in our case), and then a given model was tested with each set of data. The use of multi-group comparisons was to determine if hypothesised relationships in a model will differ, based on the value of the moderator (e.g., risk-taking). To test the moderating effects, the chi-square approach was used to check whether there are significant differences between the two models, baseline and constrained models.
The results and the discussion of the empirical analyses are presented in the following sections.

4.4. Results of empirical analysis

4.4.1. Profile of the respondents

Table 4.1 shows the characteristics of the respondents', such as the company information and the biographical information. With regards to the company information, more than 50% of respondents were local firms, while 44.3% were foreign firms. In addition, more than 30% of the firms had more than 100 shore-based employees, while 29.1%, 27.3%, and 12.5% were firms with 21-50, 1-20, and 51-100 shore-based employees respectively. Almost 70% of the firms had more than 100 employees at sea.
More than 32% of the firms had more than 31 years of establishment, further enhancing the quality and the validity of the survey results.

Table 4.1

Demographics

Characteristics of respondents	Frequency	%
Company information		
Ownership		
Local firm	149	51.6
Foreign firm	128	44.3
Others	12	4.1
Numbers of employee (shore based)		
1-20	79	27.3
21-50	84	29.1
51-100	36	12.5
>100	90	31.1
Numbers of employee (at sea)		
1-20	10	3.5
21-50	25	8.7
51-100	52	18
>100	202	69.9
Headquarters		
EU registered	168	58
Non-EU registered	121	42
Establishment (in years)		
1-10	29	10
11-20	101	34.9
21-30	65	22.5
>31	94	32.5
Biographical information		
Job title		
CEO	16	5.5
Managing director	48	16.6
Department manager/Department director	214	74
Others	11	3.8
Gender		
Male	251	86.9
Female	38	13.1
Education		
Under graduate	20	6.9
Master's degree	197	68.2
Doctorate degree	14	4.8
Others	58	20.1
Age (in years)		
Under 30	5	1.7
30-40	65	22.5
41-50	101	34.9
Above 50	118	40.8
Industry Experience (in years)		
Under 5	3	1
5-10	18	6.2
11-15	28	9.7
16-20	50	17.3
21-25	65	22.5
Above 25	125	43.3
Managerial Experience (in years)		
Under 5	25	8.7
5-10	60	20.8
11-15	71	24.6
16-20	43	14.9
21-25	32	11.1
Above 25	58	20.1

With regards to the biographical information, results show that 5.5% of the questionnaire survey respondents were CEO's, while 16.6%, and 74% were managing directors, and department managers/department directors respectively. Furthermore, respondents were asked to indicate their industry and managerial experience. More than 83% of the respondents have more than 10 years of experience in shipping, while more than 70% of the respondents have more than 10 years of managerial experience.
In conclusion, results in Table 4.1 reveal that 96% of the questionnaire respondents were department managers/department directors or above, leading to further evidence of the potential validity and reliability of the survey findings.

4.4.2. Exploratory factor analysis

Factor analysis is a dimension reduction technique aimed at finding a smaller set of underlying factors from the original variables without losing much information (Hair et al., 2006). Exploratory factor analysis (EFA) is a statistical technique of factor analysis whose main goal is to identify the underlying relationships between measured variables, and thus create the latent unobserved factor variables. The selection of the measurement items, in this study, emanated from different sources, thus we conducted the exploratory factor analysis (EFA), using principal component analysis with varimax rotation, to further confirm and validate the underlying factors. Accordingly, exploratory factor analysis with the use of SPSS' principal component analysis with varimax rotation was employed in order to identify and extract key dimensions for the variables GSCM practices, environmental and economic performance, and managers' risk-taking propensity. The results are indicated in Appendix 2 and 3.

The KMO measure of sampling adequacy (MSA) must exceed 0.50 (Hair et al., 2006). In this study, the KMO that arises from the principal component analysis was 0.908, well above the acceptable value of 0.50. The analysis revealed the underlying nine constructs with eigenvalues greater than 1. According to Hair et al. (2006), factor loadings of 0.50 or greater are considered practically significant; therefore, in this study only variables with a factor loading greater than 0.50 were extracted. Two internal green items, X5b and X6b, do not meet this criterion and were eliminated from this research.

As already mentioned, based on the Kaiser's eigenvalue greater or equal to one criterion, the principal component analysis yielded a nine-factor solution, namely internal environmental proactivity, green shipping practices, and green marketing, collaboration with suppliers, partners and customers, environmental performance, economic performance, and managers' risk-taking propensity (see Appendix 2). The cumulative variance of the nine factors is 63.607%. Accordingly, the results of EFA presented above, showed that all measurement items had strong loading on the construct.

4.4.3. Construct validity and reliability test

Content validity was supported by using previous literature and executive interviews for the development of the questionnaire. After the data collection, further analysis was performed in order to confirm the construct validity and reliability. We performed a reliability test based on Cronbach's alpha to test the constructs' validity and reliability.
The results of the reliability test are shown in Table 4.2. The lower threshold for Cronbach's alpha is 0.60 (Flynn et al., 1990; Nunnally and Bernstein, 1994), but the agreed lower acceptable limit is 0.70 (Flynn et al., 1990). Cronbach's alpha of the nine factors is well above 0.81 and, therefore, well above the limit of 0.70 (Nunnally and Bernstein, 1994). Cronbach's alpha values confirms the reliability of the constructs in this study.

Table 4.2
Reliability test

Measures	Items	Mean	S.D.	Cronbach α	CITC range
19. Internal environmental proactivity	8	3.333	1.369	0.892	0.582-0.931
20. Green shipping practices	5	3.198	1.334	0.845	0.560-0.874
21. Green marketing	6	3.273	1.370	0.878	0.632-0.916
22. Collaboration with suppliers	5	3.298	1.371	0.847	0.590-0.881
23. Collaboration with partners	5	3.316	1.298	0.817	0.539-0.874
24. Collaboration with customers	5	3.229	1.370	0.867	0.618-0.886
25. Environmental performance	6	3.182	1.344	0.859	0.571-0.904
26. Economic performance	5	3.224	1.360	0.851	0.612-0.888
27. Risk taking	6	3.485	1.170	0.869	0.810-0.864

Furthermore, we performed the corrected item-total correlation (CITC) [47] reliability test (Kerlinger, 1986), to test the constructs for internal consistency and validity.

The lower agreed limit of CITC is 0.30 (Ferketich, 1991) while Nunnaly (1978) suggests the exclusion of items with item total correlation values below 0.40. The CITC values of the nine factors were larger than 0.53. Specifically, the CITC of all items ranged from 0.539 to 0.931, all well above the limit of 0.30. Accordingly, based on the Cronbach's alpha and CITC values, we confirm the validity and reliability of the constructs.

4.4.4. Confirmatory factor analysis

Before testing the structural equation model, we conducted a confirmatory factor analysis using the maximum likelihood estimation with SPSS AMOS 21, to verify this factor structure of a set of observed variables which were chosen by the EFA. In a nutshell, this analysis was to determine if the number of factors and the loadings of measured (indicator) variables on them conform to what is expected on the basis of pre-established theory, i.e. how well the theoretical model fits the sample data.

The results of confirmatory factor analysis showed a good fit according to Hu and Bentler (1999) and Kline (1998). The results are summarised in Table 4.3. Based on the results of the various fit indices of the measurement model, we achieved a good fit (Hu and Bentler, 1999). More

[47] The CITC is basically the correlation between an item, or indicator, with the composite score of all other remaining items forming the same set (Shang et al., 2010).

specifically, a value of root means square error of approximation (RMSEA) less than 0.06 (Hu and Bentler, 1999), and a value of CMIN/DF less than 3 (Kline, 1998), are indicative of acceptable model fit.

Table 4.3
Measurement model

Fit indices		
X^2 / d.f. =1.031, RMSEA = 0.010	RMR = 0.078, CFI = 0.996, IFI = 0.996	PRATIO = 0.930, PCFI = 0.927

With respect to absolute fit indices, both the RMSEA value of 0.010 and the CMIN/DF (x^2/df) value of 1.031 are well below the acceptable value. In addition, comparative fit index (CFI) [48] and incremental fit index (IFI) are both 0.996, scores well above the acceptable value of 0.90 (Hair et al., 2010).
Furthermore, the value of root means square residuals (RMR) [49] is 0.078, below the recommended threshold value of 0.10. Overall the results indicate a good fit, thus our measurement model is acceptable and the reliability and unidimensionality are further confirmed.

4.4.5. Construct validity

The construct validity has also been tested by the development of the measurement model. Convergent validity 'relate to the degree to which multiple methods of measuring a variable provide the same results' (Yang et al., 2013). Discriminant validity refers to the degree to which measures of different variables are unrelated, i.e. are unique (Kline, 2011). More specifically, with regards to convergent validity, in our measurement model all the t-values in the Amos output are statistically significant, critical ratios (C.R.) > 1.96, and all the factor loadings of the model were above 0.50 (Kline, 2011). Thus, convergent validity is satisfied. Moreover, the average variance extracted (AVE), of the model was 0.558, a value that exceeds the recommended acceptable limit of AVE > 0.50 (Bagozzi and Yi, 1988), and the construct reliability scores (CR) were above 0.84, all well above the minimum threshold of 0.70 (Nunnally and Bernstein, 1994); consequently, convergent validity is achieved. In regards to the discriminant validity, the average variance extracted (AVE) values of all constructs were larger compared to corresponding squared correlation for each pair of constructs (Fornell and Larcker, 1981). Thus, discriminant validity was also evident. The results are shown in Table 4.4.

[48] According to Hu and Bentler (1999), CFI value of 0.95 or higher is an indicator of good fit.
[49] According to Kline (1998), the minimum acceptable value of RMR is 0.10.

Table 4.4

Construct validity

Item codes	IEP	GSP	GM	CS	CP	CC	EP	ECP
	GSCM							
IEP1	0.998							
IEP2	0.658							
IEP3	0.627							
IEP4	0.681							
IEP5	0.672							
IEP6	0.702							
IEP7	0.713							
IEP8	0.716							
GSP1		0.998						
GSP2		0.644						
GSP3		0.660						
GSP4		0.672						
GSP5		0.696						
GM1			0.995					
GM2			0.729					
GM3			0.696					
GM4			0.670					
GM5			0.733					
GM6			0.685					
CS1				0.998				
CS2				0.662				
CS3				0.707				
CS4				0.651				
CS5				0.679				
CP1					0.995			
CP2					0.632			
CP3					0.666			
CP4					0.615			
CP5					0.657			
CC1						0.991		
CC2						0.728		
CC3						0.717		
CC4						0.697		
CC5						0.671		
EP1							0.998	
EP2							0.628	
EP3							0.707	
EP4							0.646	
EP5							0.699	
EP6							0.670	
ECP1								0.998
ECP2								0.685
ECP3								0.676
ECP4								0.651
ECP5								0.722
Variance extracted	53.14%	55.65%	57.69%	56.38%	52.86%	59.24%	54.08%	57.35%
Construct reliability	89.87%	85.86%	88.89%	86.24%	84.36%	87.66%	87.28%	86.72%

Note: Model's AVE = 0.5580

Upon completion of the analysis of the measurement model and the various validity and reliability tests, we have next tested our hypothesised structural model, to examine whether our various hypotheses are supported or rejected.

4.4.6. Common method bias

Method variance constitutes one of the main sources of measurement error and consequently represented a danger for the validity of the results of the research relations (Podsakoff et al., 2003). Because this study has used a single rater in each company to answer the questionnaire, and according to Podsakoff et al. (2003), one of the main sources of common method bias arises from having a common rater to provide the measure for both independent and dependent variables, this could lead to a common method variance problem (Podsakoff et al., 2003). There exists two primary ways to control common method biases; that is a) the procedural remedies and b) statistical remedies[50]. In this study, both the 'procedural' remedies suggested by Podsakoff et al. (2003), and the statistical approach of Hartman's single factor test for the control and diminishing the common method bias problem (Podsakoff, 1986) were used.

With regards to the procedural remedies, in this study, we protect the confidentiality of the firms' responses. Respondents were assured for the anonymity as well as the confidentiality of the study, based on the procedural remedy 'protecting respondent anonymity and reducing evaluation apprehension' by Podsakoff et al. (2003). Furthermore, they were alerted that there were no right or wrong answers and 'they should answer questions as honestly as possible' (Podsakoff et al., 2003).

Furthermore, 96% of the questionnaire respondents were department managers/department directors or senior employees with more than 10 years of experience in the shipping industry and in managerial positions. Accordingly, the survey respondents' in the present study are the most qualified people to answer the questionnaire. In addition, in-depth and extensive exploratory research in GSCM literature and a careful construction of the items, by providing examples, keeping questions simple and specific, avoiding complicated syntax and more, has been followed for the selection and development of the scale items, based on the procedural remedy 'improving scale items', proposed by Podsakoff et al. (2003).

In regards to the statistical test, this study follows the previous environmental management studies (Lai et al., 2013; Leonidou et al., 2013) and performed the Hartman's single factor test in order to detect if any single factor accounts for the majority of the covariance between the dependent and independent variables (Podsakoff, 1986). The results of the single factor test show that no factor explains more than 30.5% of the variance. In addition, we employed the common latent factor (CLF) test; results showed that the common variance was 0.1%, and the marker variable, a variable not related to any other variable in the model, using the Amos. The results show that by adding the marker variable, the common variance decreased to less than 0.01%. In addition, we tested if a relationship exists between the marker variable and the variables in the model (Lai et al., 2013).

[50] For more information relating to the advantages and disadvantages of these techniques, see the study of Podsakoff et al. (2003).

We found that no significant relationship with any of the variables in the model. Therefore, based on the above procedural and statistical remedies suggested by Podsakoff et al. (2003) and Podsakoff (1986), common method variance is not a problem in this study.

4.4.7. Hypotheses testing

After the assessment of the measurement model and the various validity, reliability and bias tests, we developed the structural model, to test our various research hypotheses. It is important to note that the variables 'firm size' and 'stakeholder pressures', obtained from the literature, are added as control variables.

The overall fit of the final structural model is good with $x^2/df = 1.060$, CFI = 0.991, IFI = 0.991, RMR = 0.08, PRATIO = 0.954, PCFI = 0.946, RMSEA = 0.014.

Table 4.5

SEM results

Measures	Standardize path coefficients	P-value	Results
H1: GSCM strategy → Environmental performance	0.711	0.000	Supported
H2: GSCM strategy → Economic performance	0.756	0.000	Supported

Table 4.6

Results of multi-group analysis – moderating effects of managers' risk aversion

Main effect	Hypothesis description	High risk averse group (n1= 154)	Low risk averse group (n2= 135)	df	$\Delta\chi^2$	p	Hypothesis
	Multi group analysis with risk aversion as moderator						
Constrained path							
GSCM → EP	The managers' aversion to risk has a positive moderating effect on the relationship between GSCM and environmental performance.	β = 0.790 t = 15.947***	β = 0.490 t = 6.502***	1	15.426	<0.001	supported
GSCM → ECP	The managers' aversion to risk has a positive moderating effect on the relationship between GSCM and environmental performance.	β = 0.703 t = 12.232***	β = 0.706 t = 11.541***	1	0.319	>0.05	Not supported

The various hypothesized relationships of the model and the standardized path coefficients, as well as the significance of the hypothesized relationships are shown in Tables 4.5, and 4.6. Findings suggest that the two hypotheses regarding the relationship between proactive GSCM strategy and performance measures are supported. The standardised path coefficients indicate that all of the two

hypotheses, (H_1, H_2), are statistically significant at 0.001 level. More specifically, H_1 can be supported since a positive association was revealed between proactive GSCM strategy and environmental performance (H_1, $\hat{a}_1 = 0.711$, $P < 0.001$). Similarly, H_2 can also be supported by the findings, since positive associations were revealed between proactive GSCM strategy and economic performance (H_2, $\hat{a}_2 = 0.756$, $P < 0.001$).

The results of the various hypotheses relating to the moderating effects are shown in Table 4.6. As mentioned already, we employed multi-group analysis to test the interaction effects of H_{3a} and H_{3b}. We divided the data, using the median split, into two groups, high risk averse group (n=154), versus low risk averse group (n=135). Two separate models were run: 1) a baseline model (where all the parameter estimates varied freely between the two groups), and 2) a constrained model (where the model parameters are constrained to be equal between the two groups). For the proactive GSCM strategy – environmental performance link, the results showed significant differences in χ^2 test between the two models, suggesting that there is a moderating effect on that relationship (H_{3a}, $\Delta\chi^2_{(1)} = 15.426$, $P < 0.001$). Specifically, we find that though under the low managers' risk aversion situation the proactive GSCM strategy positively influence the environmental performance of shipping firms ($\beta = 0.490$, $t = 6.502$, $P < 0.001$), the relationship is stronger under high managers' risk aversion conditions ($\beta = 0.790$, $t = 15.947$, $P < 0.001$). Thus, we show that the more risk averse managers are within shipping firms the relationship between proactive GSCM strategy and environmental performance is stronger. This is because when a manager is averse to taking risks, especially environmental related risks, shipping firms with a proactive environmental philosophy can better reduce such risks by adopting more green practices, and thus making their processes and operations more environmentally friendly.

In the case of H_{3b} (H_{3b}, $\Delta\chi^2_{(1)} = 0.319$, $P > 0.05$), we failed to provide significant support for the moderating effect of managers' risk aversion on the relationship between proactive GSCM strategy and economic performance.

This study empirically supports that shipping firms which implement proactive GSCM strategy have better environmental and economic performance. Furthermore, this study also confirms that the more averse to risk the shipping managers are, the stronger the relationship between proactive GSCM strategy and environmental performance. A fact that does not apply, especially in the relationship between proactive GSCM strategy and economic performance.

Finally, we have considered and controlled for two variables, namely, firm size and stakeholder pressures in the model. Findings revealed that stakeholder pressures have significant positive associations with GSCM strategy ($\beta = 0.268$, $P < 0.001$). This supports further the findings of previous studies in the literature (Zhu et al., 2013, 2005). However, the influence of firm size was not found to have any significant association with environmental and economic performance.

4.5. Discussion and conclusion

The increasing sensitivity in connection to environmental protection, in addition to the increasing trend for undertaking practical measures that will decrease the negative impacts on the environment, has driven the companies to re-assess their strategies, in this way, harmonising their strategies with environmental demands. Recognising the high importance that businesses give to

environmental issues within their supply chain (e.g. customers, partners, and suppliers), shipping firms have increased their efforts to adopt practices which aim for environmental protection.

Given the importance of GSCM practices, it is essential to further improve our understanding of the relationship between GSCM strategy and performance, and to further examine the factors that encourage this relationship.

This study provides a causal model that seeks to examine empirically, how proactive GSCM strategy positively relates to environmental and economic performance of shipping firms. In addition, an innovative aspect of this study is the examination of the role of managers' risk preferences in the proactive GSCM and performance link. This study's results provide empirical evidence of the performance impacts of a proactive GSCM strategy with managers' high and low aversion to risk.

This study's results reiterate the importance in adopting a proactive GSCM strategy that incorporates internal green practices, such as internal environmental proactivity; green shipping practices; green marketing and external green collaborative practices, such as green collaboration with suppliers, partners and customers, for the encouragement of environmental and economic performance of shipping firms (in support of Yang et al. 2013).

The results further show that proactive GSCM strategy has an even more significant positive influence on environmental performance, but not on economic performance of shipping firms, especially when managers are high risk-averse rather than low risk-averse.

As evidenced throughout this study, we do not examine the direct relationship of economic performance and risk aversion. Rather, we examined the interaction effects of risk aversion on the relationship between GSCM and economic performance. However, a possible generic explanation for the lack of the strengthening effect of managers' risk aversion on proactive GSCM strategy and economic performance may be due to the nature of the industry itself. The shipping industry is a high-risk industry. Thus, taking high risks sometimes leads to high returns, which means risk aversion will not necessarily positively influence economic performance in the shipping industry. Furthermore, managers with an environmentally proactive philosophy consider environmental strategies as opportunities rather than threats (Sharma, 2000), and thus are opposed to environmentally risky projects (Stone and Wakefield, 2000). Hence, this aspect confirms the statement that being pro-actively green does not equate to being a risk-taker.

Nevertheless, managers' high aversion to risk was found to further strengthen the relationship between proactive GSCM strategy and environmental performance for shipping firms. This finding is partially consistent with the study of Stone and Wakefield (2000), which asserts that managers who care about the natural environment and place emphasis on environmental conservation are more likely to be averse to environmental related risks. This further increases the sensitisation towards the environment, whilst with a variety of environmental initiatives, and making the firm's systems and operations more environmentally friendly, the relationship between proactive GSCM strategy and environmental performance is further encouraged.

Several theoretical contributions and practical implications from this study are highlighted.

A key contribution of the study is the fact that it is the first to examine the interaction effects of managers' risk-taking propensity on the relationship between proactive GSCM strategy and performance. The results of this study contribute to the GSCM literature by confirming that a proactive GSCM strategy positively and significantly influences environmental and economic performance.

This study contributes to the GSCM literature by introducing a theoretical causal model underlying the positive effects of a proactive GSCM strategy to the environmental and economic performance of shipping firms. It further highlights the important role that managers' preferences play, in connection to the risk attached on GSCM and performance link.

With regards to its practical implications, this study identifies the essential practices needed for successful implementation of a proactive GSCM strategy. Shipping companies are encouraged to adopt GSCM practices that go beyond compliance to existing regulations. Companies' positive performance measures are strengthened when their managers are opposed to risks, and especially to environmental related risks, and have a proactive green philosophy, contrary to others. Shipping companies are encouraged to adopt internal and external proactive green strategies in their supply chain management practices. To achieve performance improvements, it is essential for shipping firms to proactively adopt internal environmental management practices, such as green training programs (Zhu and Sarkis, 2004), environmental certifications (e.g. ISO 14001, 50001), green marketing and green shipping practices (Lai et al., 2013; Yang et al., 2013), as well as green collaborative practices with supply chain members (Vachon and Klassen, 2008; Yang et al., 2013). This shows that shipping firms should not aim to only prioritise the company's success, but go further and achieve the overall success of their supply chain, by working together with their supply chain members and achieving common environmental goals collectively. In addition, managers of shipping firms must be averse to risky projects and be opposed to adopt practices and processes that may generate risks, especially the risk connected to environmental pollution. The more risk averse managers are, the more the relationship is encouraged between proactive GSCM strategy and environmental performance.

Despite the lack of moderate influence of risk aversion on the positive relationship between GSCM and economic performance, it is desirable for managers to be opposed to risks, especially to practices and processes that include environmentally related risks, and to emphasise GSCM practices.

At this point, it is important to mention certain limitations of the present study. First, for the purposes of operationalisation, data was collected specifically from several different shipping firms. A future study could employ a different sample from this or other related industries, to further verify the findings. Second, this study only takes into account one internal factor; that being managers' aversion to risk, acting as moderator on the GSCM-performance path. Future studies could consider alternative internal and external factors acting as moderators on the relationship between GSCM and performance, such as managerial sensitivity to green issues, characteristics such as firms proactive or reactive approach to environmental issues, and external factors such as stakeholder pressures. Third, the examination of factors acting as drivers of managers' risk-aversion, would lead to a better understanding of the mechanism of linking managers' role to

green supply chain strategy formulation and performance. There is a tendency for managers to be more risk-averse after a catastrophic incident occurs. Importantly, after the occurrence of an incident which causes disastrous effects in the market, managers tend to be more risk averse in their strategies, a statement supported in the study of Guiso et al. (2018). They argue that investors' risk aversion increased substantially after the 2008 financial crisis. In another study that examines the risk attitude in the shipping freight market amidst uncertainty, Ishizaka et al. (2018) show that after the Lehman Brothers' bankruptcy and the financial crisis, the average risk attitude of shipping firms tended to be more risk-averse.

In a seminal manner, after the catastrophic consequences (for the environment and firms' economic costs) of various marine accidents (such as the Exxon Valdez, and Torrey Canyon oil spills) and the stricter market and regulatory pressures on shipping firms to perform in a more environmentally friendly way, shipping managers tended to be more risk-averse and adopt more proactive green practices. Although the findings of this study support this argument, it is crucial for future research to consider the factors that drive risk aversion. Such factors may include psychological factors due to fear (e.g. fear of the negative consequences, such as bad reputation and image due to pollution). In addition, it is worth investigating the moderating effects of time varying managers' risk-aversion (e.g. prior and after a major incident, or, prior and after stricter green regulations) and how this affects the relationship between GSCM and performance in shipping.

Finally, from a methodological perspective, alternative methodological approaches could be used to test the moderating effects between the variables. A hierarchical moderated regression analysis might also be an effective method to identify the role of moderating variables on the relationship between GSCM and performance measures.

Conclusion of the thesis

My conclusion reviews the research questions and stresses the importance for shipping companies to adopt GSCM strategy, as much for their performance as for their competitiveness. To this end, I draw attention to the limitations of current GSCM literature, while and the unique conceptual models developed in order to address them.

The main objective of this thesis was to provide comprehensive evidence as to the importance of shipping firms adopting a proactive GSCM strategy. To achieve this, three innovative empirical models were examined: i) the drivers and implications of adopting a proactive GSCM strategy in shipping, ii) the range of GSCM strategy adoption by shipping firms and the resulting effect on financial performance, and finally iii) the moderating role that managers' risk preferences have on the mechanism between proactive GSCM and performance.

The models presented in chapters two, three, and four illustrate the innovation of the research, reiterating the contribution of this study to both theory and practice.

The shipping industry was selected due to the associated stakeholders becoming increasingly aware and concerned with regards to environmental protection, as well as the unique characteristics of the shipping industry, i.e. intense competition, freight volatility, capital intensity, as well as high risk and uncertainty, that influence the performance and competitiveness of firms acting within it.

In chapter two, a unique conceptual model was developed in order to examine the internal drivers of proactive GSCM strategy, namely, resources and capabilities, and the effects of such strategy on the environmental and economic performance and ultimately to the competitive advantage of shipping firms. Structural equation modelling was used to examine the hypothesised relationships between the latent variables of this model. The key aspects that emerged in the development and successful implementation of a proactive GSCM strategy included valuable and unique resources, such as human, financial, and experiential, and capabilities, such as shared vision, stakeholder management, and strategic proactivity. In doing so, this thesis further supports the principles of RBV/NRBV theories.

Chapter three goes a step further by clustering shipping firms according to their choices regarding GSCM strategy and the resulting effects on their financial performance. K-means cluster analysis and ANOVA tests were used to examine the hypothesised relationships between the latent variables of this model. The results categorise shipping firms into three clusters, namely "leaders", "proactive", and "reactive", and conclude that shipping firms within the first two groups enjoy better financial performance. The results of this study are in line with established environmental management literature, (Aragón-Correa et al., 2008; Menguc et al., 2010; Sharma and Vredenburg, 1998), which has previously clustered manufacturing firms according to the levels of environmental strategy adoption, ranging from reactive to proactive, and showing that firms that

adopt proactive environmental management strategies achieve better financial performance. This study confirms these findings for the shipping sector, where proactive GSCM strategy is shown to positively influence the financial performance of shipping firms.

Based on the results of the examinations in chapters two and three, the study in chapter four takes into account a crucial factor influencing the green preferences of shipping firm strategy, namely, managerial propensity for risk-taking. Here, the effect of manager preferences on the relationship between GSCM strategy and performance is provided the attention it deserves, as it is managers who are responsible for implementing, supporting, and committing to company strategies (Kohli and Jaworski, 1990). Multi-group moderation in structural equation modelling is used to examine the hypothesised causal relationships between the latent variables of this model. The findings indicate that the moderating effects of risk-averse managers are positive in the relationship between proactive GSCM and environmental performance. As managers' risk aversion grows, especially regarding projects that involve environmental risk, the bigger the emphasis they will put on environmental conservation, adopting more proactive GSCM practices aimed at preventing pollution. This further enhances the positive relationship between proactive GSCM strategy and environmental performance. This is the first study that examines the moderating role of managers' strategic preferences on the mechanism between GSCM and performance. The results of this study can therefore improve strategic environmental management decisions.

Overall the results of this thesis stress the role of GSCM strategy in the achievement of key business objectives for proactive shipping firms, such as improved performance and competitiveness. Environmentally friendly shipping firms want to provide high-quality services that respect and safeguard the environment, as well as deliver products to people and markets across the globe with the lowest environmental footprint and cost. This in turn will lead to service differentiation and competitive advantages. When shipping firms adopt a proactive GSCM strategy, it is thus a win-win situation both for themselves as well as the environment.

Shipping firms must allocate high-quality human, financial, and experiential resources in order to support proactive green supply chain management strategy. It is also important for managers to develop the relevant capabilities, namely, shared vision, stakeholder management and strategic proactivity. By implementing proactive GSCM practices, shipping firms can reduce the environmental impact from their operations and improve their environmental performance, and at the same time they can improve their economic performance, e.g. through the use of energy efficient systems. This can eventually lead to a competitive advantage.

In terms of practical implications, shipping companies are encouraged to adopt green strategies in their supply chain management proactively, i.e. by implementing more than what is required for basic compliance with laws and regulations. In addition, this study highlights the importance of also going beyond organisational boundaries and setting common environmental goals and objectives with supply chain members. External green collaborative practices ease coordination and collaboration between shipping firms and their supply chain members, so that they can

overcome potential environmental issues more efficiently, thus increasing the service value of the overall supply chain.

Shipping firms must look beyond standalone success and build close collaborative relationships with their supply chain members and set common environmental goals. By sharing resources, skills, and knowledge, shipping firms can overcome potential environmental obstacles and issues in more efficient, integrated ways, achieving in that way the common environmental goals, that is the reduction of their impact to the environment and the increase of the performance of the overall supply chain. It has become very important for shipping firms to succeed at the supply chain level, since this will result in the success at the firm's level (Yang et al., 2013).

It should also be recognised that increasing environmental regulation, the growing market and public drive for environmental protection, as well as intensifying competition make the adoption of proactive green supply chain strategies critical for shipping firms to differentiate their activities from rival firms and improve their performance and competitiveness. Shipping firms that adopt a proactive GSCM strategy offer the same maritime transport services as their reactive counterparts, but with a difference in quality and cost, while also respecting and safeguarding the environment. This leads to service differentiation, performance improvements and, eventually, to competitive advantages.

The results of this thesis are in line with prior GSCM studies (Rao and Holt, 2005; Zhu et al., 2012; Zhu and Sarkis, 2004), which recommend the adoption of GSCM practices as beneficial to the performance and competitiveness of manufacturing firms. This thesis confirms these findings for the shipping sector, where proactive GSCM strategy is shown to positively influence the performance and competitiveness of shipping firms.

The conclusion proves that the basis of this thesis is right, and that the research questions have successfully been answered.

APPENDICES

C2. Appendix 1 (Measurement items)

Prior research on measurement items

Resources	Prior studies
Human Resource Quality	
X1.1. In our company, employees can learn new technologies easily. X1.2. In our company, employees usually provide new ideas. X1.3. In our company, employees possess abilities to use new technologies to solve problems. X1.4. In our company, employees share knowledge with each other.	Lin and Ho (2008)
Financial	
X1.5. We have adequate financial resources available to devote to proactive GSCM activities. X1.6. We have adequate capital resources to devote to this company's proactive GSCM activities. X1.7. The speed of acquiring and deploying financial resources for proactive GSCM is satisfactory. X1.8. We have adequate ability to find additional financial resources for green initiatives when needed.	Leonidou et al. (2013), and Morgan et al. (2004)
Experiential	
X1.9. We have adequate knowledge of the characteristics and trends in our market. X1.10. We have extensive operational expertise in the shipping industry.	Leonidou et al. (2013)
Capabilities	
Shared vision	
X2.1. Our company's environmental objectives are well-known to all employees. X2.2. All our employees make significant efforts to reach the firm's environmental objectives. X2.3. Employees often offer valuable ideas for improving firm's abilities to achieve its environmental objectives.	Aragón-Correa et al., (2008), and Leonidou et al. (2013)
Stakeholder management	
X2.4. We fully understand customer requirements regarding environmental issues. X2.5. We fully understand requirements of other stakeholders regarding environmental issues. X2.6. We fully establish and maintain close relationships with suppliers regarding environmental issues. X2.7. We establish and maintain close collaborations with internal/external strategic partners regarding environmental issues.	Aragón-Correa et al., (2008), and Leonidou et al. (2013)
Strategic proactivity	
X2.8. The field within which the firm currently conducts our business is narrow (related areas with prospect of change). X2.9. The field within which the firm currently conducts our business is broad (diversified and continuing to develop).	Aragón-Correa et al., (2008)

X2.10. Our main focus of concern in relation to the company's technological process is having cost-efficient technologies. X2.11. Our main focus of concern in relation to the company's technological process is having flexible and innovative technologies. X2.12. Planning in our company is tremendously rigorous and predetermined. X2.13. Planning in our company is tremendously open and flexible to allow us to seize new opportunities.	
Internal GSCM practices	
Internal environmental proactivity	
Y1.1. We always attempt to go beyond basic compliance with laws and regulations on environmental issues. Y1.2. We commit ourselves to support GSCM. Y1.3. In our company cross-functional cooperation effectively supports green operations. Y1.4. We provide green education and training. Y1.5a. We are committed and we have obtain the ISO 14000 certification. Y1.5b. We have been committed and we are in the process to obtain the ISO 14000 certification. Y1.6a. We are committed and we have obtain the ISO 50001 certification. Y1.6b. We have been committed and we are in the process to obtain the ISO 50001 certification. Y1.7. We effectively manage the environmental risks affecting our business. Y1.8. It is a priority that the ships we order/trade/operate are environmental friendly (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank).	Bowen et al., (2001), Yang et al., (2013) and Zhu et al., (2007)
Green shipping practices	
Y1.9. We mainly use environmental-friendly materials and equipment (e.g. non-toxic paint, electric deck machine). Y1.10. We mainly use environmental-friendly materials and equipment such as Ballast Water Handling System. Y1.11. We mainly use clean-burning, low-sulphur fuels for main and auxiliary engines. Y1.12. We adopt optimal vessel speed and routing system. Y1.13. We promote the environmental-friendly recycling of scrap ships.	Lai et al., (2011) and Yang et al., (2013)
Green marketing	
Y1.14. We provide customers with information regarding our environmental-friendly practices through our website or other means. Y1.15. We intend to increase the budget allocated on green advertising within next year. Y1.16. We adopt the notion of resource and energy conservation in promotion. Y1.17. We use environmental friendly arguments in our marketing strategy. Y1.18. We regularly update environmental conservation information in our firm's Website. Y1.19. We often attract customers with green initiatives and eco-service.	Shang et al., (2010) and Yang et al., (2013)
External Green practices	

Green collaboration with suppliers	
Y2.1. We achieve common environmental goals collectively with suppliers. Y2.2. We develop a mutual understanding of environmental risk and responsibilities with suppliers. Y2.3. We work together with suppliers to reduce environmental impact from operations. Y2.4. We make plans to resolve GSCM related problems with suppliers. Y2.5. We provide resources, skills, and knowledge to strengthen GSCM along with our suppliers.	Vachon and Klassen, (2008) and Yang et al. (2013)
Green collaboration with partners	
Y2.6. We achieve common environmental goals collectively with partners. Y2.7. We develop a mutual understanding of environmental risk and responsibilities with partners. Y2.8. We work together with partners to reduce environmental impact from operations. Y2.9. We make plans to resolve GSCM related problems with partners. Y2.10. We provide resources, skills, and knowledge to strengthen GSCM along with our partners.	Vachon and Klassen, (2008) and Yang et al. (2013)
Green collaboration with customers	
Y2.11. We achieve common environmental goals collectively with customers. Y2.12. We develop a mutual understanding of environmental risk and responsibilities with customers. Y2.13. We work together with customers to reduce environmental impact from operations. Y2.14. We make plans to resolve GSCM related problems with customers. Y2.15. We provide resources, skills, and knowledge to strengthen GSCM along with our customers.	Vachon and Klassen, (2008) and Yang et al. (2013)
Environmental performance	
Y3.1. Reduction of greenhouse gases (e.g. CO2, SOx, NOx...). Y3.2. Reduction of waste water (e.g. sewage). Y3.3. Reduction of noise pollution. Y3.4. Reduction of wastes (e.g. oily waste, sludge and rubbish). Y3.5. Reduction of consumption of hazardous/ harmful/ toxic materials. Y3.6. Reduction of frequency for environmental accidents.	Yang et al. (2013), and Zhu et al. (2007)
Economic performance	
Y3.7. Decrease of cost for materials purchasing. Y3.8. Decrease of cost for energy consumption. Y3.9. Decrease of cost for disposal of hazardous materials. Y3.10. Decrease of fee for waste treatment. Y3.11. Decrease of fine for environmental accidents.	Yang et al. (2013), and Zhu et al. (2007)
Competitive advantage	
Y4.1. Being environmentally conscious can lead to substantial cost advantages for our company. Y4.2. Our company has realized significant cost savings by improving the environmental quality of our services.	Banerjee et al. (2003), and Yang et al. (2013)

Y4.3 .By regularly investing in new eco-friendly technologies, processes and strategies, our company can be a leader in the market.	
Y4.4. Our company can enter lucrative new markets by adopting proactive GSCM strategies.	
Y4.5. Our company can increase service quality by making its current operations more environmentally friendly.	
Y4.6. Reducing the negative environmental impact of our company's activities will lead to a quality improvement in its services.	
Y4.7. Corporate image improvements.	
Y4.8. Customer satisfaction increases.	
Y4.9. Productivity increases.	
Y4.10 Higher profits.	

C2. Appendix 2 (Principal component analysis)

Resources	F12	F13	F15
X1.1. In our company, employees can learn new technologies easily.	**0.661**		
X1.2. In our company, employees usually provide new ideas.	**0.553**		
X1.3. In our company, employees possess abilities to use new technologies to solve problems.	**0.758**		
X1.4. In our company, employees share knowledge with each other.	**0.674**		
X1.5. We have adequate financial resources available to devote to proactive GSCM activities.		**0.721**	
X1.6. We have adequate capital resources to devote to this company's proactive GSCM activities.		**0.667**	
X1.7. The speed of acquiring and deploying financial resources for proactive GSCM is satisfactory.		**0.643**	
X1.8. We have adequate ability to find additional financial resources for green initiatives when needed.		**0.639**	
X1.9. We have adequate knowledge of the characteristics and trends in our market.			**0.601**
X1.10. We have extensive operational expertise in the shipping industry.			**0.842**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 8 iterations.

Capabilities	F2	F10	F14
X2.1. Our company's environmental objectives are well-known to all employees.			**0.638**
X2.2. All our employees make significant efforts to reach the firm's environmental objectives.			**0.617**
X2.3. Employees often offer valuable ideas for improving firm's abilities to achieve its environmental objectives.			**0.706**
X2.4. We fully understand customer requirements regarding environmental issues.		**0.690**	
X2.5. We fully understand requirements of other stakeholders regarding environmental issues.		**0.665**	
X2.6. We fully establish and maintain close relationships with suppliers regarding environmental issues.		**0.681**	
X2.7. We establish and maintain close collaborations with internal/external strategic partners regarding environmental issues.		**0.696**	
X2.8. The field within which the firm currently conducts our business is narrow (related areas with prospect of change).	**0.729**		
X2.9. The field within which the firm currently conducts our business is broad (diversified and continuing to develop).	**0.781**		
X2.10. Our main focus of concern in relation to the company's technological process is having cost-efficient technologies.	**0.766**		
X2.11. Our main focus of concern in relation to the company's technological process is having flexible and innovative technologies.	**0.810**		
X2.12. Planning in our company is tremendously rigorous and predetermined.	**0.702**		
X2.13. Planning in our company is tremendously open and flexible to allow us to seize new opportunities.	**0.753**		

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 8 iterations.

GSCM practices	F1	F5	F6	F7	F8	F11
Y1.1. We always attempt to go beyond basic compliance with laws and regulations on environmental issues.	**0.818**					
Y1.2. We commit ourselves to support GSCM.	**0.679**					
Y1.3. In our company cross-functional cooperation effectively supports green operations.	**0.620**					
Y1.4. We provide green education and training.	**0.648**					
Y1.5. We are committed and we have obtain the ISO 14000 certification.	**0.630**					
Y1.6. We are committed and we have obtain the ISO 50001 certification.	**0.672**					
Y1.7. We effectively manage the environmental risks affecting our business.	**0.719**					
Y1.8. It is a priority that the ships we order/trade/operate are environmental friendly (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank).	**0.637**					
Y1.9. We mainly use environmental-friendly materials and equipment (e.g. non-toxic paint, electric deck machine).			**0.789**			
Y1.10. We mainly use environmental-friendly materials and equipment such as Ballast Water Handling System.			**0.637**			
Y1.11. We mainly use clean-burning, low-sulphur fuels for main and auxiliary engines.			**0.708**			
Y1.12. We adopt optimal vessel speed and routing system.			**0.669**			
Y1.13. We promote the environmental-friendly recycling of scrap ships.			**0.722**			
Y1.14. We provide customers with information regarding our environmental-friendly practices through our website or other means.		**0.748**				
Y1.15. We intend to increase the budget allocated on green advertising within next year.		**0.589**				
Y1.16. We adopt the notion of resource and energy conservation in promotion.		**0.650**				
Y1.17. We use environmental friendly arguments in our marketing strategy.		**0.669**				
Y1.18. We regularly update environmental conservation information in our firm's Website.		**0.612**				
Y1.19. We often attract customers with green initiatives and eco-service.		**0.613**				
Y2.1. We achieve common environmental goals collectively with suppliers.					**0.717**	
Y2.2. We develop a mutual understanding of environmental risk and responsibilities with suppliers.					**0.632**	
Y2.3. We work together with suppliers to reduce environmental impact from operations.					**0.695**	
Y2.4. We make plans to resolve GSCM related problems with suppliers.					**0.615**	
Y2.5. We provide resources, skills, and knowledge to strengthen GSCM along with our suppliers.					**0.650**	
Y2.6. We achieve common environmental goals collectively with partners.						**0.704**
Y2.7. We develop a mutual understanding of environmental risk and responsibilities with partners.						**0.607**
Y2.8. We work together with partners to reduce environmental impact from operations.						**0.695**
Y2.9. We make plans to resolve GSCM related problems with partners.						**0.575**
Y2.10. We provide resources, skills, and knowledge to strengthen GSCM along with our partners.						**0.462**
Y2.11. We achieve common environmental goals collectively with customers.				**0.751**		
Y2.12. We develop a mutual understanding of environmental risk and responsibilities with customers.				**0.657**		
Y2.13. We work together with customers to reduce environmental impact from operations.				**0.721**		

Y2.14. We make plans to resolve GSCM related problems with customers.	**0.658**
Y2.15. We provide resources, skills, and knowledge to strengthen GSCM along with our customers.	**0.673**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 8 iterations.

Performance	**F4**	**F9**
Y3.1. Reduction of greenhouse gases (e.g. CO2, SOx, NOx...).	**0.792**	
Y3.2. Reduction of waste water (e.g. sewage).	**0.677**	
Y3.3. Reduction of noise pollution.	**0.702**	
Y3.4. Reduction of wastes (e.g. oily waste, sludge and rubbish).	**0.603**	
Y3.5. Reduction of consumption of hazardous/ harmful/ toxic materials.	**0.649**	
Y3.6. Reduction of frequency for environmental accidents.	**0.635**	
Y3.7. Decrease of cost for materials purchasing.		**0.723**
Y3.8. Decrease of cost for energy consumption.		**0.645**
Y3.9. Decrease of cost for disposal of hazardous materials.		**0.621**
Y3.10. Decrease of fee for waste treatment.		**0.716**
Y3.11. Decrease of fine for environmental accidents.		**0.614**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 8 iterations.

Competitive advantage	**F3**
Y4.1. Being environmentally conscious can lead to substantial cost advantages for our company.	**0.863**
Y4.3. By regularly investing in new eco-friendly technologies, processes and strategies, our company can be a leader in the market.	**0.649**
Y4.4. Our company can enter lucrative new markets by adopting proactive GSCM strategies.	**0.669**
Y4.5. Our company can increase service quality by making its current operations more environmentally friendly.	**0.649**
Y4.6. Reducing the negative environmental impact of our company's activities will lead to a quality improvement in its services.	**0.666**
Y4.9. Productivity increases.	**0.701**
Y4.10. Higher profits	**0.703**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.a

a. Rotation converged in 8 iterations.

C2. Appendix 3 (KMO Test)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.928
Bartlett's Test of Sphericity	Approx. Chi-Square	14871.819
	Df	2775
	Sig.	0.000

C2. Appendix 4 (Total Variance explained)

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	24.092	32.122	32.122	24.092	32.122	32.122	5.164	6.885	6.885
2	3.113	4.150	36.272	3.113	4.150	36.272	4.742	6.322	13.207
3	2.795	3.726	39.999	2.795	3.726	39.999	4.376	5.834	19.042
4	2.635	3.513	43.512	2.635	3.513	43.512	4.039	5.386	24.427
5	2.245	2.993	46.505	2.245	2.993	46.505	3.951	5.268	29.695
6	2.056	2.742	49.246	2.056	2.742	49.246	3.616	4.821	34.516
7	1.891	2.521	51.768	1.891	2.521	51.768	3.511	4.681	39.197
8	1.860	2.481	54.248	1.860	2.481	54.248	3.389	4.519	43.716
9	1.655	2.206	56.454	1.655	2.206	56.454	3.342	4.455	48.172
10	1.564	2.085	58.540	1.564	2.085	58.540	2.807	3.742	51.914
11	1.443	1.924	60.464	1.443	1.924	60.464	2.742	3.656	55.569
12	1.404	1.873	62.336	1.404	1.873	62.336	2.608	3.477	59.046
13	1.376	1.834	64.171	1.376	1.834	64.171	2.568	3.424	62.470
14	1.200	1.600	65.771	1.200	1.600	65.771	1.964	2.619	65.089
15	1.078	1.437	67.208	1.078	1.437	67.208	1.589	2.119	67.208

C3. Appendix 1 (Measurement items)

Prior research on measurement items

Internal green practices	Prior studies
Internal environmental proactivity	
X1.1. We always attempt to go beyond basic compliance with laws and regulations on environmental issues.	Bowen et al., (2001), Yang et al., (2013) and Zhu et al., (2007)
X1.2. We commit ourselves to support GSCM.	
X1.3. In our company cross-functional cooperation effectively supports green operations.	
X1.4. We provide green education and training.	
X1.5a. We are committed and we have obtain the ISO 14000 certification.	
X1.5b. We have been committed and we are in the process to obtain the ISO 14000 certification.	
X1.6a. We are committed and we have obtain the ISO 50001 certification.	
X1.6b. We have been committed and we are in the process to obtain the ISO 50001 certification.	
X1.7. We effectively manage the environmental risks affecting our business.	
X1.8. It is a priority that the ships we order/trade/operate are environmental friendly (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank).	
Green shipping practices	

X1.9. We mainly use environmental-friendly materials and equipment (e.g. non-toxic paint, electric deck machine).	Lai et al., (2011) and Yang et al., (2013)
X1.10. We mainly use environmental-friendly materials and equipment such as Ballast Water Handling System.	
X1.11. We mainly use clean-burning, low-sulphur fuels for main and auxiliary engines.	
X1.12. We adopt optimal vessel speed and routing system.	
X1.13. We promote the environmental-friendly recycling of scrap ships.	
Green marketing	
X1.14. We provide customers with information regarding our environmental-friendly practices through our website or other means.	Shang et al., (2010) and Yang et al., (2013)
X1.15. We intend to increase the budget allocated on green advertising within next year.	
X1.16. We adopt the notion of resource and energy conservation in promotion.	
X1.17. We use environmental friendly arguments in our marketing strategy.	
X1.18. We regularly update environmental conservation information in our firm's Website.	
X1.19. We often attract customers with green initiatives and eco-service.	
External Green practices	
Green collaboration with suppliers	
X2.1. We achieve common environmental goals collectively with suppliers.	Vachon and Klassen, (2008) and Yang et al. (2013)
X2.2. We develop a mutual understanding of environmental risk and responsibilities with suppliers.	
X2.3. We work together with suppliers to reduce environmental impact from operations.	
X2.4. We make plans to resolve GSCM related problems with suppliers.	
X2.5. We provide resources, skills, and knowledge to strengthen GSCM along with our suppliers.	
Green collaboration with partners	
X2.6. We achieve common environmental goals collectively with partners.	Vachon and Klassen, (2008) and Yang et al. (2013)
X2.7. We develop a mutual understanding of environmental risk and responsibilities with partners.	
X2.8. We work together with partners to reduce environmental impact from operations.	
X2.9. We make plans to resolve GSCM related problems with partners.	
X2.10. We provide resources, skills, and knowledge to strengthen GSCM along with our partners.	
Green collaboration with customers	
X2.11. We achieve common environmental goals collectively with customers.	Vachon and Klassen, (2008) and Yang et al. (2013)
X2.12. We develop a mutual understanding of environmental risk and responsibilities with customers.	
X2.13. We work together with customers to reduce environmental impact from operations.	

X2.14. We make plans to resolve GSCM related problems with customers.	
X2.15. We provide resources, skills, and knowledge to strengthen GSCM along with our customers.	
Financial performance	
Y1. Increase of profitability.	Judge and Douglas, (1998); Panayides, (2003) and Rao and Holt, (2005)
Y2. Sales growth.	
Y3. Increase of ROI.	

C3. Appendix 2 (Cluster analysis)

Final cluster centers.

Variable	Cluster		
	1	2	3
We always attempt to go beyond basic compliance with laws and regulations on environmental issues.	4.25	3.82	2.11
We commit ourselves to support GSCM.	3.79	3.68	2.13
In our company cross-functional cooperation effectively supports green operations.	3.93	3.77	2.48
We provide green education and training.	3.93	3.50	2.03
We are committed and we have obtain the ISO 14000 certification.	3.90	3.73	2.20
We are committed and we have obtain the ISO 50001 certification.	3.84	3.63	2.07
We effectively manage the environmental risks affecting our business.	3.86	3.71	1.99
We mainly use environmental-friendly materials and equipment (e.g. non-toxic paint, electric deck machine).	4.11	3.13	2.36
We mainly use environmental-friendly materials and equipment such as Ballast Water Handling System.	3.59	3.10	2.33
We mainly use clean-burning, low-sulphur fuels for main and auxiliary engines.	3.76	2.97	2.29
We adopt optimal vessel speed and routing system.	3.77	2.98	2.08
We promote the environmental-friendly recycling of scrap ships.	3.87	3.13	2.41
We provide customers with information regarding our environmental-friendly practices through our website or other means.	4.31	2.84	2.37
We intend to increase the budget allocated on green advertising within next year.	4.11	2.77	2.26
We adopt the notion of resource and energy conservation in promotion.	3.98	2.81	2.31
We use environmental friendly arguments in our marketing strategy.	4.07	2.50	2.51
We regularly update environmental conservation information in our firm's Website.	4.08	2.58	2.28
We often attract customers with green initiatives and eco-service.	4.03	2.63	2.45
It is a priority that the ships we order/trade/operate are environmental friendly (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank).	3.97	3.68	1.90
We achieve common environmental goals collectively with suppliers.	4.28	3.15	2.34
We develop a mutual understanding of environmental risk and responsibilities with suppliers.	3.91	2.98	2.43
We work together with suppliers to reduce environmental impact from operations.	3.97	3.00	2.40
We make plans to resolve GSCM related problems with suppliers.	3.86	3.06	2.21
We provide resources, skills, and knowledge to strengthen GSCM along with our suppliers.	4.02	3.13	2.22
We achieve common environmental goals collectively with partners.	4.13	3.21	2.39
We develop a mutual understanding of environmental risk and responsibilities with partners.	3.82	2.92	2.38
We work together with partners to reduce environmental impact from operations.	3.74	3.39	2.30
We make plans to resolve GSCM related problems with partners.	3.93	3.23	2.55
We provide resources, skills, and knowledge to strengthen GSCM along with our partners.	4.16	2.92	2.47
We achieve common environmental goals collectively with customers.	4.29	2.65	2.31
We develop a mutual understanding of environmental risk and responsibilities with customers.	4.10	2.71	2.22
We work together with customers to reduce environmental impact from operations.	4.01	2.68	2.41
We make plans to resolve GSCM related problems with customers.	4.04	2.68	2.34
We provide resources, skills, and knowledge to strengthen GSCM along with our customers.	3.92	2.40	2.25

Notes: The final cluster centers are computed as the mean for each variable within each final cluster. The final cluster centers reflect the characteristics of the typical case for each cluster. Note that cluster 1 has the highest values in all the variables, followed by cluster 2, and cluster 3 following. The smallest difference in clusters 2 and 3 located on variables "We use environmental

friendly arguments in our marketing strategy", "We provide resources, skills, and knowledge to strengthen GSCM along with our customers", "We often attract customers with green initiatives and eco-service", "We work together with customers to reduce environmental impact from operations", "We regularly update environmental conservation information in our firm's Website", "We achieve common environmental goals collectively with customers" and "We make plans to resolve GSCM related problems with customers".

C3. Appendix 3 (Normality test)

P-values of the Kolmogorov-Smirnov test of normality for the variables "Increase of profitability", "Sales growth" and "Increase of ROI".

	Leaders	Proactive	Reactive
Increase of profitability	0.000	0.000	0.000
Sales growth	0.000	0.000	0.000
Increase of ROI	0.000	0.000	0.000

C3. Appendix 4 (Homogeneity of variance test)

Levene test of homogeneity of variances for variables "Increase of profitability", "Sales growth" and "Increase of ROI".

	Levene Statistic	Sig.
Increase of profitability	22.885	0.000
Sales growth	0.739	0.479
Increase of ROI	4.148	0.017

C3. Appendix 5 (Summary statistics)

Summary statistics for variables "Increase of profitability", "Sales growth" and "Increase of ROI".

	Cluster	N	Mean	Std. Dev.	Std. Error	Minimum	Maximum
Increase of profitability	Leaders	140	4.250	0.858	0.072	2	5
	Proactive	62	3.823	0.840	0.107	2	5
	Reactive	87	2.115	0.559	0.060	1	3
Sales growth	Leaders	140	4.079	0.945	0.080	1	5
	Proactive	62	3.774	1.062	0.135	1	5
	Reactive	87	2.195	0.950	0.102	1	4
Increase of ROI	Leaders	140	4.107	1.064	0.090	1	5
	Proactive	62	3.742	1.039	0.132	2	5
	Reactive	87	2.092	0.858	0.092	1	4

C4. Appendix 1 (Measurement items)

Prior research on measurement items

GSCM practices	Prior studies
Internal GSCM practices	
Internal environmental proactivity	
X1.1. We always attempt to go beyond basic compliance with laws and regulations on environmental issues.	Bowen et al., (2001), Yang et al., (2013) and Zhu et al., (2007)
X1.2. We commit ourselves to support GSCM.	
X1.3. In our company cross-functional cooperation effectively supports green operations.	
X1.4. We provide green education and training.	
X1.5a. We are committed, and we have obtain the ISO 14000 certification.	
X1.5b. We have been committed and we are in the process to obtain the ISO 14000 certification.	

X1.6a. We are committed, and we have obtain the ISO 50001 certification. X1.6b. We have been committed and we are in the process to obtain the ISO 50001 certification. X1.7. We effectively manage the environmental risks affecting our business. X1.8. It is a priority that the ships we order/trade/operate are environmental friendly (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank).	
Green shipping practices	
X1.9. We mainly use environmental-friendly materials and equipment (e.g. non-toxic paint, electric deck machine). X1.10. We mainly use environmental-friendly materials and equipment such as Ballast Water Handling System. X1.11. We mainly use clean-burning, low-sulphur fuels for main and auxiliary engines. X1.12. We adopt optimal vessel speed and routing system. X1.13. We promote the environmental-friendly recycling of scrap ships.	Lai et al., (2011) and Yang et al., (2013)
Green marketing	
X1.14. We provide customers with information regarding our environmental-friendly practices through our website or other means. X1.15. We intend to increase the budget allocated on green advertising within next year. X1.16. We adopt the notion of resource and energy conservation in promotion. X1.17. We use environmental friendly arguments in our marketing strategy. X1.18. We regularly update environmental conservation information in our firm's Website. X1.19. We often attract customers with green initiatives and eco-service.	Shang et al., (2010) and Yang et al., (2013)
External Green practices	
Green collaboration with suppliers	
X2.1. We achieve common environmental goals collectively with suppliers. X2.2. We develop a mutual understanding of environmental risk and responsibilities with suppliers. X2.3. We work together with suppliers to reduce environmental impact from operations. X2.4. We make plans to resolve GSCM related problems with suppliers. X2.5. We provide resources, skills, and knowledge to strengthen GSCM along with our suppliers.	Vachon and Klassen, (2008) and Yang et al. (2013)
Green collaboration with partners	
X2.6. We achieve common environmental goals collectively with partners. X2.7. We develop a mutual understanding of environmental risk and responsibilities with partners. X2.8. We work together with partners to reduce environmental impact from operations. X2.9. We make plans to resolve GSCM related problems with partners.	Vachon and Klassen, (2008) and Yang et al. (2013)

X2.10. We provide resources, skills, and knowledge to strengthen GSCM along with our partners.	
Green collaboration with customers	
X2.11. We achieve common environmental goals collectively with customers. X2.12. We develop a mutual understanding of environmental risk and responsibilities with customers. X2.13. We work together with customers to reduce environmental impact from operations. X2.14. We make plans to resolve GSCM related problems with customers. X2.15. We provide resources, skills, and knowledge to strengthen GSCM along with our customers.	Vachon and Klassen, (2008) and Yang et al. (2013)
Environmental performance	
Y3.1. Reduction of greenhouse gases (e.g. CO2, SOx, NOx...). Y3.2. Reduction of waste water (e.g. sewage). Y3.3. Reduction of noise pollution. Y3.4. Reduction of wastes (e.g. oily waste, sludge and rubbish). Y3.5. Reduction of consumption of hazardous/ harmful/ toxic materials. Y3.6. Reduction of frequency for environmental accidents.	Yang et al. (2013), and Zhu et al. (2007)
Economic performance	
Y3.7. Decrease of cost for materials purchasing. Y3.8. Decrease of cost for energy consumption. Y3.9. Decrease of cost for disposal of hazardous materials. Y3.10. Decrease of fee for waste treatment. Y3.11. Decrease of fine for environmental accidents.	Yang et al. (2013), and Zhu et al. (2007)

C4. Appendix 2 (Principal component analysis)

GSCM practices	F1	F2	F3	F4	F5	F6	F7	F8	F9
IEP1. We always attempt to go beyond basic compliance with laws and regulations on environmental issues.	**0.853**								
IEP2. We commit ourselves to support GSCM.	**0.687**								
IEP3. In our company cross-functional cooperation effectively supports green operations.	**0.652**								
IEP4. We provide green education and training.	**0.649**								
IEP5. We are committed and we have obtain the ISO 14000 certification.	**0.666**								
IEP6. We are committed and we have obtain the ISO 50001 certification.	**0.680**								
IEP7. We effectively manage the environmental risks affecting our business.	**0.737**								
IEP8. It is a priority that the ships we order/trade/operate are environmental friendly.	**0.685**								
GSP1. We mainly use environmental-friendly materials and equipment.					**0.795**				
GSP2. We mainly use environmental-friendly materials and equipment such as Ballast Water Handling System.					**0.635**				
GSP3. We mainly use clean-burning, low-sulphur fuels for main and auxiliary engines.					**0.701**				
GSP4. We adopt optimal vessel speed and routing system.					**0.653**				
GSP5. We promote the environmental-friendly recycling of scrap ships.					**0.735**				
GM1. We provide customers with information regarding our environmental-friendly practices through our website or other means.			**0.782**						
GM2. We intend to increase the budget allocated on green advertising within next year.			**0.648**						
GM3. We adopt the notion of resource and energy conservation in promotion.			**0.667**						
GM4. We use environmental friendly arguments in our marketing strategy.			**0.668**						
GM5. We regularly update environmental conservation information in our firm's Website.			**0.649**						
GM6. We often attract customers with green initiatives and eco-service.			**0.645**						
CS1. We achieve common environmental goals collectively with suppliers.								**0.739**	
CS2. We develop a mutual understanding of environmental risk and responsibilities with suppliers.								**0.630**	
CS3. We work together with suppliers to reduce environmental impact from operations.								**0.699**	
CS4. We make plans to resolve GSCM related problems with suppliers.								**0.668**	
CS5. We provide resources, skills, and knowledge to strengthen GSCM along with our suppliers.								**0.664**	
CP1. We achieve common environmental goals collectively with partners.									**0.735**
CP2. We develop a mutual understanding of environmental risk and responsibilities with partners.									**0.629**
CP3. We work together with partners to reduce environmental impact from operations.									**0.689**
CP4. We make plans to resolve GSCM related problems with partners.									**0.627**
CP5. We provide resources, skills, and knowledge to strengthen GSCM along with our partners.									**0.500**
CC1. We achieve common environmental goals collectively with customers.						**0.772**			
CC2. We develop a mutual understanding of environmental risk and responsibilities with customers.						**0.697**			
CC3. We work together with customers to reduce environmental impact from operations.						**0.679**			
CC4. We make plans to resolve GSCM related problems with customers.						**0.699**			
CC5. We provide resources, skills, and knowledge to strengthen GSCM along with our customers.						**0.655**			
Performance									
EP1. Reduction of greenhouse gases (e.g. CO2, SOx, NOx...).		**0.817**							
EP2. Reduction of waste water (e.g. sewage).		**0.704**							
EP3. Reduction of noise pollution.		**0.713**							
EP4. Reduction of wastes (e.g. oily waste, sludge and rubbish).		**0.591**							
EP5. Reduction of consumption of hazardous/ harmful/ toxic materials.		**0.680**							
EP6. Reduction of frequency for environmental accidents.		**0.676**							
ECP1. Decrease of cost for materials purchasing.							**0.750**		
ECP2. Decrease of cost for energy consumption.							**0.664**		
ECP3. Decrease of cost for disposal of hazardous materials.							**0.621**		
ECP4. Decrease of fee for waste treatment.							**0.748**		
ECP5. Decrease of fine for environmental accidents.							**0.626**		
Risk taking propensity									
RT1. In general we have a strong proclivity for low-risk projects.				**0.923**					
RT2. In general we have a strong proclivity for high-risk projects.				**0.722**					
RT3. In general we believe that owing to the nature of the environment, it is best to explore it gradually via timid, incremental behavior.				**0.820**					
RT4. In general we believe that owing to the nature of the environment, bold, wide-ranging acts are necessary to achieve the company's objectives.				**0.647**					
RT5. When confronted with decision-making situations involving uncertainty, we typically adopt a cautious, 'wait-and-see' posture in order to minimize the probability of making costly decisions.				**0.841**					
RT6. When confronted with decision-making situations involving uncertainty, we typically adopt a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.				**0.696**					

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 8 iterations.

C4. Appendix 3 (KMO Test)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.908
Bartlett's Test of Sphericity	Approx. Chi-Square	9473.521
	df	1275
	Sig.	0.000

Survey Questionnaire on Green Supply Chain Management (GSCM) in the Shipping Industry

Conducted by

Department of Commerce, Finance and Shipping
The Cyprus University of Technology

Aim of the survey questionnaire:

We are conducting a short survey on the topic of green supply chain management (GSCM) in the shipping industry, and we are asking for your participation in this important research project which is a part of a PhD thesis. We are particularly interested in trying to understand whether or not proactive GSCM practices positively impact on the performance and competitiveness of shipping firms.

This survey is being conducted by the Department of Commerce, Finance and Shipping at the Cyprus University of Technology. Only companies operating in the shipping industry are invited to participate in this important survey thus your response is very important to our research team.

We understand that you are extremely busy and, therefore, have tried to make the survey as short as possible and easy to fill out. The survey should take 10-15 minutes to fill out. **All your responses will remain strictly confidential.**
Neither the respondent nor their company will be identified at any stage of the analysis, nor in any publication of results.

1. Please answer all the questions with the most appropriate answers.
2. Please be reminded that the questionnaire can be answered by CEO, Managing director, or Department Director/Department manager.

Should you have any questions about this survey, or need additional information, please do not hesitate to conduct us.

Stelios Alexandrou, PhD Candidate
Supervised by:
Prof. Photis M. Panayides (Chair)

Dr. Dimitris Tsouknidis

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Cyprus University of Technology
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Thank you in advance for your valuable time and contribution to this important research!!

Disclaimer:

All responses to this questionnaire are strictly confidential and will be used only for research purposes without any direct or indirect reference on persons or companies.

1. Part One:

1.1 Company Information

1. What is the name of your company? : _____

2. What is the type of ownership of your company (majority)?

   (1) Local firm (2) Foreign firm (4) Others (please specify): _____

3. How many employees does your company currently have?

   a) Shore based:
   (1) 1-20 (2) 21-50 (3) 51-100 (4) > 100
   b) At sea:
   (1) 1-20 (2) 21-50 (3) 51-100 (4) > 100

4. Where is your company registered (headquarters)?

   (1) EU registered (please specify country): _____
   (2) Non – EU registered (please specify country): _____

5. How long has your company been established (in years)?

   (1) 1-10 (2) 11-20 (3) 21-30 (4) > 31

6. What is the size of your company in Total Assets? : _____ (in '000s €)

1.2 Biographical Information

1. Your position in the company:

   (1) CEO (2) Managing Director (3) Department Director/Department manager
   (4) Others (please specify):_____

2. Gender:

   (1) Male (2) Female

3. Education: (1) Under graduate (2) Master's degree (3) Doctorate degree (4) Others (please specify): _____
4. Age (in years): (1) Under 30 (2) 30-40 (3) 41-50 (4) Above 50
5. Industry experience (in years): (1) Under 5 (2) 5-10 (3) 11-15 (4) 16-20 (5) 21-25 (6) Above 25
6. Managerial experience (in years): (1) Under 5 (2) 5-10 (3) 11-15 (4) 16-20 (5) 21-25 (6) Above 25

2. Part Two:

2.1 Internal Green Supply Chain Management (GSCM) Practices.

Please select, as to what extent do you agree or disagree with each statement, as the statement relates to your internal environmental proactivity, green shipping practices and green marketing.

Number		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	We always attempt to go beyond basic compliance with laws and regulations on environmental issues.	1	2	3	4	5
2.	We commit ourselves to support GSCM. [51]	1	2	3	4	5
3.	In our company cross-functional cooperation[52] effectively supports green operations.	1	2	3	4	5
4.	We provide green education and training.	1	2	3	4	5
5.	a) We are committed and we have obtain the ISO 14000 certification[53].	1	2	3	4	5
	b) We have been committed and we are in the process to obtain the ISO 14000 certification.	1	2	3	4	5
6.	a) We are committed and we have obtain the ISO 50001 certification[54].	1	2	3	4	5
	b) We have been committed and we are in the process to obtain the ISO 50001 certification.	1	2	3	4	5
7.	We effectively manage the environmental risks affecting our business.	1	2	3	4	5
8.	We mainly use environmental-friendly materials and equipment (e.g. non-toxic paint, electric deck machine).	1	2	3	4	5

[51] **GSCM** mainly refers to the way which companies add the environmental thinking into supply chain management. Green should be included at any stage in the chain from the initial supplier to the end-user (Skjoett-Larsen, 2000).

[52] **Cross-functional cooperation** is an intra-company cooperation including the cooperation between the various different departments within that company.

[53] **ISO 14000** is a series of environmental management standards developed and published by the International Organization for Standardization (ISO) http://www.iso.org/iso/home/standards/management-standards/iso14000.htm.

[54] **ISO 50001** supports organizations in all sectors to use energy more efficiently, through the development of an energy management system (EnMS) http://www.iso.org/iso/home/standards/management-standards/iso50001.htm.

9.	We mainly use environmental-friendly materials and equipment such as Ballast Water Handling System.	1	2	3	4	5
10.	We mainly use clean-burning, low-sulphur fuels for main and auxiliary engines.	1	2	3	4	5
11.	We adopt optimal vessel speed and routing system.	1	2	3	4	5
12.	We promote the environmental-friendly recycling of scrap ships.	1	2	3	4	5
13.	We provide customers with information regarding our environmental-friendly practices through our website or other means.	1	2	3	4	5
14.	We intend to increase the budget allocated on green advertising within next year.	1	2	3	4	5
15.	We adopt the notion of resource and energy conservation in promotion.	1	2	3	4	5
16.	We use environmental friendly arguments in our marketing strategy.	1	2	3	4	5
17.	We regularly update environmental conservation information in our firm's Website.	1	2	3	4	5
18.	We often attract customers with green initiatives and eco-service.	1	2	3	4	5
Please answer the following question only in case your firm is active on ordering/or trading ships.						
19.	It is a priority that the ships we order/trade/operate are environmental friendly (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank).	1	2	3	4	5

2.2 External Green Supply Chain Management (GSCM) Practices.

Please select, as to what extent do you agree or disagree with each statement, as the statement relates to your green collaboration with suppliers, partners and customers.

Number		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Suppliers [55]					
1.	We achieve common environmental goals collectively with suppliers.	1	2	3	4	5
2.	We develop a mutual understanding of environmental risk and responsibilities with suppliers.	1	2	3	4	5
3.	We work together with suppliers to reduce environmental impact from operations.	1	2	3	4	5
4.	We make plans to resolve GSCM related problems with suppliers.	1	2	3	4	5
5.	We provide resources, skills, and knowledge to strengthen GSCM along with our suppliers.	1	2	3	4	5
	Partners [56]					
6.	We achieve common environmental goals collectively with partners.	1	2	3	4	5

[55] Suppliers (e.g. fuel company, shipbuilding company, and others) (Yang et al., 2013).
[56] Partners (e.g. stevedoring company, terminal operators, trucking company, and others) (Yang et al., 2013).

7.	We develop a mutual understanding of environmental risk and responsibilities with partners.	1	2	3	4	5
8.	We work together with partners to reduce environmental impact from operations.	1	2	3	4	5
9.	We make plans to resolve GSCM related problems with partners.	1	2	3	4	5
10.	We provide resources, skills, and knowledge to strengthen GSCM along with our partners.	1	2	3	4	5
	Customers [57]					
11.	We achieve common environmental goals collectively with customers.	1	2	3	4	5
12.	We develop a mutual understanding of environmental risk and responsibilities with customers.	1	2	3	4	5
13.	We work together with customers to reduce environmental impact from operations.	1	2	3	4	5
14.	We make plans to resolve GSCM related problems with customers.	1	2	3	4	5
15.	We provide resources, skills, and knowledge to strengthen GSCM along with our customers.	1	2	3	4	5

3. Part Three:

3.1 Resources

Please select, as to what extent do you agree or disagree with each statement, as the statement relates to your human, financial and experiential resources.

Number		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	In our company, employees can learn new technologies easily.	1	2	3	4	5
2.	In our company, employees usually provide new ideas.	1	2	3	4	5
3.	In our company, employees possess abilities to use new technologies to solve problems.	1	2	3	4	5
4.	In our company, employees share knowledge with each other.	1	2	3	4	5
5.	We have adequate financial resources available to devote to proactive GSCM activities.	1	2	3	4	5
6.	We have adequate capital resources to devote to this company's proactive GSCM activities.	1	2	3	4	5
7.	The speed of acquiring and deploying financial resources for proactive GSCM is satisfactory.	1	2	3	4	5

[57] Customers (e.g. oil company, shippers, forwarders, and others).

8.	We have adequate ability to find additional financial resources for green initiatives when needed.	1	2	3	4	5
9.	We have adequate knowledge of the characteristics and trends in our market.	1	2	3	4	5
10.	We have extensive operational expertise in the shipping industry.	1	2	3	4	5

3.2 Capabilities

3.2.1 Please select, as to what extent do you agree or disagree with each statement, as the statement relates to your capabilities of shared vision and stakeholder management.

Number		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	Our company's environmental objectives are well-known to all employees.	1	2	3	4	5
2.	All our employees make significant efforts to reach the firm's environmental objectives.	1	2	3	4	5
3.	Employees often offer valuable ideas for improving firm's abilities to achieve its environmental objectives.	1	2	3	4	5
4.	We fully understand customer requirements regarding environmental issues.	1	2	3	4	5
5.	We fully understand requirements of other stakeholders regarding environmental issues.	1	2	3	4	5
6.	We fully establish and maintain close relationships with suppliers regarding environmental issues.	1	2	3	4	5
7.	We establish and maintain close collaborations with internal/external strategic partners regarding environmental issues.	1	2	3	4	5

3.2.2 Capability of strategic proactivity[58]

Please select from the following the most appropriate descriptions for your company.

Number		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	The field within which the firm currently conducts our business is narrow (related areas with prospect of change).	1	2	3	4	5

[58] The measures refer to proactivity in a shipping firm's generic business strategy. According to Aragón-Correa et al. (2008), 'strategic proactivity is a firm's ability to initiate changes in its strategic policies regarding its entrepreneurial, engineering, and administrative activities, rather than reacting to events'.

2.	The field within which the firm currently conducts our business is broad (diversified and continuing to develop).	1	2	3	4	5
3.	Our main focus of concern in relation to the company's technological process is having cost-efficient technologies.	1	2	3	4	5
4.	Our main focus of concern in relation to the company's technological process is having flexible and innovative technologies.	1	2	3	4	5
5.	Planning in our company is tremendously rigorous and predetermined.	1	2	3	4	5
6.	Planning in our company is tremendously open and flexible to allow us to seize new opportunities.	1	2	3	4	5

4. Part Four:

4.1 Risk Taking

Please select from the following the most appropriate descriptions for your risk-taking propensity.

Number		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	In general we have a strong proclivity for low-risk projects (with adequate and safer rates of return).	1	2	3	4	5
2.	In general we have a strong proclivity for high-risk projects (with chances of very high returns).	1	2	3	4	5
3.	In general we believe that owing to the nature of the environment, it is best to explore it gradually via timid, incremental behavior.	1	2	3	4	5
4.	In general we believe that owing to the nature of the environment, bold, wide-ranging acts are necessary to achieve the company's objectives.	1	2	3	4	5
5.	When confronted with decision-making situations involving uncertainty, we typically adopt a cautious,	1	2	3	4	5

	'wait-and-see' posture in order to minimize the probability of making costly decisions.					
6.	When confronted with decision-making situations involving uncertainty, we typically adopt a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.	1	2	3	4	5

5. Part Six:

6.1 Stakeholder Pressures

Please select, as to what extent you felt pressures from the following stakeholders to implement GSCM practices.

Number		Not at all important	Low importance	Neutral	Very important	Extremely important
1.	Clients.	1	2	3	4	5
2.	Government.	1	2	3	4	5
3.	Shareholders.	1	2	3	4	5
4.	Employees.	1	2	3	4	5
5.	Non-Governmental Organizations (NGOs)/Society	1	2	3	4	5

6. Part Seven:

7.1 Performance

Please select, as to what extent do you agree or disagree with each statement, as the statement relates to your environmental and economic performance improvements associated with the implementation of Green Supply Chain Management (GSCM) practices.

Number		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	Reduction of greenhouse gases (e.g. CO2, SOx, NOx...).	1	2	3	4	5
2.	Reduction of waste water (e.g. sewage).	1	2	3	4	5
3.	Reduction of noise pollution.	1	2	3	4	5
4.	Reduction of wastes (e.g. oily waste, sludge and rubbish).	1	2	3	4	5

5.	Reduction of consumption of hazardous/ harmful/ toxic materials.	1	2	3	4	5
6.	Reduction of frequency for environmental accidents.	1	2	3	4	5
7.	Decrease of cost for materials purchasing.	1	2	3	4	5
8.	Decrease of cost for energy consumption.	1	2	3	4	5
9.	Decrease of cost for disposal of hazardous materials.	1	2	3	4	5
10.	Decrease of fee for waste treatment.	1	2	3	4	5
11.	Decrease of fine for environmental accidents.	1	2	3	4	5
12.	Increase of profitability.	1	2	3	4	5
13.	Sales growth.	1	2	3	4	5
14.	Increase of ROI[59]	1	2	3	4	5

7. Part Eight:

8.1 Competitive Advantage[60]

Please select, as to what extent do you agree or disagree with each statement, as the statement relates to your Competitive Advantage.

Number		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	Being environmentally conscious can lead to substantial cost advantages for our company.	1	2	3	4	5
2.	Our company has realized significant cost savings by improving the environmental quality of our services.	1	2	3	4	5
3.	By regularly investing in new eco-friendly technologies, processes and strategies, our company can be a leader in the market.	1	2	3	4	5
4.	Our company can enter lucrative new markets by adopting proactive GSCM strategies.	1	2	3	4	5

[59] 'ROI measures the amount of return on an investment relative to the investment's cost'. Is calculated as: ROI= (gain from investment – cost of investment) / cost of investment.

[60] These measures refer to the environmentally based competitive advantage improvements of a shipping firm as a result of the implementation of proactive GSCM practices.

5.	Our company can increase service quality by making its current operations more environmentally friendly.	1	2	3	4	5
6.	Reducing the negative environmental impact of our company's activities will lead to a quality improvement in its services.	1	2	3	4	5
7.	Corporate image improvements	1	2	3	4	5
8.	Customer satisfaction increases	1	2	3	4	5
9.	Productivity increases	1	2	3	4	5
10.	Higher profits	1	2	3	4	5

Again, thank you very much for your help and contribution to this important research!!

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