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Make Shipping Green Again

How big data practices affect environmental sustainability in shipping

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Abstract

In recent years, the shipping industry has faced important pressure to address CO_2 emissions from steadily increasing maritime trade flows. While regulators still have to come to an agreement regarding their intervention, solutions brought by big data are already offering new opportunities to address this problem. Numerous researchers have addressed the relationship between organizations and the environment, nevertheless the effects of big data on environmental sustainability have so far received little attention from the academic world. The question therefore arises what supports the implementation of such practices and how transparency in stakeholder relationships can be enabled. By drawing on findings from a qualitative study, this thesis aims at filling the theoretical gap by framing the implementation of big data practices as a change process. Consequently, a number of factors influencing the use of big data practices for environmental sustainability could be identified and attributed to the interaction with different stakeholders including firms, customers, competitors and regulators. The nature of these dynamics could further be enlightened as big data practices turned out to improve transparency and trust.

Key words

big data, environmental sustainability, shipping, emissions, change process, transparency, stakeholder relationships.

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Table of content

Table of Graphics

FIGURES

TABLE

Glossary

AIS data	Automatic Identification System data. Tracking system indicating vessel's position
Charterer	Organization or person chartering the vessel
Charter party	Contract stipulating the terms of the chartering
Classification society	Organization that defines and verifies standards for the construction and operation of vessels
Liner	Ship owner operating according to fixed schedules and tariffs
Ship manager	Person or organization in charge of the operational and/or technical management of a ship
Ship owner	Person or organization owning a ship or shares of a ship
Tonnage	Shipping considered in terms of total carrying capacity
Tramp	Ship owner offering his fleet on the spot market

1. Introduction

1.1. Shipping in Modern Times

"Maritime transport is the backbone of global trade and the global economy"

UN Secretary-General Ban Ki-moon
on World Maritime Day 2016

Textile, food, electronics, … the majority of what we consume has been shipped at some point during its journey to the final consumer. No doubt that every year, shipping accounts for more than 90% of intercontinental trade (ICS, 2018; IMO, 2018b). Hence, the shipping industry is not only the backbone of the world economy with over 50.000 internationally trading merchant ships registered in more than 150 nations (ICS, 2018). By being worldwide and fast it is certainly also a substantial indicator of globalization and interconnectedness of our world. Besides seaborne trade, shipping has also proven to be an attractive option when it comes to passenger transportation. Every year, about 400 million passengers travel between EU ports (Brambilla & Martino, 2016). Particularly in northern Europe, the geographic situation allowed the development of an important passenger ferry market, with the Baltics being the second most important region when it comes to ferry traffic in the EU (Statista, 2014). Indeed, in 2014, 47% of people in Sweden stated that they used ship or ferry services, only outnumbered by Malta with 54% (Statista, 2014). Despite growing competition from low cost airlines, the industry has recorded stable performances, which are closely linked to the economic situation of the region they are operating in (Brambilla & Martino, 2016). Industry participants are as diverse as the goods and people transported. Ship owners, charterers, terminal operators, port authorities, classification companies, ship yards, crew members and manufacturers are only examples of actors composing maritime transportation (Stopford, 2009). The future operation of shipping will continuously require innovative action. To continuously ensure a safe and reliable transportation mode, such a multi-faceted network will be needed (DNV GL, 2018).

Looking ahead, shipping's close link to economic growth, merchandise trade and industrial activities indicates an ongoing positive growth. Indeed, in 2016, 10,3 billion tons of seaborne trade volume have been recorded by the U.N. (UNCTAD, 2017). Over the medium term, this growth trend is expected to persist, forecasting an annual compounded growth rate of 3,2% (Stopford, 2016; UNCTAD, 2017). No doubt, mobility of people and goods remain the major advantages of the internal European market and will persist in being major drivers of citizen's quality of life. As a consequence, the European Commission stated in their White Paper on transport (2011) the objective "to shift 50% of medium distance intercity passenger and freight journeys from road to rail and waterborne transport" (EC, 2011). Building on steady growth indicators and favourable political decisions, the odds seem to be in favour of a prosperous future for this historic industry. Nevertheless, substantial challenges will urgently have to be addressed (Stopford, 2016).

1.2. The Challenge of Environmental Sustainability

"Shipping is the most carbon efficient means of transporting most goods across the world"

(World Shipping Council, 2018)

Even though shipping remains an efficient way of transportation, the times when wind power alone was moving ships across oceans are long gone. Hence, the increase in transportation streams has not remained unnoticed when it comes to the environment. The International Council on Clean Transportation (ICCT) estimates the environmental impact of shipping to 3% of all anthropogenic CO_2 and GHG emissions. This represents approximately 1 billion tons CO_2 every year (Olmer, Bryan, Biswajoy, Xiaoli, & Dan, 2017; T. W. Smith et al., 2015). Besides CO_2, emissions from shipping also include other harmful substances such as sulphite oxides (SO_x) and nitrogen oxides (NO_x). These are further damaging our eco-system and contributing to global air pollution (T. W. Smith et al., 2015). Consequently, reducing the environmental impact of shipping is considered one of the key challenges for the industry (Stopford, 2016).

Since 1973, the International Maritime Organisation (IMO) has increasingly dedicated efforts to address the environmental impacts of marine transportation. While early attention focused on pollution from oil, the convention soon incorporated additional issues including pollution from chemicals, garbage, sewage, or other harmful substances. In 1992, the Kyoto Protocol designated the IMO as intermediary to reduce GHG emissions from shipping. MARPOL Annex IV was amended in 1997, addressing more specifically emissions from ships and air pollution (IMO, 2018c). The latest revision (2010) included a progressive revision of emissions and introduced the idea of emission control areas (ECA). These were designed to reduce air pollution (SO_x and NO_x) in specified sea areas (IMO, 2018a). Additionally, special energy efficiency regulations were formulated and entered into force in 2013 (SEEMP, EEDI). Affecting technical and operational inefficiencies, they were specifically designed to reduce emissions from ships (Narula, 2014).

Nevertheless, all of these efforts seem like a drop in the ocean when taking into account industry forecasts. Indeed, if no action is taken, the ICCT predicts shipping's contribution to CO_2 emissions to rise to 17% by 2050 (Olmer et al., 2017). Efficiency gains will however be insufficient to reduce the impact in absolute terms (Olmer et al., 2017; T. W. Smith et al., 2015). Consequently, the seriousness of the situation has caused the discussions on environmental regulation to pick up momentum in the past years (Narula, 2014). Due to the international nature of the industry, shipping has up until today not been included in the European emission trading scheme (EU ETS) (EC, 2013). However, in order to include the sector progressively into a policy framework tackling GHG emissions, the Commission formulated a strategy in 2011(EC, 2011). The latter outlines a step-by-step process starting by enhanced data collection, monitoring and reporting (MRV regulation) to set more precise emission targets in order to evolve towards advanced measures (DNV GL, 2016). Martin Stopford, a leading academic in maritime economics, classified these regulations among the top five issues worth management consideration (2015b). As the EU agreed that a global solution would be preferable, the existing European mechanisms will possibly be aligned with IMO tools once the latter will be fully established (EU Regulation 2015/757, 2015).

1.3. Smart Shipping: Digitalization of the Shipping Industry

> *"Trends such as the fourth industrial revolution, big data and electronic commerce are unfolding, and entail both challenges and opportunities for countries and maritime transport"*

(UNCTAD, 2016)

The digital revolution that has been observed in numerous industries did not spare the world of shipping (Morley, 2018). Vessels are increasingly equipped with sensors monitoring machine operations, hull degradation or energy use on boards. Data is not only collected by the ship operators but also by many other stakeholders closely involved in the operation of the vessel (DNV GL, 2018). These data streams are constantly growing. Indeed, DNV GL projects the maritime VSAT network capacity to grow from 17 Gigabits per second (Gbps) in 2017 to 217 Gbps in 2025 (DNV GL, 2017). This illustrates not only the infancy of the industry when it comes to digitalization but also the huge potential that is yet to be reached.

Various technological innovations are at the origin of change dynamics in the shipping industry (Stopford, 2015b). The classification society DNV GL listed big data analytics among sensors, connectivity, platforms, cloud computing and handheld devices as key technology for the sector (DNV GL, 2017). Examples of change enabled by digitalization are as diverse as the industry itself. Indeed, 49% of German ship owners state that digitalization has affected their business strongly or very strongly in the last 5 years, altering business models and operations (PWC, 2017). Simulators allow to have precise visualizations of the future ship and past data gives valuable information on fatigue and utilization of specific parts (Nichols, 2017). Today, digital services can provide ship owners with the ability to track their ship, get exact monitoring of processes on board and compare performance among their fleet. Detailed performance reports give precise information on nearly every incident occurring on board (Ando, 2011). Emerging from these trends, and in order to harvest the knowledge of the collected data, an increasing number of providers have seized the opportunity of developing analytical services (Saxon & Stone, 2017). Maritime clients can benefit from a growing offer of insight generating solutions. The digital revolution in shipping not only drives an increasing interconnectedness of the industry but also a better predictability of the present and future due to big data (Morley, 2018). Besides, big data tackles the lack of market transparency (Saxon & Stone, 2017), which leading industry representatives increasingly call for (BSR Group, 2018).

Despite the growing number of opportunities, the industry seems reluctant to embrace the new digital trend (Egloff, Sander, Riedl, Mohottala, & Georgaki, 2018). Due to its traditional mind-set (Fagerholt, 2004; Morley, 2018), only parts of the industry seem to move towards a data dominated future. Generally, ship owners see digitalization with a certain degree of scepticism. Nevertheless, one out of two ship owners in Germany stated that their business had been altered in the past 5 years (PWC, 2017). Based on this, the interesting question will be whether reluctance will persist or if the industry will experience a change of mind-set with regards to digitalization.

1.4. Problem Description and Research Focus

Since Vikings and Romans began to build sea going ships, mankind has been attracted by the sea. Over the centuries, our ability to overcome the challenges imposed by the environmental obstacles of nature constantly improved. Today, the challenges are two-fold and mainly lie in the way the industry will face the future. On a macroeconomic level, ensuring competitiveness in the global economy through reliable and environmental-friendly transportation within Europe and elsewhere will be key. On a microeconomic level, shipping companies will have to turn environmental restrictions into opportunities. In the light of innovative digitalization developments and big data applications, a future strategy must take into account these shifting external dimensions.

At the overlap of the outlined areas of interest, shipping, environmental sustainability and digitalization, a series of fascinating synergies arise. Indeed, big data practices are increasingly used to improve efficiency and optimize vessels operation to ultimately reach lower emission levels. Ship owners however do not show a uniform response to these unfolding market trends. On one side, stricter environmental regulation is being imposed across the entire industry. On the other side, the conservative attitude of many industry players impedes a fast development towards the digital age. Consequently, this thesis aims to uncover the factors that influence ship owners in these decisions. The study will therefore explore what enables and hinders ship owners to implement big data practices for environmental sustainability. How are processes within shipping companies being affected by regulatory restrictions? How are roles and interactions of different stakeholders impacted? Do these impacts cause a change in perception regarding environmental sustainability and digitalization? These considerations allowed to formulate the following research questions:

RQ1: What influences big data practices for environmental sustainability in shipping?

RQ2: How do big data practices for environmental sustainability support transparency in shipping?

To answer the above outlined research questions, key stakeholders influencing the decision to implement big data practices for environmental sustainability will be taken as a point of reference. These include the firms themselves, regulators, customers and competitors (Pruzan-Jorgensen & Farrag, 2010). Transparency will be studied within the same context.

1.5. Delimitations

In order to explore the above outlined research questions within the limited time dedicated to this thesis, certain delimitations were made. First, the focus will lie on environmental sustainability, excluding other types of sustainability that can often be found in research and literature such as social, ecological and economic sustainability (Glavič & Lukman, 2007). Further it will concentrate on CO_2 emissions not addressing the numerous measures that have been taken in order to tackle other types of emissions such as SO_x and NO_x emissions. As for digitalization, it will first and foremost consider big data and analytics rather than other digitalization categories identified as relevant for shipping such as sensors and IoT technologies, connectivity, handheld devices, platforms and cloud computing (DNV GL, 2017). From a regulatory point of view, this thesis will focus on the European MRV Regulation (EU Regulation 2015/757, 2015).

2. Literature review

The following section will critically discuss existing literature in the field of organizations and the environment (2.1.) as well as big data and digitalization (2.2.). This will allow to ultimately identify the research gap of this thesis (2.3.).

2.1. Environment and organizations

In recent years and in particular after the Rio de Janeiro Earth Summit in 1992, researchers have dedicated a growing amount of attention to the relationship between companies and the environment (Etzion, 2007). This domain of research incorporates various aspects including but not limited to familiar concepts such as corporate environmentalism (Banerjee, 2001) and corporate social sustainability (CSR) (Friedman, 2007). Environmental sustainability "seeks to improve human welfare by protecting the sources of raw materials and ensuring that the sinks for human wastes are not exceeded" (Goodland, 1995). It should be differentiated from sustainable development (Etzion, 2007). In line with the outlined research questions, it however seems relevant to primarily present research that focuses on influences of companies' environmental performance.

2.1.1. Firm attributes

First, one can identify research on firms as individual entities and their attributes relevant to environmental issues Etzion (2007). On one side, strategic attributes can actively be managed in order to improve environmental performance. Indeed, it has been consistently shown that innovation (Christmann, 2000), workforce perceptions (Sroufe, Curkovic, Montabon, & Melnyk, 2000), organizational values (Jiang & Bansal, 2003; Bansal, 2003), integrating stakeholder's views (Marcus & Anderson, 2006; Russo & Fouts, 1997; Sharma & Vredenburg, 1998) and information flow (Lenox & King, 2004) are positively linked to environmental performance. The argument brought forward by these researchers is that by modifying existing ways of doing business, a general consideration for environmental issues can be incorporated in new practices. On the other side, contingency attributes are attributes that are not endogenous to environmental performance, including R&D, size of the organization, slack and international scope (Etzion, 2007). While the direction of the causality between R&D expenses and environmental performance remains unclear (Christmann, 2000; Foster & Green, 2000; A. King & Lenox, 2002; McWilliams & Siegel, 2000; Sroufe, 2003) a positive effect of size on environmental regulation could be established with significant correlation (Bowen, 2000). Further, low slack has been proven to negatively affect environmental performance as no excess resources are free to be dedicated to environmental issues (Henriques & Sadorsky, 1996). Finally, international scope can be beneficial for environmental performance. Multinational corporations tend to standardize their environmental standards across their countries of operation (Khanna & Anton, 2002) for which they then take the country with the most stringent policy as a reference (Christmann, 2004). Among these characteristics, Etzion (2007) points out the aspect of stakeholder concerns. These are likely to become increasingly important in the field of environmental behaviour due to growing interconnectedness and the need for cooperation to address the bigger challenge of climate change.

2.1.2. Transparency

Connecting to the importance of stakeholders, transparency in information exchange is a recurring topic in the field of organizations and the environment. Through the concept of CSR, transparency and sustainability have been repeatedly connected in the context of the organization (Rownan, 2016). These have commonly taken the form of sustainability reports aiming to provide stakeholders with accountability. A great amount of research has been dedicated to this field investigating variables such as performance impact and stakeholder relationships (Berggren & Bernshteyn, 2007; Brandes & Darai, 2017; Fernandez-Feijoo, Romero, & Ruiz, 2014; Mori, Best, & Cotter, 2014). Indeed, over time, companies and their suppliers have provided a growing amount of information to their customers, uncovering the multiple steps of their supply chains (Kashmanian, 2017). "Supply chain mapping, traceability, third-party certification, and goal setting, as well as reporting progress toward these efforts" (Kashmanian, 2017) are other common examples of transparency practices in organizations.

2.1.3. Industry & Organizational Field

Academic interest has further focused on the industry level, which is of particular interest for stakeholders external to the company such as customers and competitors (Etzion, 2007). As a matter of fact, environmental incidents can trigger the "reputation commons problem" (A. A. King, Lenox, & Barnett, 2002). Negative event with high level of public attention tend to reflect back on an entire industry rather than on a single company. Further, the intensity of consumer contact is positively correlated with environmental conscious behaviour (A. A. King et al., 2002) implying a greater attention from for example ferry operators than from container, tanker or bulk operators. Industries also appear as the level targeted by regulators (Etzion, 2007), impacting growth and profitability (Banerjee, 2001; Fineman & Clarke, 1996). Besides restrictions, firms can be required to monitor and report data, which can already be sufficient to result in, for example, emission reductions (Kleiner, 1991; Porter & van der Linde, 1995). Identical regulatory pressure can however trigger different responses from companies subsequently resulting in varying outcomes (Darnall, 2003; Milstein, Hart, & York, 2002; Prakash & Kollman, 2004).

Research has long held the standpoint that environmental regulation increases production costs, makes companies relocate their plants and affects productivity negatively (Friedman, 2007). Nevertheless, this argument has been reverted by Porter and van der Linde (1995) who suggested that environmental regulation can actually be a driver of innovation. Hence, it contributes not only to improved environmental performance but also to improved business performance by boosting competitiveness on international markets. The explanation lies in the waste of resource that is overcome by regulatory incentives (Palmer, Oates, & Portney, 1995). Information on these opportunities is thus generated by the external stakeholder (i.e. the regulator), a view that is opposed by the argument that regulators are not good at leading to innovation (Palmer et al., 1995). According to the Porter & van der Linde's (1995) definition of innovation as something that alters design, service, production, marketing or support, big data practices fit into this category. The Porter hypothesis should however be evaluated with care, as it has been criticized for its lack of rigorous foundation (Jaffe & Palmer, 1997).

2.1.4. Shipping

When looking closer at research specifically centred around shipping and the environment, papers revolve around the environmental impact and potential strategies of compliance with regulation as well as policy recommendations.

The considerable impact of shipping on the environment is an unavoidable evidence that has been highlighted by international maritime institutions (T. W. Smith et al., 2015) and research (Eyring et al., 2010). Academic work regarding the impact of regulation mainly covered the trade-offs of operational decisions. Brynolf et al. (2014) and Lin and Lin (2006) focused for example on the numerous compliance options for ship owners regarding MARPOL Annex VI on sulphur oxide. Likewise, Schinas & Stefanakos (2012, 2014) studied the financial effects of the same regulation. Psaraftis & Kontovas (2010) investigated the economic trade-offs related to practices improving environmental performance such as the installation of exhaust gas cleaning technologies or the use of alternative fuels. As for CO_2 more specifically, the debate revolves around the reasonable contribution of the industry in reducing GHG emissions (Eide, Endresen, Skjong, Longva, & Alvik, 2009). The options to internalize environmental externalities with policy instrument include a global emissions trading scheme (Dessens, Anger, Barker, & Pyle, 2014) or a maritime carbon tax (Lee, Chang, & Lee, 2013).

The combination of an ongoing oversupply, high fuel prices and regulatory pressure, has caused the sustainability debate in shipping to become more solution-oriented (Narula, 2014). Indeed, green shipping practices have gained popularity, driven by customer pressure and industry standards, besides regulation (Lai, Lun, Wong, & Cheng, 2011). The equation for improved environmental sustainability in shipping is rather straightforward: reduced fuel consumption leads to reduced emissions (Narula, 2014). This can be fulfilled by a large number of options amongst which are increased efficiency and optimization. Nevertheless, sustainability in the maritime industry is still poorly researched (Cheng, Zanjirani Farahani, Lai, & Sarkis, 2015). The conservative thinking of the industry (Fagerholt, 2004) has resulted in a lack of academic efforts dedicated to future oriented studies (Mansouri, Lee, & Aluko, 2015). Recent work often addresses solutions such as speed optimization (J. J. Corbett, Wang, & Winebrake, 2009) or weather routing (Windeck & Stadtler, 2011). It however leaves a void when it comes to the previously outlined impact on innovation (Porter & van der Linde, 1995). Research has moreover been characterized by extensive use of modelling approaches which allowed very little practical implications (Mansouri et al., 2015).

2.2. Big data

2.2.1. Definition

Big data appears as a fairly new concept in management research (G. George, Haas, & Pentland, 2014) hence calling for an introductory definition of the term. The most wide-spread characterization of big data is commonly known as the 5 V's – volume, velocity, variety, value, veracity (Abbasi, Chiang, & Sarker, 2016; Chen, Chiang, & Storey, 2012; Hashem et al., 2015). Big data entails the idea that the amount of data generated grows daily in an exponential way and is not only available real-time or near real-time but also from a multitude of sources. This ultimately creates new value for its users (McAfee & Brynjolfsson, 2012). Variable reliability of the data due to the entailment of human judgement was later added as a defining characteristic (Gandomi & Haider, 2015). Hence, by overcoming the limitations of traditional sampling, big data allows organizations to discover new horizons of insight. It not only offers heterogeneous views but also enhances certainty due to automatized data collection (Etzion & Aragon-Correa, 2016). However, generating new insights also requires processing tools to develop in order to cope with new levels of volume and complexity. Often, big data generates complexities such that numerous analysis tools such as models and tags are required to generate simplifying interpretations (Calvard, 2016).

2.2.2. Sustainability Application of Big Data in Shipping

Big data is as a prominent application of digitalization when it comes to sustainability (Fruth & Teuteberg, 2017). From a historical perspective, in contrast to many previous evolutions related to technology, "the big data revolution was born not only digital, but also environmentally conscious" (Etzion & Aragon-Correa, 2016). Consequently, the implications that big data can have on the field of organizations and their interactions with their environment are steadily expanding (Gerard George, Osinga, Lavie, & Scott, 2016). Currently, four main implications can be identified, namely efficiency improvement, mass customization, better resource allocation and risk management (Etzion & Aragon-Correa, 2016). These are made possible for example through more reliable forecasting or applications such as smart meters.

Many outcomes of big data analytics such as efficiency improvement and smart resource allocation align very well with the concept of sustainability (Etzion & Aragon-Correa, 2016). In shipping, besides vessel design and "smart-shipping", big data analytics can be identified as a major area of technological innovation (Zaman, Pazouki, Norman, Younessi, & Coleman, 2017). Nevertheless, companies in this sector are commonly seen as rather conservative (Fagerholt, 2004), hence reluctant to engage in innovative practices. When combining existing knowledge on sustainability dynamics in shipping (Narula, 2014) with opportunities arising from big data analytics (Zaman et al., 2017), a preliminary representation of the occurring process can be sketched (Figure 1) .

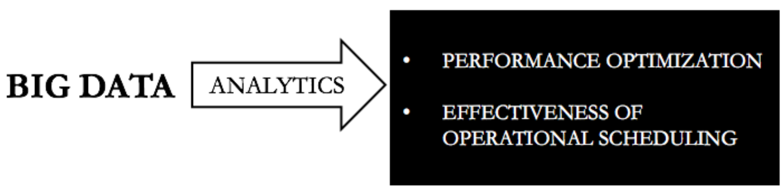

Figure 1. Own representation of big data practices for environmental sustainability based on Narula (2014) and Zaman et al. (2017)

Analytics enabled by availability of big data have two main outcomes when it comes to environmental sustainability in shipping. First by monitoring a ships' operation, performance optimization in various forms such as eco-driving and energy management are enabled. Secondly, the availability of data stemming also from other actors of the system such as ports or competitor vessels ultimately can lead to improved effectiveness of operational scheduling. An illustrating example would be intelligent traffic management by ports, reducing congestions and hence avoiding uneven speed curves that cause higher emissions. (Zaman et al., 2017) This relationship is also the target of the EU Commission's MRV regulation, as part of their objective is to trigger fuel consumption improvements by requiring monitoring of emissions (Nelissen & Faber, 2014).

2.3. Synthesis and Gap

From the above outlined literature, it appears that research on organizations and the environment covers mainly the conditions under which organizations engage in environmental sustainability. However, once confronting this field with big data literature, it remains unexplored "how sustainability opportunities are identified, envisaged and framed" (Etzion & Aragon-Correa, 2016). Indeed, the effects of digitalization, and in particular big data, on sustainability remain largely in the shade. At the same time, the shipping industry comes as a promising industry to fill this research gap. As outlined before, little research in this sector has addressed future oriented fields such as sustainability and digitalization (Cheng et al., 2015). Previous maritime research has been largely focusing on regulatory costs and compliance issues and rather than on digitalization and big data practices (Fruth & Teuteberg, 2017).

By combining existing knowledge on optimization dynamics in shipping, a preliminary effect of big data on environmental sustainability was able to be established (Figure 2). It however remains unclear how this process in embedded in the organization as well as in the industry. Consequently, this thesis aims on one side to fill the empirical gap of qualitative research on sustainability in shipping by looking more specifically at the application of big data for environmental sustainability. On the other side, it aims to contribute to the infant conceptualization and theory on big data and the dynamics of its use and implementation in organizations.

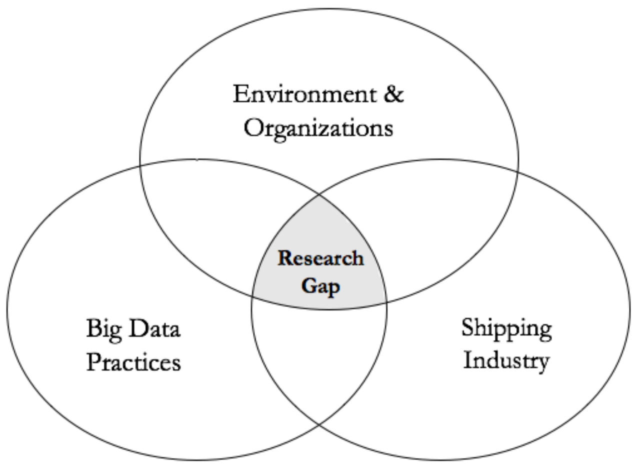

Figure 2: Visual representation of research gap

3. Theoretical lens

In an attempt to fill the above outlined research gap, the following theoretical lens provides insight on how big data can affect environmental sustainability in the shipping industry. It constructs a two-folded framework to enable the analysis of the collected empirical data. Framing big data as change process (3.1.) allows in a first part to develop factors influencing at the firm-level (3.1.1.) and industry-level (3.1.2.). It describes the impact of different stakeholders on the process of big data analytics for environmental sustainability. The second part addresses organizational transparency in organization-stakeholder interactions and its impact on trust (3.2.).

3.1. Big Data as Change Process

In the past decade, big data has disrupted multiple industries such as health care, retail and manufacturing, changing the way business is done (McKinsey Global Institute, 2011). For management research, it generated a great amount of opportunities to investigate and theorize the concept and its consequences on organizational processes (G. George et al., 2014). While many researchers addressed the altered dimensions of data (Abbasi et al., 2016; Hashem et al., 2015) others also considered the change dynamics surrounding big data (McAfee & Brynjolfsson, 2012). Indeed, in order to generate value for organizations and industries, effective change management comes as an essential first step. Leadership, talent management, technology, decision making, and company culture are only some examples of areas that have to be monitored carefully by managers (McAfee & Brynjolfsson, 2012).

Defining big data as change process allows to take a step back and draw on previous literature of change. A.D. Meyer, Brooks & Goes (1990) classified change into four distinct categories according to the characteristics of change and the level at which the change occurs (Figure 4). While first order change is the continuous adding up of small modification that do not modify the initial state of the system, second-order change modifies the underlying dynamics of the system (Watzlawick, Weakland, & Fisch, 1974) . This dichotomy has been applied to various situations such as the single vs. double loop learning (Argyris, 1977). As for the change level, it varies between the traditionally analysed firm level (Andrews, 1971; Ansoff, 1965; Hofer & Schendel, 1978) and the industry level of change.

The introduction of big data in the shipping industry, has so far not resulted in a major disruption of the industry. Indeed, historically established players still dominate the industry and the initial state of the system has not yet been substantially modified (Stopford, 2015a). Hence, the focus can be placed on the left-hand side of the figure.

	First order change	Second order change
Firm-level	**ADAPTATION** Focus: Incremental change within organizations Mechanism: • Incrementalism • Resource dependence	**METAMORPHOSIS** Focus: Frame braking change within organizations Mechanism: • Life cycle stages • Configuration transitions
Industry level	**EVOLUTION** Focus: Incremental change within established industries Mechanism: • Natural selection • Institutional isomorphism	**REVOLUTION** Focus: Emergence, transformation and decline of industries Mechanism: • Punctuated equilibrium • Quantum speciation

Figure 3: Four categories of change from A.D. Meyer et al. (1990)

3.1.1. Firm-level Change

Research on organizational change reaches back to the 1970s and 80s (A. D. Meyer et al., 1990). In this field, authors argue that organizations track the changes in their environment on an ongoing base and adapt accordingly. Hence, they modify processes and products in order to ultimately stabilize on practices that prove successful (Miles, Snow, Meyer, & Coleman, 1978; Quinn, 1980). An alternative view proposed by Pfeffer & Salancik (2003) is that organizations change because of the change that is imposed on them by external dependencies.

When translating this perspective to the studied change process, big data practices for environmental sustainability, it is relevant to take inspiration from industries in which the implementation of big data is further ahead. In the manufacturing context Dubey, Gunasekaran, Childe, Wamba & Papadopoulos (2016) conducted research on how big data analytics can support world-class sustainable manufacturing (WCSM). This framework builds on manufacturing organizations that have shown consistently superior sustainability achievements and can be classified into the firm level. Monitoring and technology have become useful tools for organizations. By improving decision making, big data can enable superior sustainability performance and help organizations to reach related strategic sustainability goals. In an attempt to bridge the identified knowledge gap, the authors identified the following eight pillars: *leadership, regulatory pressure, supplier relationship management, employee involvement, customer relationship, total quality management, total productive maintenance* and *lean manufacturing*. They further argue that focusing on these factors favours the positive impact of big data on sustainability performances within WCSM.

In order to apply Dubey et al's (2016) model to the shipping sector, the factor that relates specifically to the manufacturing sector (lean manufacturing) was dismissed in the context of this thesis. Further, the relative impact on environmental performance as opposed to other sustainability forms and the findings from the pre-studies guided the choice of relevant factors. Therefore, *leadership*, *regulatory pressure*, *employee involvement* and *customer relationship management* were retained for the analytical framework of this thesis.

3.1.2. Industry-level Change

In an attempt to complement the infant literature on big data, it appeared relevant to consult theory on organizational responses to change. Indeed, the trend towards environmental sustainability in shipping, has been emerging since the 1990s (A. D. Meyer et al., 1990). The industry level is furthermore the level at which environmental regulation in formulated (Etzion, 2007), hence calling for broader perspective on industry level change and its influencing factors.

Industry-level change theories, referred to as evolution models (A. D. Meyer et al., 1990), claim that industry players as a collective are influenced by external conditions, while individual firm entities remain relatively static. Here two streams of research can be differentiated. On one side, population ecologists argue that varying entry and exit levels cause the industry to change (Hannan & Freeman, 1977; Scott, 1987). On the other side, institutional theorists hold the opinion that institutional environments force firms to adapt to certain external expectations (DiMaggio & Powell, 1983; Zucker, 1987). Considering that the global pressure to be environmentally sustainable originates from external factors such as regulators and customers, this second stream of literature was identified as applicable to this thesis.

Indeed, J.W. Meyer & Rowan (1977) argue that organizational structures emerge by reflecting the rationalization of institutional rules. The latter are defined as "myth which organizations incorporate, gaining legitimacy, resources, stability and enhances survival prospects" (Ibid.). The overall concept thus describes that organizations are "driven to incorporate the practices and procedures defined by prevailing rationalized concepts of organizational work and institutionalized" (J. W. Meyer & Rowan, 1977). Surprisingly, the immediate efficacy of these measures does not affect their positive impact on legitimacy and survival chances. Hence, professions, programs and technologies are institutionalized and function in a myth-like manner.

When analysing incremental industry change, institutional theory has further been related to the previously discussed field of sustainability in organizations. In the case of corporate social responsibility, Campbell (2007) presents a series of economic and institutional conditions influencing organization's likelihood to engage in CSR practices. He first presents the argument that poor economic conditions and weak financial performance of firms create a hostile environment for CSR practices. Similarly, too much or too little competition leaves firms little slack resources for sustainability measures. Institutional conditions can mediate these effects. When regulatory bodies impose strong and well enforced regulations based on stakeholder's consensus, CSR practices are facilitated. In some cases, industry players engage in self-regulation imposing stricter rules on themselves for example to address an otherwise insufficient state regulation. In all of these processes, monitoring by NGO's and other independent industry actors further impacts positive CSR behaviours. Finally, firms that belong to industry associations and act environment favourable to CSR, also increase their likelihood for like-minded conducts.

At this point it time, Campbell's (2007) theory can systematically be applied to the research question of this thesis. According to Campbell (2007), firms act socially responsible if they do not willingly cause harm to any of their stakeholders or immediately try to rectify harm as soon as it is discovered. This definition thus includes the dimension of environmental sustainability since it affects communities around the world. Some amendments can be made to the previously outlined conditions. Currently, no efforts regarding self-regulation of GHG emissions have been recorded in the shipping sector. Additionally, the dimension of industry associations and normative environments was excluded as they require a broader framework of analysis that could not be ensured within this thesis. Consequently, *financial performance, competition, regulation, monitoring* and *industrial self-governance* were retained as relevant factors to complement this analytical framework.

3.1.3. Summary of Change Factors

Framing big data as change process allows a creative combination of two distinct literature streams in order to construct a list of factors influencing big data practices for environmental sustainability in shipping. First, the firm-level analysis leads to a translation of factors stemming from the big data application in manufacturing. Secondly, the industry-level perspective complemented the framework with four more holistic sustainability factors from institutional theory (state regulation being already identified at the firm-level).

Firm-level
- Leadership
- Regulatory pressures
- Customer relationship management
- Employee involvement

Industry-level
- Competition
- Financial performance
- Industrial self-governance
- Monitoring

Figure 4: Visual representation of change factors

3.2. Transparency in Organization – Stakeholder Relationships

Big data has generally been shown to be related to increased organizational transparency (Wamba, Akter, Edwards, Chopin, & Gnanzou, 2015). Indeed, value can often be created simply by giving key stakeholders access to relevant information (McKinsey Global Institute, 2011). Nevertheless, in order to understand how this transparency can support improved environmental performance, the following section will outline its role in the organization stakeholder relationship.

The importance of transparency is frequently highlighted in the organizational context. Nevertheless, organizational transparency as a foundation of trust in organization stakeholder relationships has first been theorized by Schnackenberg & Tomlinson (2016). With their research, they address the void of rigorous theoretical development in the field of organizational transparency and first constructed a definition of transparency incorporating various management traditions:

> *"Transparency is the perceived quality of intentionally shared information from a sender"*
> (Schnackenberg & Tomlinson, 2016)

Indeed, transparency is characterized by the sharing of knowledge allowing information exchange between parties to be increasingly aware, coherent and comprehensible (Pagano & Röell, 1996). It can further support behavioural changes by employees (Kaptein, 2008). Moreover, it incorporates the idea that information has to be shared intentionally. Situations of unintended miscommunications are therefore excluded. Finally, transparency is connected to the perception of the information received and its quality.

Building on this definition, the Schnackenberg & Tomlison (2016) suggest three main managerially relevant components of transparency: *information disclosure*, *clarity* and *accuracy*. First, *disclosure* describes that information is made available within reasonable time (Bloomfield & O'Hara, 1999; Williams, 2008). Transparent information therefore has to be shared openly. Next, *clarity* entails that received information is perceived as lucid and comprehensible. That is, communicated information has to vehicle a transfer of meaning and consequently "hang together". Finally, *accuracy* refers to the perceived correctness of the information that is being transmitted from the sender to the receiver. More concretely, for information to be transparent it cannot be biased on purpose or contrived (Walumbwa, Luthans, Avey, & Oke, 2011). This also relates to the reliability of transmitted information.

Building on Mayer, Davis, & Schoorman's (1995) model of trust, the authors investigated how organizational transparency can positively impact performance results via the organization-stakeholder relationship. The trustworthiness of an organization is assessed along three concepts: *ability, benevolence* and *integrity*. Ability refers to having influence in a particular sphere, benevolence describes the good intention of the trustee and integrity relates to a perceived adherence to certain principles. Deriving from this conception of trustworthiness, Schnackenberg and Tomlinson (2016) argue that the perception of transparency is an antecedent to the perception of trustworthiness.

First, by disclosing information, the organization risks that this information is subsequently used against themselves. The firm therefore communicates its commitment to make joint gains rather than individual gains. Furthermore, it displays the organization's intention to behave in an integer way. Stakeholders are enabled to make informed decisions despite potentials risks for the organization deriving from the disclosure of information. Second, sharing information with clarity implies that organizations understand stakeholder's perspectives. Third, conveying information in a manner that is perceived as accurate is positively linked to the organization's perceived ability as well as its perceived integrity as it signals honesty. Hence, the way stakeholders perceive the quality of information (disclosure, clarity, accuracy) of information communicated by the organization positively impacts trust in the former. This relies on the underlying assumption that trustworthiness is the linking element between transparency and trust.

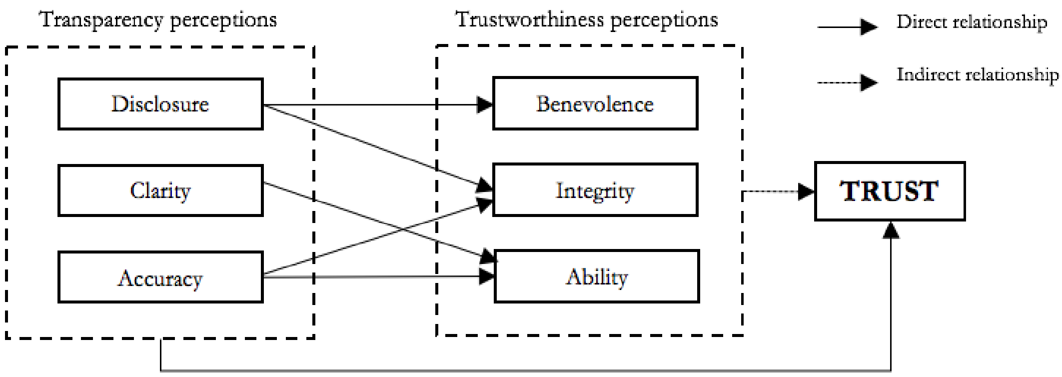

Figure 5: Schnackenberg & Tomlison's (2016) model of transparency

3.3. Synthesis

Deriving from the literature review, this thesis starts from the assumption that big data can have a positive effect on environmental sustainability in shipping (Narula, 2014; Zaman et al., 2017). This is enabled by optimizing performance and enhancing effectiveness of operational scheduling. In the next step, the theoretical framework aimed to generate a preliminary list of factors that could explain how this process emerges within shipping companies. Along this reasoning, four main actors have been identified as relevant in the organizational environment: customers, competitors, regulators, and the firm itself. The outlined theoretical framework will consequently allow a two-folded analysis. First, it will aim to explain how these factors can be associated to each of the identified interactions ultimately enabling the big data for environmental sustainability process (RQ 1). Secondly, it will evaluate the concept of transparency between the stakeholders and establish its role for the big data for environmental sustainability process (RQ 2).

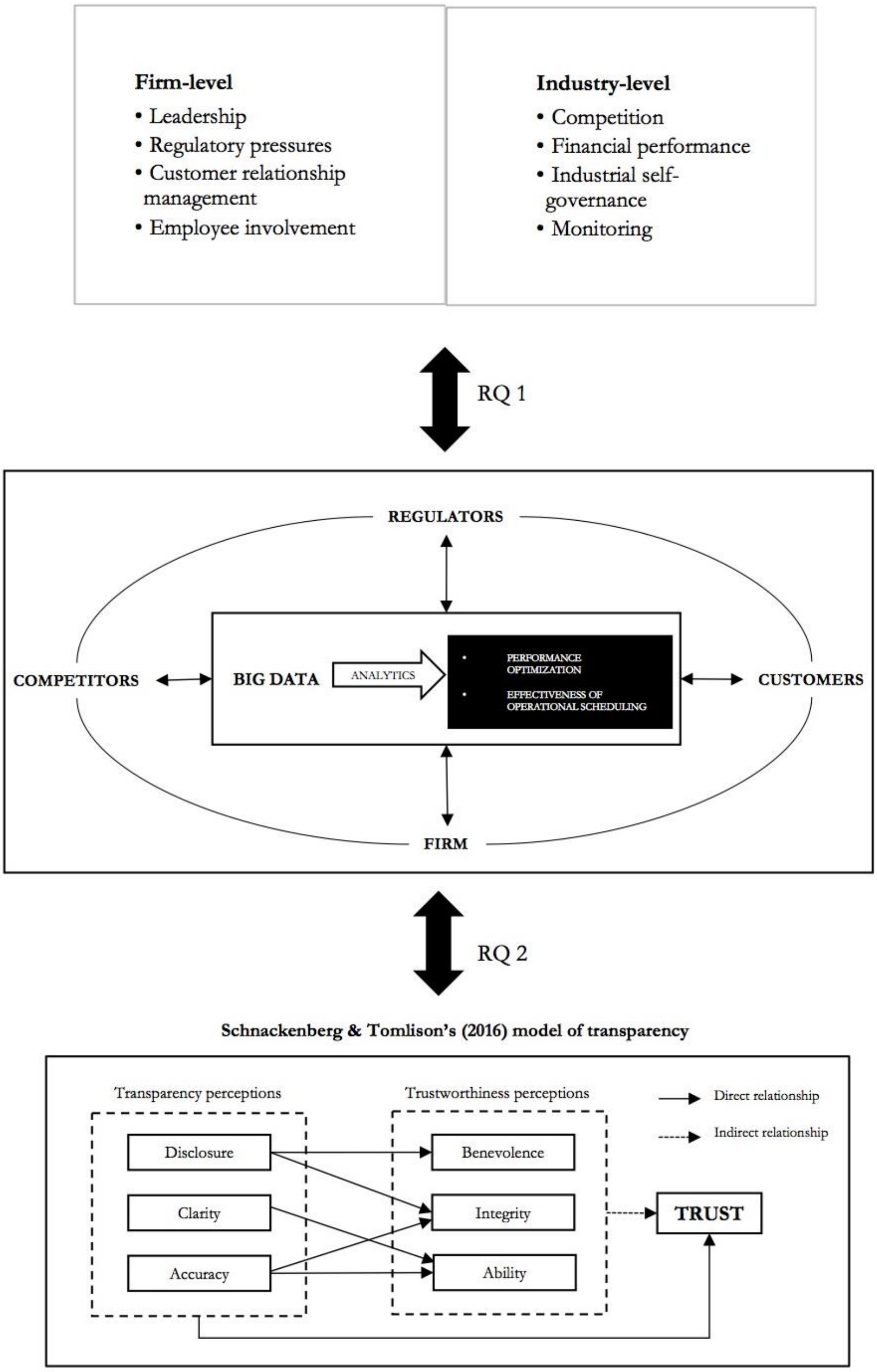

Figure 6: Visual representation of the theoretical framework

4. Methodology

The following section will outline the choice of a qualitative study to investigate how big data can support environmental sustainability in shipping (4.1.). An abductive research approach was implemented with regards to the empirical work (4.2.). Following an introductory pre-study, primary data was collected and analysed (4.3.). The final section critically discusses the quality of the study (4.4.).

4.1. Methodological Fit

In an attempt to fill the above outlined research gap, a qualitative study seemed of best interest. First, the objective was to use explanations provided by involved actors, to make processes linking particular variables visible (Barbour, 2014). Secondly, the study aimed to investigate how macro elements (regulation) affect micro behaviours (understandings). In these particular cases, qualitative research can provide a more complete illustration (Barbour, 2014). Further, the current state of research on how big data can support organizations and in particular environmental performance is still it its infant stage. Hence, the rationale to conduct an exploratory study was underlined. Finally, shipping companies often seem reluctant to implement performance optimization, even though it theoretically lowers fuel costs. This behaviour can be perceived as inherent paradox and apparently illogical, making qualitative research a suitable method of investigation (Bryman & Bell, 2011).

Additionally, the newness of the regulatory frame (MRV regulation was implemented August 31st 2017) leads towards a qualitative rather than quantitative study. Indeed, at the current point in time no data has been published regarding the performance of ship owners. Rather than showing causalities, the aim was to understand how people see the role of big data and which trade-offs are involved when facing the current challenges (Barbour, 2014).

Consequently, semi-structured expert interviews were chosen to capture people's statement in their specific functions representing a certain field of activity (Flick, 2014). In the case of this thesis, this mainly related to environmental experts or IT experts in shipping companies. Meuser & Nagel (2002) highlighted the benefits of expert interviews when reconstructing process knowledge. In this particular case, the research aims at reconstructing how big data can support environmental sustainability in shipping hence relying on the interviewee's knowledge regarding forces driving the implementation of this practice.

4.2. Research Approach

In accordance with Bryman & Bell's (2011) description of qualitative research, this study takes an epistemological position that focuses on understanding the outside world through the description of its participants. Further, it aligns with a constructivist ontology assuming that reality emerges from the interaction of individuals or in this specific case individuals and technology. As outlined before, big data and sustainability in shipping are young concepts in the management research. Hence, expert interviews were chosen as a cross-sectional method of research in order to "reconstruct subjective views in a specific aspect" (Flick, 2014). The stated goal of this thesis was to provide understanding and empirically grounded explanations of big data practices for environmental sustainability in shipping. It was therefore designed to uncover influences and relations to consequently lay the ground for more comprehensive and precise future research on causalities and their magnitude (Edmondson & McManus, 2007).

Building on existing conceptualizations, the process was characterized by a recurrent back and forth between the collected data and the theoretical framework (Roulston, 2010). This abductive method has the benefit of pushing the researcher to reflect on his process. Hence, underlying assumptions of the model were ideally never taken for granted (Flick, 2014). Throughout the interview process, a constant exchange between theory, empirics and analysis took place. As suggested by Dubois & Gadde (2002) this is particularly appropriate when using case studies aiming at theory development. Indeed, the objective of identifying factors that influence big data practices in shipping companies reinforced the rationale for this decision. Within the framework of this thesis, it was further pertinent to abandon the idealistic objective of grounded theory. Instead, a more realistic objective was adopted that aims at evaluating current practices and processes to develop of exiting theory (Flick, 2014). The developed theoretical framework was consequently applied to the data in order to identify which forces stand out in the shipping industry. This process ultimately allowed to complement the framework with new insights.

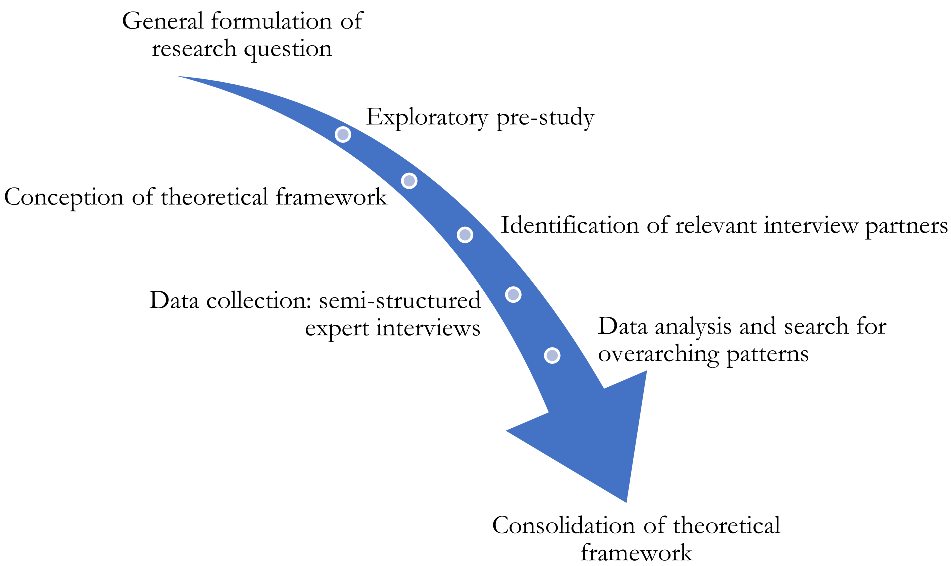

Figure 7: Visual representation of the research approach

4.3. Data Collection

4.3.1. Exploratory Pre-study

The initially identified area of interest, digitalization and sustainability in the shipping industry, had to be narrowed down in order to set a scene that is reasonable to explore within the limited amount of time dedicated to this master thesis. With this objective in mind, a pre-study consisting in three 20 to 90-minute unstructured interviews was conducted. It aimed at identifying key challenges for the shipping industry when it comes to digitalization and sustainability, today and in the coming years. The outcomes of this pre-study supported the decision to take a closer look at big data analytics within the context of emission to air. These topics stood out due to their extreme contemporary relevance.

4.3.2. Sampling

In order to integrate expert interviews in a coherent way, interviews were selected with a purposive sampling method (Flick, 2014). Considering the diversity of ship owners, this had the benefit of including rather extreme and deviant cases (Patton, 2015). Besides the theoretical rationale, this choice built on recommendations from the pre-study. Consequently, the interview sample ranged from small family owned shipping companies with few vessels to big ferry operators. In order to get a full understanding of the industry's dynamics, the sample also included representatives of other industry segments such as a ship broker, a classification society and a provider of monitoring solutions. 14 individual interviews and one group interview with three participants were conducted. The interviews were held via phone, via Skype or face-to-face and lasted between 30 and 90 minutes with a group interview of 120 minutes.

Since the shipping industry is comparably small and unknown, getting in touch with interviewees was carried out with the support of the Swedish ship owners association. The initial sampling strategy of constructing four distinct case studies covering four combinations of size and degree of digitalization had quickly to be abandoned due to poor response rates. In order to reach a representative number of interviews within reasonable time, the geographical sample was extended to Germany. When taking this step, the sampling strategy maintained its focus on typical cases (Patton, 2015) such as family-owned shipping companies with varying characteristics. The shipping industry being extremely competitive, market actors were sometimes reluctant to give interviews. Hence, the sample was partly driven by accessibility (Patton, 2015). However, after having overcome this initial drawback, a greater number of Swedish and German ship owners could be reached, that were characterized by their initial interest in the studied topic. A detailed overview can be found in annex 3. A brief overview is provided in the following table (table 1) including the first interviewees who were part of the pre-study.

Table 1. Brief overview of interviewees

Name	Position	Organization	Type of operation
Pia Berglund	Vice VD	Svensk Sjöfart	Ship owners association
Florian Bollongino	Innovation Manager	DNV GL Maritime	Classification Society
Claus Brandt	Partner	PWC Hamburg	Auditing - Consulting
Fredrik Larsson	Senior Policy Advisor, Safety & Environment	Sveriges Redareförening	Ship owners association
Andrus Vaher	Environmental protection and working environment specialist	Tallink – Ship owner	Ferry
Peter Knudsen	CEO	Blueflow	Provider of monitoring solutions
Christian Tokola	IT Developer	Blueflow	Provider of monitoring solutions
Claes Berglund	Director Public Affairs and Sustainability	Stena Lines – Ship owner	Ferry - Tankers – Offshore - Bulk
Daniel Schmode	Fleet Performance Project Manager	DNV GL Maritime	Classification Society
Carolina Ulff	Shipbroker	Tore Ulff AB	Broker
Ann-Kathrin Diercks	Responsible for Insurance claims & Crewing	Vega Reederei – Ship owner	Container - Bulk - Tanker
Jens Wagner	Head of ICT	F. Laeisz – Ship owner	Container - Bulk - Gas carrier - PCTC - Research
Frank Paleokrassas	Corporate Manager Fleet Performance	Bernhard Schulte Shipmanagement	Ship Management
Wilke Briese	CEO	Reederei Briese – Ship owner	Multipurpose - Heavylift - Research
Susanna Airola	Environmental coordinator	Viking Lines – Ship owner	Ferry
Capt. Pär Brandholm	Environmental & Nautical Manager	Laurin Maritime – Ship owner	Tanker
Dietrich Scheder-Bieschin	Managing Director	MACS - Ship owner	Multipurpose - Liner
Christopher Pålsson	Managing Director maritime-insight, Head of consulting	Lloyd's List Intelligence - Maritime intelligence	Consulting

4.3.3. Semi-structured Expert Interviews

Semi-structured interviews were chosen, being a commonly preferred method in qualitative research (Edmondson & McManus, 2007). They have the benefit of focusing on how interviewees frame and describe the investigated practices, revealing which factors stand out in importance (Bryman & Bell, 2011). Consequently, a pre-established interview guide with a series of open questions was designed leaving room for interviewees to elaborate further on certain aspects (Saunders & Lewis, 2012). The availability of an interview guide is particularly crucial in expert interviews, as it provides a narrower focus to the interview. Consequently, the interviewer can more effectively exclude irrelevant topics (Flick, 2014). By talking to individuals from different areas of expertise, the process aimed to tap into various knowledge registers. Questions were specifically oriented around the main topics of inquiry, big data practices and environmental sustainability. In line with semi-structured interviewing, frequent follow-up questions were asked to fully understand the specificities of every case. The interview guide was generally adapted to the type of operation. Further, specific interview guides were designed for interviewees who were not ship owners. The remaining challenge was to ensure that, rather than discussing general knowledge on the topic, the interviewee answered the proposed question (Meuser & Nagel, 2002).

The interview style was inspired by Rubin & Rubin's (2005) conversational interview. After a brief introduction of the conducted research, some warm-up questions were asked. Setting the scene was particularly important as most interviews were conducted over phone, with interviewees who had not been met face-to-face previously. Following this initial phase, interviewees were invited to describe their big data and sustainability practices as well as the related barriers and facilitators. Open-ended questions focused on building trust and a collaborative discussion with the interviewee. They were further encouraged to share practical examples and experiences to illustrate the problem area and the surrounding context. A critical challenge was to address often unpopular regulatory issues without drifting away into political discussions. Main questions were complemented with probing question in anticipation of the analysis stage. This allowed to evaluate the sequence and weight of processes, which seemed very relevant when investigating the influence of different factors on big data practices. (Rubin & Rubin, 2005)

The abductive approach invited to a constant reinterpretation of findings. Consequently, some aspects were investigated more in depth with some interviewees than with others as they seemed more applicable and relevant to different cases (Roulston, 2010). All interviews were recorded, translated into detailed interview notes and coded within 48 hours following the interview. Interview findings were further complemented by industry reports, press releases and statistical databases in order to provide a numerical estimation of the phenomenon under investigation.

4.3.4. Data Analysis

The analysis was structured into multiple phases of data processing inspired by grounded theory analysis (Hood, 2007). First, the collected data was browsed for recurring lines of convergence. This step had the objective of spotting recurring patterns and classifying the collected data accordingly. Next, these patterns were constantly contrasted with factors identified by Dubey et al. (2016) and Campbell (2007) in the spirit of the abductive research approach. In a process of constant comparison, it was therefore ensured to maintain a close connection between the conceptualization and the collected data (Bryman & Bell, 2011). Hence the empirical data was coded with the previously identified factors leaving room for the emergence of new labels or and so-called "core categories" (Glaser & Strauss, 1967) that might not be covered by the pre-determined framework. This step is defined as "theoretical coding" by Glaser & Strauss (1967). One of the main hurdles was to ensure a narrative flow that grasps the importance of different contexts when breaking up the data into these theoretical categories (Coffey & Atkinson, 1996). As a result, an aggregated list of patterns and categories came out of the data analysis process.

4.4. Quality of the Study

The qualitative nature of this study makes traditional quality indicators such as reliability and validity inappropriate to critically evaluate the conducted research (Bryman & Bell, 2011). Hence Lincoln & Guba (1985) defined more applicable criteria amongst which are credibility and transferability.

4.4.1. Credibility

Qualitative findings can be defined as credible if they are congruent with reality (Merriam, 1988). Hence, credibility referring to the broader idea of trustworthiness, entails two main concepts. First it understands that the research is conducted according to good practice, hence that research design and execution were carefully performed. Secondly, research findings were presented to members of the shipping industry in order to confirm the right understanding of the studied shipping industry (Bryman & Bell, 2011). Triangulation with secondary data was complement by targeting a sample of experienced interviewees who were able to share experience from a longer time span. As an additional strategy for increased credibility, the data was "peer debriefed" (Lincoln & Guba, 1985) hence regularly discussed with people who were not involved in the research process.

4.4.2. Transferability

As qualitative studies cover a rather small sample compared to the whole population affected by the studied phenomena, transferability becomes a crucial dimension of quality (Lincoln & Guba, 1985). It further refers to a problem-oriented extrapolation (Merriam & Tisdell, 2015). This was achieved by sampling such that deviant and extreme cases would be included hence aiming at representing a broad spectrum of ship owners. To increase transferability, it was further ensured that the interviewees were relevant members of the shipping industry. Further the current context of the shipping industry was outlined in order to give the informed reader the possibility to determine whether the study is transferable to the entire industry (Given, 2008).

5. Dynamics of the Shipping Industry

In order to set the scene for the following presentation of empirical findings, this section introduces some key dynamics of the shipping industry to the reader. This includes a brief explanation of the industry's organization (5.1.) followed by a description of the difference between time charter and voyage charter (5.2.). Finally, an overview of recent development at the regulatory level is provided (5.3.).

5.1. Industry Organization

Generally speaking different types of cargo require different types of shipping services, resulting in different characters across the industry. Today three main cargo segments can be distinguished: dry shipping, specialized shipping and liner shipping. Dry shipping transports raw material and semi-manufactures which is complement by liner shipping which carries smaller general cargo parcels. Specialized shipping is in charge of uncommon cargoes for example cars or chemicals. The demand to transport these three types of cargo is satisfied by two different streams of supply. One consists of companies with own fleets, using their own vessels to move their own cargo. The other is constituted by independent ship owners who charter their vessels to cargo owners. (Stopford, 2009).

5.2. Time Charter vs. Voyage Charter

Two main contractual arrangements are relevant for the context of this thesis: time charter and voyage charter. Hence a ship owner hires his vessel out to a charterer for a specific amount of time during which the ship owner stays in charge of the operational management and the charterer directs the ships to specific ports. The charterer party usually includes a bunker clause stipulating that the charterer covers fuel costs. In the case of *voyage charters*, the contract between the ship owner and the charterer differs. Port costs and bunker costs are typically paid by the owner. A price per ton is negotiated to carry a particular cargo in a certain vessel (Stopford, 2009).

5.3. Monitoring, Reporting and Verification Regulation (MRV Regulation)

In order to implement its 2013 strategy to address GHG emissions from maritime transport, the commission formulated the previously mentioned MRV regulation, which entered into force in August 2017 (EU Regulation 2015/757, 2015). This regulation appears as relevant to understand this thesis, as it can commonly be understood as a monitoring tool as defined by Campbell (2007). It stipulates the obligation that for vessels over 5000 gross tonnes in EU ports transporting cargo or passengers to report CO2 emissions/fuel consumption, distance travelled, time spent at sea and cargo carried on voyage basis. This data has to be reported to a verified third party and will annually be publicly disclosed. The expected goal of the policy is a reduction of CO_2 emissions by at least 2% by 2030 (Nelissen & Faber, 2014).

6. Empirical Insights

Drawing on interviews with different industry experts, the following section will present the main findings and emphasize the factors previously identified by the theoretical framework. First, the application of big data in shipping will be presented confirming the relationship established from previous literature (6.1.) Next, findings relating to external stakeholders will be presented (6.2.) followed by a section on internal dynamics (6.3) and concluding remarks (6.4.).

6.1. Big Data in Shipping

6.1.1. Application

In order to ground the following insights, the fundamental concept of big data and environmental sustainability in shipping appears crucial to repeat:

> *"If you can minimize or reduce something that often means less costs. So that also goes hand-in-hand. If you emit less of course you also have lower fuel expenses."*

This relationship materializes through the use of monitoring systems that collect data from various sensors on board. Once aggregated with relevant weather, position or speed information, it is presented in a user-friendly format to the crew. Their use on board has profoundly shaped the access to information with regards to the vessel's operation. While in earlier times, noon reports and daily reports were merely the only source of information, modern technology has altered the dimensions of today's operation:

> *"Earlier, you occasionally received an email from the vessel or some data and you knew: it's going from A to B. Speed is approximately 20 knots, weather will be bad, etc. Today, we receive much more data, much more possibilities, especially from a technical point of view. How is the engine running? What is the consumption? […] I can see if ships are operating in the same regions or compare sister vessels in order to see whether they are navigating in an optimal way."*

This emphasizes the different theoretical characteristics of big data in shipping. Indeed, it identifies the volume of data, its variety (engine performance, consumption) and also implicitly its velocity as modern technologies allow office access to this data real-time or almost real-time.

> *"We currently have our old reporting system, which collects data on emissions but it's a theoretical model. So, I don't think those numbers are quite right yet. I think this [digital performance monitoring] will give us more accurate values for the real CO_2 emissions. It will be interesting to compare it with our old report system…. Now it's the real flow and used fuel!"*

This statement underlines multiple critical elements. First, monitoring and generating reports itself is something that has been done for quite a long time due to the financial rationale. Secondly, a main added value from the introduction of digital monitoring and big data is accuracy of information. Building on this evolution of data, future plans are to identify how this information can be processed and exploited. Most ship owners stated that nowadays they have the ability to use

20-50% of the collected data. More advanced analytics with predictive value were commonly mentioned as the way into the future.

When it comes to more effective scheduling, the current state of the industry is not as advanced, yet. Information on ships' positions is commonly available thanks to AIS tracking, but systems do not include routes of other vessels, yet.

> *"It would be much better if all routes would be planned, and if there were a better coordination ahead, for example a computer to optimize all the movements. We have AIS systems to know where we are, and we can see where all the other ships are as well, but the next step will be to know where the other ships are going"*

Similarly, port scheduling is currently far from being fully optimized as waiting times at arrival are still very common.

6.1.2. Organizational Use of Big Data

The outlined big data practices were shown to improve internal availability of information. On this basis, interviewees put forward the point that by using monitoring systems they gain a better understanding of what it is happening on board on a real time base. This improved information quality would in a second step allow a higher degree of optimization and energy efficiency.

> *"In the longer run I think that people will see that the benefits of getting more accurate data. It's smart and it's always easier to make analysis that you can use. When you take decisions on what to do next it's nice to know that you have the best possible data."*

This statement comes with a side note. In many cases, the full automation of data collection is not ensured yet. Indeed, the data coming in is still checked by humans on a regular basis. Its well-functioning and reliable accuracy currently remains one of the major burdens.

Nevertheless, the modality of this improvement had to be further investigated. It naturally led to the question whether having certain performance information available improves environmental awareness within the organization. It turned out that big data has not precisely created awareness for environmental topics. Building on the basic fuel-emission equation, tracking fuel consumption is something that has been done for a really long time, long before the availability of digital tools.

> *"Environmental awareness has certainly increased both on land and in the fleet over the past years […] but this is certainly independent of current technological standard."*

Nevertheless, one of the interviewees explained that his company actually tested this process on one of their vessels. As a matter of fact, when his company first started using performance monitoring systems on board, they conducted a small experiment on one of their vessels. The system was installed without giving the crew any instructions. It was ensured that external conditions were maintained identical, hence the ship was trading in exactly the same area with the same speed profile. After a three months trial period, they went out to train the crew, explaining the actual use of the system and confronting them with the observed result. Indeed, the ship had already recorded a performance increase of 9%, of which at least 2% were attributed to the nudging experiment of the management.

These statements further enlighten the concrete application of big data to improve environmental sustainability, further raising the question which forces are driving the implementation of this practice.

6.2. External Change Drivers

6.2.1. The Business Model

The cargo segment differentiates between voyage charter and time charter, with time charter representing about 60 percent of the market. The contractual arrangement of time charters has an important impact on the studied process. Indeed, the ship owner is the one making investments in software and hardware on board such as monitoring software, flow meters or sensors. Nevertheless, since the charterer covers the bunker costs, the ship owner does not perceive the direct economic benefit from reducing his fuel consumption. This dynamic leads to an inherent misalignment of incentives:

> *"The business model in the shipping industry sort of outsources the motivation to be sustainable. We do have the data and describe the vessels in terms of speed and consumption including eco-speed but the decision and the benefit to operate a vessel more slowly in order to reduce emissions is outsourced. Based on the charter party it is not in our interest but in the interest of our client."*

Further, charterers are in charge of the scheduling and decide which ports are being called. Consequently, the flexibility and interest of ship owners to act upon the potential insights generated by big data are limited.

> *"We have no interest or no added-value to analyse this data, it does not serve any purpose. We actually cannot harness any value from this data as it is does not lie in our power of disposition to take decisions according to the data."*

The motivation to engage in practices regarding fuel efficiency therefore highly variates depending on roles in the industry organization.

> *"To this regard, the interest of every party is different. Of course, a charterer and an operating owner will want and care about fuel savings because they are paying the fuel bill. The ship owner will primarily be interested in saving things such as lubricants for example or operating expenses. And the ship manager wants to make sure that the ships run the best way possible for their clients being therefore more or less aligned with non-operating owner you could say."*

These empirical insights underline the core distinctions in the motivation of ship owners to engage in big data use for environmental sustainability. The question further arises where the motivation to invest in monitoring systems stems from, if the perception of financial benefits is that limited.

6.2.2. Customer Demand and Competitiveness

6.2.2.1. Cargo Transportation

The type of operation and business model of the ship owner also impacts who characterize as his customers. In the cargo segment, the transport typically characterizes as B2B. Among these ship owners, customers differ depending on the type of charter.

Ship owners who promote their fleet on the time charter market have charterers as their customers. These can for example be other ship owners who seeks to expand the capacity of their fleet for a limited amount of time. Charterers see big data practices for environmental sustainability as an indicator for energy efficiency. As previously described, ship owners with performance monitoring devices are likely to have relatively lower fuel consumption. This would result in lower bunker costs for charterers. Nevertheless, currently there seems to be no willingness to pay for a premium on rates for improved monitoring and performance.

> *"I'm honestly not sure whether in the end it is paid by the customer to be green and burn little fuel. We are a branch that is very cost driven und in which the freights are mostly attributed based on the cheapest price for a certain order. Sometimes you rather have to fulfil the transparency requirements. They want to make sure that whoever gets to do the job is compliant. They put these requirements on themselves. I don't think that it makes a big difference when it comes to the price, but you avoid being kicked out of the competition by not being able to offer these, this is an advantage."*

This underlines once again the misalignment of incentive as better rates would be the only way for ship owners to directly return their investment on monitoring devices on their vessels. Nevertheless, more accurate information on fuel consumption can prove to be a useful negotiation tool.

> *"If an owner engages in a discussion with one of the charterers whereby they claim overconsumption for a certain voyage or something like this, no matter what we present to them they will present something else to us because they have their system and we have our own system. So, it always ends up in a discussion that is more of a negotiation than something transparent and inarguable because there is no one way to represent in and to measure it."*

The interviewee further elaborated that standardized monitoring system provides transparency for all parties involved as discussions can be based on accurate figures. Nonetheless, as charterers and their clients are also increasingly impacted by more stringent environmental regulation, a turnaround might be lying ahead.

> *"The importance (of environmental sustainability) rather increases and I think over the years more attention will be dedicated to this topic especially as the freight side increasingly asks for transparency regarding environmental guidelines. They want to know how much CO_2 was emitted during the transport in order to themselves establish their footprint."*

As a matter of fact, many producers of consumer goods are starting to be more aware of their environmental footprint as end consumers increasingly require this information. Consequently, it appears that these companies put stricter requirements on themselves in order to avoid for example bad press.

For shipping companies operating with voyage chartering, the customers are usually cargo owners. In this case, the motivation to use monitoring devices to reduce emissions is much more intuitive. Since the responsibility for fuel costs in on the owner side, a direct financial benefit is perceived. Consequently, the pressure to reduce emissions came much earlier and was mainly cost driven.

> *"You strictly have to differentiate between tramp and liner trade. On the liner side, sustainability is very important. When you look at websites of liner shipping companies, it is all about sustainability. Because these ship owners sell directly to end consumers. The tramp companies are one stage before. They don't have an interface with the end consumer hence the marketing of green tonnage is completely dependent on our customer."*

The differentiation made by the interviewee here is that tramp traders offer their ships on the charter market for time charter (as referred to here) or voyage charter. Their focus on sustainability depends entirely on the sustainability preference of their charterer. Liner companies operate according to a fixed schedule under published tariffs and have direct contracts with cargo owners. Consequently, the reduced distance to the end consumer stands out as a main barrier for tramp companies to become more sustainable.

6.2.2.2. Passenger Transportation

As for ferry operators, leaving aside for a moment the cargo customers, a sizeable segment of their customers are individuals, making the business B2C. This however turned out to leave the priority of environmental considerations unchanged. The lacking awareness and consideration of customers regarding environmental efforts made by shipping companies therefore creates frustration and questioning:

> *"I sometimes say that, they [the customers] appreciate more that we have ecological wine in the shop. They see that "Oh it's really good" and then we make this 20-million-euro investment, but they can't relate to that. They don't realize. It's not in the awareness of the public. So, that's an additional challenge: why should we do this? Nobody asks for it, it just costs money."*

Whether ship owners' initiatives take the form of big data practices or of more visible and expensive retrofits to alternative fuels such as LNG does not seem to matter. Currently, customers do not have a strong appreciation for sustainability measures. Notwithstanding this situation, in a similar way than for charterers, a shift in perception can be sensed. The rapidly changing awareness of customers regarding air emissions can be compared to the shift in the perception of waste disposal. While some years ago, a passenger throwing his plastic cup overboard left co-passenger indifferent, it is highly likely to trigger a general outcry today. The emission debate, although suffering from a lack of direct visibility, is expected to accelerate likewise, supported inter alia by dynamics in other transportation modes such as the diesel gate in the automobile branch.

It can therefore be concluded that today there is no real customer demand for better environmental sustainability and the related big data practices. One of the interviewees operating mainly in northern Europe raised an important point in the dynamics surrounding this process:

> *"We call it like a hygiene factor. So, I think the customers are now more responsible and they know a lot more. They just assume that we are doing the right thing. When I compare it to for example ten years ago, you could promote it much more. Since historically we have been doing a lot more than the legislation demanded and we could easily promote this to our customers."*

While most ferry passengers do not choose the operator over a competitor for its better environmental performance, they often seem to inherently assume a certain level of environmental consideration. The request of information from ferry passengers is expected to grow and will force operators to find a balance with regards to information disclosure. Disclosing too much information could give competitors sensitive details about the companies' operation. Ship owners stated that they currently have more data than they would be willing to share with their customers. Hence issues surrounding cyber-security and disclosure policies are likely to become of raising importance for all participants in the industry.

6.2.3. Role of the Regulator

Having outlined the currently poor demand from customers for better environmental availability, many interviewees pointed to the role of the regulator.

> *"Shipping is very low on the food chain, I mean from a consumer perspective you don't really know, or you don't really care. If you buy something in a store that gets transported by a containership here, for you as a consume to ask, "What fuel did that containership use?", it's for a very long, far-fetched idea. So that's why I think that what is going to fix shipping is actually regulations and not pressure from customer."*

This accurately describes the developments in the last decades. Starting with waste disposal and ballast water treatment, the IMO has consequently been addressing the impact of shipping in the environment. With regards to emission, this materialized in energy efficiency regulations such as SEEMP and EEDI addressing the technical and operational functioning of the vessel. Further, the introduction of ECA in certain European waters has forced owners to run either on cleaner fuel or to install technologies to clean exhaust gas (IMO, 2018a). As a result of the regulatory upturn, many ship owners feel like they face an unreasonable amount of regulation hindering optimal operation. At the same time, owners seem to be aware that regulation is needed to push the industry towards a better consideration of the environment.

> *„The regulatory pressure in shipping is very very high but the shipping industry does not do anything out of inner motivation. Hence there will definitively be change resistance."*

The MRV regulation formulated by the EU is an interesting dimension of the studied big data practice for environmental sustainability. Indeed, the objective of the regulator is to collect accurate data in order to be able to formulate realistic emissions reduction goals. The industry's reaction has however been rather negative. Despite, the technical question of how emission factors are being calculated, which will not be further elaborated on in this thesis, many actors actually stated that they have already been collecting identical data prior to the implementation. Hence, a general complaint is that the regulator only puts an additional administrative burden on the crew.

> *"We have done it for years already, yes. This is not something new for us. Of course, the format and the requirements were a bit of a new thing to everybody, but we could gather that information from our existing data base."*

It appears that the MRV regulation fails to be sufficiently extensive. This is because it does not require a degree of accuracy that is adequate to provide all ship owners with new insights. The discussion however further arises, whether digital tools might actually facilitate the data collection. By responding to the regulatory demands in a fully automatic way, they leave more time for the crew to fulfil their other tasks on board.

> *"For us, monitoring tools have the main advantage of allowing us to respond better to these environmental requirements."*

Indeed, if systems are well implement and include direct and continuous emission monitoring, the reporting can work almost automatically. Here, a broad spectrum of digital maturity could be observed. More accurate monitoring equipment requires higher investments but also results in lower operational costs. On the other end of the spectrum, less digitally mature ship owners, using for example bunker delivery notes, complained about high operational costs to fulfil administrative tasks related to MRV.

Another fear of ship owners is related to the disclosure of information. The MRV regulation states that emission related data including CO_2 emission and average fuel consumption per vessel will be published yearly. Since acting in an extremely competitive market, owners fear that price sensitive information will become public. Moreover, the regulation only affects ships calling EU ports and is perceived as an inherent disadvantage compared to companies operating outside the regulated area. The sum of these features became another source of ship owners' resentment towards the MRV regulation.

In contrast to this, industry experts defended the opinion, that despite the general resentment of ship owners, the benefits of the regulation will outweigh its costs in terms of additional time and equipment investments. Indeed, interviewees expected savings in terms of CO_2 emissions to be considerably higher than the endured costs. While they confirmed this relationship they also highlighted the broadness of the spectrum between the most and the least advanced ship owners. Hence the burden of additional costs will not be distributed equally across the industry. Rather, it will hit some owners more severely than others. Nevertheless, the public disclosure of information is hoped to trigger a positive change in behaviour from the industry's "black sheep".

The EU is currently considering a harmonization of their MRV system with the upcoming IMO monitoring system. As a consequence, some interviewees expressed a general fear to make investments in inadequate technologies, thus to "bet on the wrong horse". Responding to the question what barriers inhibit further improvements of environmental performance, a ship owner said the following:

> *"The regulatory uncertainties! The IMO and the suppliers of compliance systems are not fully evaluated and certified. We, as ship owners, don't have the security that compliance with regulation in the future is ensured. Consequently, the investment decision is extremely inhibited."*

It can be understood that ship owners are afraid to lock themselves into systems that might soon be outdated. If devices generate insufficient information for contemporary regulatory requirements, expensive investments might have to be overhauled before having been paid off. However, this argument only holds under the assumption that the only rationale to implement monitoring systems are regulatory requirements. In many cases, ship owners have installed devices to benefit from the savings internally and to improve environmental performance out of their own initiative.

6.2.4. Independent Industry Platforms

Another dimension in the debate surrounding big data practices in shipping lead to actors outside of the previously outlined stakeholders. In a general movement towards more transparency, a series of third party platforms of different format emerged across the industry. The main platforms mentioned by the interviewees were the following.

- BetterFleet[1], created by Carbon War Room, exactEarth, Righthship and University Maritime Advisory Service, is the first openly available online portal reporting operational efficiency of vessels around the world. The information reported is aggregated from publicly disclosed information and AIS data.

- Business for Social Responsibility's (BSR) Clean Cargo Working Group (CCWG)[2] B2B initiative builds on the voluntary collaboration of industry members mainly in the container segment representing together 85% of the global container capacity.

- BIMCO's Shipping Key Performance Indicator (KPI) system[3] is an industry tool to report operational performance including extensive indicators on environmental performance and energy efficiency. As the CCWG report, it is based on voluntary participation. It allows ship owners to benchmark their own efficiency and improve their internal and external communication on KPI's.

The overreaching goal besides sharing best practices is to provide standardized information and benchmarking indicators. The idea is that by making this information openly available, customers can make better informed choices. Indeed, charterers get access to free independent information regarding the energy efficiency of different vessels. Consequently, they have the ability to guide their commercial decisions by sustainability considerations. Hence, the availability of more precise monitoring data triggers public transparency that further leads to improved environmental

[1] https://rmi.org/our-work/transportation/shipping-efficiency/betterfleet/
[2] https://www.bsr.org/en/collaboration/groups/clean-cargo-working-group
[3] https://www.bimco.org/ships-ports-and-voyage-planning/shipping-kpi-system

sustainability. This should ultimately create a competitive advantage for "greener" shipping companies, provided that customers start to adjust their choices in the light of these insights.

6.2.5. Core Industry Dynamics

Besides these main drivers of big data practices, some core dynamics of shipping were further mentioned as influencing the implementation of big data practices.

First, shipping companies face a **trade-off between commercial and environmental needs**. Indeed, delivering cargo on time is a challenge with highest priority. Every day on board comes with additional costs. Speed of delivery also constitutes an important factor with regards to competition stemming from other transport modes such as aviation. At the same time, increased speed equals increased fuel consumption hence increased emissions. This is particularly true for liner companies and ferry operators who operate on schedule.

> *"There is a certain trade-off between the needs of a liner shipping company in transporting their cargo from A to B as fast as possible. There are multiple input factors influencing the decisions. Not only sustainability, but sustainability plays a very important role."*

These companies constantly have to balance these opposing needs. Reducing emissions can only be done up until the point at which on-time arrival is ensured. Here the previously discussed coordination of the system would come in handy. Indeed, vessels often have to deal with waiting times at arrival because there is no free space for unloading yet. If this information could be made available to the vessel during the journey, speed could be reduced in order to arrive precisely when a spot at the pier is freed. Slower voyage speed would result in reduced emissions. This observation can be translated to passenger transportation. When booking a trip from Stockholm to Riga, the customer expects the ferry to arrive on time. Slow-steaming to achieve lower emissions is therefore limited. Consequently, the trade-off between environmental performance and operational obligations can be stated as a barrier to further optimize operations.

Secondly, the **global dynamics of the industry** put pressure on companies in the industry. Indeed, when doing a trade from Hamburg to Hong Kong, a German ship owner not only competes with his national or European peers but with ship owners from all over the world. This further explains the resistance of European shipping companies to be included in the EU emission trading market as it would consist in an inherent competitive disadvantage on the global level. The fact that European ship owners make a large majority of their business outside of European waters further reinforces this resistance. Consequently, there is a lack of motivation to be at the forefront of big data and environmental sustainability as long as these represent extra costs for which no premium on the market can be perceived.

> *"If the others don't do it, it is very hard to do it alone because it is partly connected to optimizing the system. If you are the only one doing that, you don't want to do it. There is no point."*

> *"All of this will take time because everything we do has to be global. It is very hard to do local projects unless they are in domestic trade or in small areas. So, it's a big challenge but I'm sure we will do it. The big companies will start!"*

The last sentence of this quote leads directly to the third key industry characteristic: the **fragmentation of the industry**. The shipping industry is not only extremely diverse but also includes a comparably large number of player compared to the overall size of the industry. This becomes particularly apparent when comparing it to the aviation industry, which is dominated by very few main suppliers and a dozen of operating companies (KPMG, 2018). Hence, the interviewee expects the industry incumbents to slowly drive the change as it needs a critical size to impose a system that will consequently dominate the market. Another actor driving the transitions towards big data practices are class societies:

> *"The reason for being them [the class societies] and not us and not the shipyards, is that all ship owners are relatively really small compared to the size of the industry. That makes it very hard for single ship owners to drive the development themselves."*

Finally, since vessels are assets of considerable size and value, the **duration of useful life and of investments cycle** further impacts the speed of change towards big data and environmental sustainability.

> *"Ship owners are obviously concerned with environmental sustainability but traditionally this is illustrated by a renewal of the fleet. Whenever a fleet is renewed, and these are in shipping longer investment cycles, one works with the goal of environmental sustainability to comply with the current standard of technology and regulation."*

The interviewee further explained that in Germany, a ship owner keeps his vessel about 15 years before its technical state is outdated to an extend that the vessel cannot be operated according to contemporary market standards anymore. For owners with in-house chartering, this can be even longer (20-25 years) as the vessel is not exposed to direct competition. Hence, a fleet should renew itself within cycles of 15-25 years. This investment cycle is however much longer than what has recently been observed in modern technological innovations such as smart phones (Carton, Mongardini, & Li, 2018).

This has not been confirmed throughout all interviews as some ship owners mentioned that they have actively done technical retrofits. Hence, this statement should be evaluated with care as it is closely related to the availability of resources. Nevertheless, it points out that ships are limited by their core attributes when it comes to the potential to save fuel through performance optimization. Just like eco-driving assistants for cars will never get to the point where a truck consumes 5 litres for 100 km, the fuel consumption of vessels can be optimized until up to a certain technical limit.

In the light of this information it is useful to remind the reader of the previously outlined tension regarding regulatory uncertainties. Indeed, with consideration of the asset value and the magnitude of related investments, the conservative behaviour of ship owners regarding new technologies becomes more comprehensible.

6.3. Internal Change Drivers

6.3.1. Economic Conditions

The global shipping industry has encountered serious problems triggered by the global financial crisis in 2007 – 2008. This ongoing bad situation resulting in extremely low charter rates has put an extreme pressure on ship owners further restricting their scope of action regarding investments in performance monitoring technology.

> *"Since we don't make money, we also can't spend it to more environmentally sustainable than what the regulator requires it from us."*

Moreover, the shipping industry can be characterized as extremely cost-driven, leaving little space for investments that do not seem immediately necessary in times of low profit. The sum of high competition, heavy regulation and an ongoing bad economic situation has created pressure for many ship owners.

> *„Shipping is extremely competition-oriented. It's a competition fight, with inexistent margins or profit, a fleet that is getting consistently older and diverse new technical regulations imposed by regulators which we have to fulfill."*

Consequently, the primary barrier that arises with regards to the implementation of big data solutions, is the matter of resources. While suppliers of monitoring solutions claim that the investment would be paid off within one or two years, many ship owners are difficult to convince in times of struggle. Independent of the geographical location of the shipping company (Sweden or Germany), implementing big data practices is primarily driven by financial incentives.

> *„Many say that they do it for environmental reasons and I do believe that they want to work on that but if there wasn't a financial interest as well they probably wouldn't do it. "*

> *„It's all about savings, savings, savings. They all want to pay less. "*

This holds true despite savings being comparably low and indirect for owners operating on time-charter market. The expectation that remuneration and consideration for more sustainable transportation will rise in the future provides an explanation for this position.

Time resources were further identified as an important factor for the successful implementation of performance monitoring projects. Besides investment costs, owners have to calculate labour costs related to the implementation of the system. Further, as long as owners are preoccupied with the survival of their companies, little room is left for forward oriented discussions around big data practices and environmental sustainability.

> *"Before going into digital projects you need to be prepared and let it take the time. If you don't have that, then it is easier to say no not now. "*

This is where ship owners often pinpointed an additional barrier. On one side, people working on board have multiple other roles and the use of monitoring devices comes as an additional task. On the other side, the implementation of the monitoring system has to planned and coordinated from office personal ashore.

6.3.2. Leadership in Family-owned Companies

The decision to implement advanced monitoring systems is closely linked to a top management commitment. Indeed, a management team that is personally devoted to environmental sustainability has been commonly mentioned by the interviewees as one of the main drivers of progress in digitally mature companies. Furthermore, the investigation on reasons explaining why certain shipping companies are more advanced than others yielded another interesting dimension:

> *"The shipping industry is mostly dominated by family companies. I think that they make a good haven for shipping because it so cyclical. It's very hard to explain to shareholders that "Ok we've done a loss for 3 years but I'm sure next year it's going to be fine". Shareholders don't accept that. They just leave and do something else. But in families you have a long-term view and you know it's cyclical and that eventually you will have a few good years followed by some bad years."*

Hence, being sustainable, which today implies the use of the discussed tools, not only requires the commitment from the top management but also the possibility to take on projects that might not results in direct financial returns.

> *"It's entirely different; we are not working on a quarter to quarter basis. We are talking about long term strategic goals that have been constant for many years. Our management usually talks about planning a generation ahead so it's not quite the same as a publicly owned company that changes board every 3 or 4 years."*

The long-term perspective that comes along with family ownership forces companies to take into account sustainability concerns with greater seriousness. As the growing importance of this topic is almost certain, it becomes a matter of future competitiveness and survival on the market. The recent developments at the IMO regarding the industry's effort to cut CO_2 emission by at least 50% until 2050 (IMO, 2018d) can only reinforce this statement.

A common feature that stands out across these statements, is that many ship owners are family-owned or still strongly dominated by the founding family of the company.

> *"We have seen some families that are very ahead with sustainability issues. I think Wallenius, is such a shipping company. They have been very on the forefront of being on the green side so to say. They have been running on much lower sulphur fuels than other companies long before they had to do it because it was a commitment from the owner and that would never happen if it was a stock listed company. But not everybody is like that."*

Indeed, family ownership remains the dominating ownership in today's shipping industry especially in container feeder and tramp bulk carrier sections (Soare, 2015). It appears that this becomes a relevant dimension to the discussion surrounding big data practices. Having outlined that at the moment there are very little financial rewards for ship owners, these are insufficient to justify investments in performance monitoring tools. Hence, it calls for the personal commitment of owners, who have relative freedom of their decisions as they do not have to justify themselves in front of shareholders. The downside of this arrangement is that family ownership often comes with a long tradition. Hence, family companies might show the tendency to be trapped in outdated mind-sets and hence more prone to conservative decision-making.

6.3.3. Employee Involvement & Training

Finally, the successful improvement of environmental performance through monitoring devices is closely related to the dimension of employee involvement.

> *"There are some systems out there, claiming that the technology itself will save fuel, that just by installing a system you will save fuel automatically. But it doesn't work like that. You need to have everyone on board. Everyone's mind-set must be to save fuel. From the office, to the master, to the chief engineer. Everyone needs to accept this. That's the challenge... to get everyone on board. If you manage that, then you will save fuel."*

The interviewee highlighted that the crew has to be given the ownership of the project for it to generate consistent efficiency gains. Involving employees in every step of the process becomes a critical factor of success. Consequently, training the crew on board on the use of monitoring devices and the necessity to save fuel has become increasingly important in the process towards better environmental performance.

> *"Training is an important point and there is definitively room for improvement here. You have to drill the master and engineers to understand which consumption impact is related to sailing at different speeds in order to optimize it. Operator as well as master and chief engineer, all three, should be sensitized in order to get them to do it. There I also think that big data is a very important tool to compare ships across the fleet and see which operator operates the ship more efficiently per mile. Here I see a lot of potential."*

As described by the interviewee, data enabled cross-fleet comparisons become a useful tool in training. Indeed, voyage performance of different masters can be tracked more accurately giving for example room to initiate healthy competition on low fuel consumption among masters. This is particularly applicable to ferry operators as voyages are easy to compare.

> *"It's easier if you run a ferry because you run the same route every day and you can compare everyone. You want to beat your own record: so last time I did this run and I only consumed this much fuel and next time I am going to do better. Or this captain consumes more fuel than that captain. So why is this? They are doing the same run?! We are trying to create competition between the captains and we give them system support to optimize the routes depending on weather and current and traffic, etc, etc."*

Additionally, Swedish operators have the specificity that they operate locally. Hence, many crew members live in direct proximity to the sea they operate in.

> *"The Baltic Sea is their own home sea."*

Hence there is an increased commitment and motivation to engage in practices that are more considerate of the environment they themselves live in. Operating locally, overcomes the inherent problem that shipping, and its environmental impact are very abstract for all stakeholders involved.

6.4. Concluding Remarks

The empirical findings regarding big data practices for improved environmental sustainability in the shipping industry have uncovered a series of intriguing factors and dynamics. First, previously identified applications were substantiated throughout the interviews. Big data practices have the main contribution of allowing performance monitoring and enabling an improved access to accurate and reliable information. The advancement of operational scheduling turned out to be at an earlier stage of development. Multiple factors could be identified as relevant in the decision to implement this process in shipping companies. Customers seem to have a growing but currently weak demand for better environmental performance. The impact of the regulator is correlated to the degree of digital maturity of ship owners previous to the implementation of the policy. The fear of regulatory uncertainties was also highlighted. Further, the misalignment of incentives in current chartering contracts constitutes an important barrier to invest in performance monitoring technology.

In addition to this, some key characteristics of the industry were highlighted as obstacles to further progress in the field of big data practices in shipping. These included the trade-off between commercial and environmental objectives, the global exposure of the industry, its high degree of fragmentation and the duration of investment cycles. From a firm perspective, economic conditions and financial performance dominated the debate around big data practices. Leadership and management commitment in family-owned companies offered an explanation for differences in development between ship owners. Finally, employee involvement in innovation processes and big data use for employee training and awareness raising were commonly identified.

7. Analysis

In this section, the empirical findings will be analysed taking the perspective of the previously developed theoretical framework. It therefore aims to provide a tentative answer to the pre-formulated research questions. First, it will look at the supporting factors regarding big data practices for environmental sustainability in shipping (7.1.). Secondly, it will analyse the role of transparency in these practices (7.2.).

7.1. What Influences Big Data Practices for Environmental Sustainability in Shipping? (RQ 1)

The empirical findings allow at this point to analyse the previously identified factors regarding their relevance for the shipping industry. Moreover, their presence in exchanges between stakeholders (firm, customers, regulator, competitors) and the process of big data practices for environmental sustainability is reviewed (Figure 8).

Customers were shown to play an interesting role in the organizational field of ship owners. First, it was determined that currently there is no significant demand nor pressure from customers to use big data practices for environmental sustainability. This could partly be explained by a weak consumer contact (A. A. King et al., 2002). Instead, these practices were labelled as a hygiene factor ensuring a ship owner's competitiveness on the market. Despite an absent relationship with customer satisfaction, multiple interviewees pointed to a steady development towards such a link. A rising demand for better information and monitoring, particularly in the cargo segment, gave evidence of this. Indeed, certain customers started putting more stringent environmental regulation on themselves. This hints towards industrial self-regulation (Campbell, 2007) in the customer segment that could impact ship owners' decisions in the future. The misalignment of incentives in chartering contracts has however to be fixed, to increase customer's influence. While ship owners bear the investments in monitoring technologies, charterers perceive the large majority of benefits from reduced fuel consumption. Notwithstanding, a premium for particularly efficient vessels is not being paid, yet. Hence, it can be argued that Dubey et. al's (2016) factor of customer relationship is applicable. Indeed, customers do impact a ship owners' decision to implement performance monitoring. However, at the current point in time, this rather constitutes a demand for monitoring rather than for green practices.

As indicated throughout this thesis, **regulators** take a prominent position in the dynamics surrounding big data practices for environmental sustainability in shipping. Indeed, they appeared at both, the firm- and the industry-level of change (Campbell, 2007; Dubey et al., 2016). Their role is two folded: it can be analysed first with its immediate effect on big data practices and secondly with regards to a more long-term formulation of a CO_2 strategy for the shipping sector. With regards to MRV, as ship owners outlined in detail their compliance strategies, the policy's implementation was demonstrated. Its uniform impact on the industry allowed the conclusion that up until this early point, it has been rather well enforced. However, the findings revealed that the regulation lacked a degree of accuracy that constitutes a progress for the entire industry. As some actors were already more advanced, the regulation failed to trigger the previously outlined innovation in big data practices (Porter & van der Linde, 1995). It is currently still possible to fulfil the requirements without the use of automated performance monitoring. Consequently, new optimization gains with regards to fuel consumption could be reached only for parts of the industry.

Secondly, the EU MRV has to be evaluated as a preliminary step to a comprehensive GHG emission policy. In this context, it gathers the necessary information to formulate a policy that balances available technologies with economic and environmental consequences. According to Campbell (2007), this step significantly helps the effectiveness of future regulation. Consequently, this form of state monitoring allows to build a solid information base that will also improve public transparency as the reported data will be disclosed online. It further can constitute in itself an incentive to reduce emissions (Kleiner, 1991). At this point in time, it can be concluded that the regulator therefore impacts big data practices in shipping through well enforced but weak requirements. It also provides public monitoring of environmental performance throughout the sector. It therefore presents the first step towards an inclusive and well-founded CO_2 strategy.

With regards to **competitors** and the competitive landscape, the current situation in the shipping industry characterizes, according to Campbell (2007), as "too much competition". On one side, European ship owners make a large part of their business outside of European waters. On the other side, the global character of the market makes it easy for competitors from around the world to enter the direct competition regardless of their country of origin. Hence, the shipping industry is constantly exposed to global market forces. When profit margins are low to a degree that the organization's survival is put at risk, cost reductions become the highest maxim. Especially in the face of international competition with lower ethical and environmental standards, the competitive pressure is typically high. As outlined by previous research, little slack resources leave no room for environmental investments (Henriques & Sadorsky, 1996). This tendency could clearly be sensed throughout the empirical study. Consequently, competitors affect big data practices in shipping in a negative way by restraining the room for investments of long-term interests.

In addition to direct competitors, a rise of independent industry cooperation providing monitoring platforms was noted. The reporting of efficiency indexes and environmental performance on platforms such as BetterFleet, Clean Cargo Working Group or Bimco Shipping KPI has two main benefits. First, it enables the previously mentioned monitoring by customers. Secondly, it enhances sharing of best practices among ship owners. Hence, these actors were identified as facilitators in the information exchange between the identified stakeholders.

Moving on to the **firm** level allows to evaluate the influence of internal factors on the studied process. Leadership, as a pre-defined factor, presented theory congruent empirical findings. Top management awareness and personal dedication to the issues of environmental sustainability were consistently highlighted as influencing factors. This was further reflected in a generally positive attitude towards sustainable practices and a commitment to make the necessary investments in monitoring technologies. More advanced interviewees pinpointed this aspect as the main reason for their development stage. However, this was always subject to a financial dimension. A clear connection to resources becomes apparent as economic conditions were shown to impact big data practices of ship owners. Indeed, the ongoing poor situation of the freight market was recurrently pointed out by owners. Particularly in the cargo segment, it constitutes a critical barrier to invest in more advanced performance monitoring tools. With little or no slack resources, investments without a direct financial benefit are categorically refused. In times of cost reductions, owners do not have resources to spare for high-end monitoring devices going beyond regulatory requirements. If performance monitoring practices are present, employee involvement and training are key to achieve optimization and improved environmental performance. In line with the common understanding of change management (e.g. Kotter, 1996), building trust and sharing the project ownership with employees were identified as important steps. The aspect of training can further be added to Dubey et. al's (2016) employee involvement dimensions. Indeed, training is important to ensure consistent benefits from installed systems. Crew members and office personal have to be made aware of fuel consumption as variable of environmental performance. In this process, big data can become a useful teaching tool to illustrate the relationship between for example speed and emission.

In addition to the pre-determined factors, ownership turned out to affect big data practices for environmental sustainability. The findings revealed that the longer time horizon of family-owned ship owners facilitated investments in big data practices. This is further supported by Campbell's (2007) argument that the necessity to maximize shareholder's value is the origin of the issue that companies fail to engage in sustainability behaviours. Hence, family-ownership can ease this dimension by providing an owner that is committed to the environment with a larger scope of action. Nevertheless, this has to be put into perspective with the traditional mind set of many family-led companies, that can hinder innovative and future oriented decisions.

The findings attributed the differences in digital maturity to the firm-related factors. Indeed, especially leadership and ownership stood out as game-changing variables. As a matter of fact, ship owners who had already been using monitoring systems for multiple years before the MRV regulation assigned this to the farsightedness of a committed owner. This seems logical considering that all other factors related to customers, competitors and regulation remain relatively equal for all ship owners. An exception can be made for Swedish ferry operators as they operate in a more localised setting, where global pressure is not as strong.

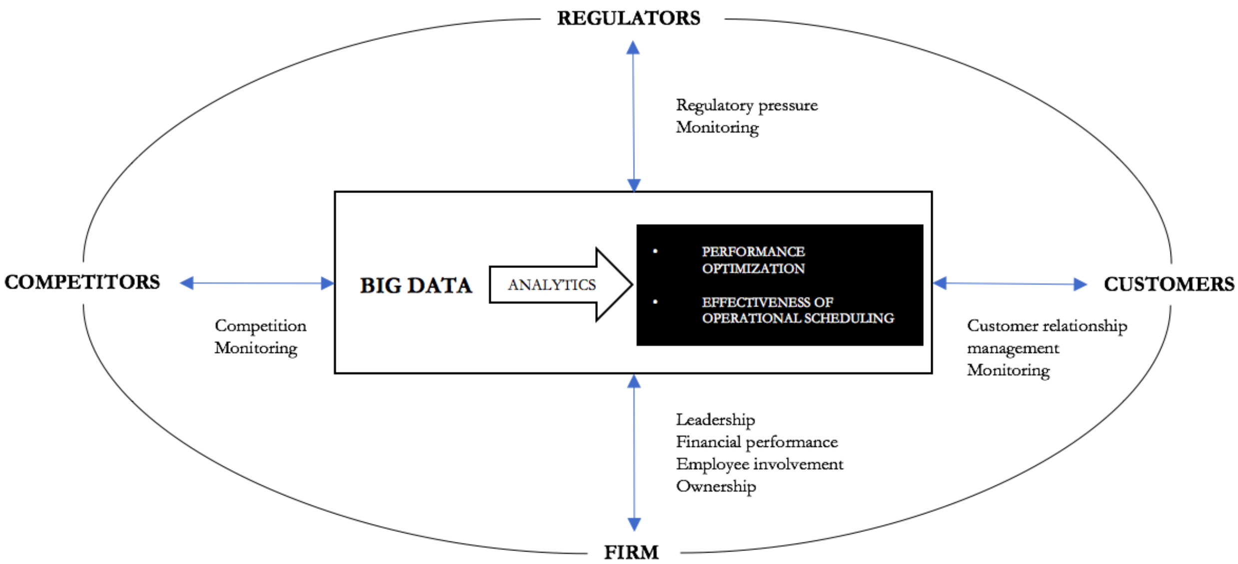

Figure 8: Visual representation of change factors affecting big data practices for environmental sustainability in shipping

7.2. How Do Big Data Practices for Environmental Sustainability Support Transparency in Shipping? (RQ 2)

Diving into each of these interactions, the nature of organization-stakeholder relationships could be further enlightened. As a matter of fact, the previously defined characteristics of transparency (Schnackenberg & Tomlinson, 2016) can now be discussed based on the empirical insights in the context of big data practices for environmental sustainability in shipping. Transparency between ship owners (organization) and their stakeholders (customers, competitors, regulators) could manifestly be improved by reinforcing certain core attributes of the shared information.

Big data practices were shown to have a consistently positive effect on **accuracy**, as a core constituent of transparency. From the perspective of the ship owner, this substantiated in the form of modern performance monitoring providing an improved level of accuracy. When compared to previously used manually entered noon reports, new systems overcome problems related to human error and approximate underlying assumptions of models. This accuracy, required only up to a certain degree by regulatory obligations such as MRV, was only considered as a regulatory achievement by less digitally mature ship owners. More progressive ship owners had already implement advanced systems at an earlier point in time out of their own initiative. Regardless of their initial trigger, big data practices have the main effect of improving accuracy by reinforcing data correctness.

An effect on **disclosure** appeared in a more indirect application. On the basis of reasonable time of information disclosure, big data practices enable a new velocity of data generation, that is superior to previously available data streams (McAfee & Brynjolfsson, 2012). Indeed, interview findings contrasted the historic use of occasional mail reporting with real-time monitoring from the office. The impact on disclosure is however subject to the assumption that the acceleration of data inflow is transmitted to the information outflow. It is therefore assumed that if ship owners have a faster access to data, they will subsequently also provide their stakeholders with relevant information within a shorter period of time. Consequently, the established relationship is of a more indirect nature.

Finally, **clarity** is affected to the extent that the standardization of data monitoring practices favoured enhanced clarity of information. Indeed, the common ground of understanding was improved when negotiating with third parties for example regarding a bunker claim. Hence, it can be deducted that clarity in information exchange is reinforced. Clarity of presented information was moreover determined as area of development. Currently not all data that is collected can also be analysed and presented in a comprehensible way. This leaves room for improvement when it comes to the explanatory value of its display.

Extending the analysis to repercussions on trust, improved data accuracy gives a more favourable picture of the ship owners ability. In point of fact, the ship owner can provide a more precise picture of his operation. He further communicates honesty regarding his commitment to reduce emissions by sharing accurate information on emitted CO_2 thus positively affecting his integrity. Benevolence and integrity are primarily impacted due to their relationship with disclosure. Indeed, ship owners can more credibly communicate their commitment to shared goals regarding emission reduction. This also holds true for his integer behaviour regarding the environment. A striking example are voluntary reporting platforms. Here best environmental practices are purposefully shared, despite the risk of losing a competitive edge and disclosing sensitive information. Finally, improved clarity implies that owners have moved on to a broad-sighted understanding that the challenge of reducing GHG emissions constitutes a societal challenge. Being able to communicate their environmental impact becomes very relevant. Doing this in a way that is understandable for stakeholders of different interests and backgrounds further testifies their ability.

In the context of this study, awareness in information exchanges deserves to be emphasized. Awareness was indeed pinpointed as an essential first step towards improved environmental performance. This entails providing customers with information on the CO_2 footprint of their voyage. Consequently, they are being equipped with the necessary knowledge to make a better-informed decision with regards to environmental sustainability. The same conclusion can be made for charterers who can see the energy efficiency of different vessels on third party platforms. Access to this kind of information allows to commission a ship owner while being aware of the efficiency of the vessel. Charterers who brand themselves as committed to the environment are therefore put into a position in which commercial choices can be made in a coherent way. As for competitors, the availability of extensive benchmarking information can lead to more informed strategic orientations. Finally, regulators can get a better understanding of the environmental impact of the shipping industry. As a result, they can formulate future regulation, such as a comprehensive strategy to cut GHG emissions from shipping, on a more pertinent and comprehensible knowledge base.

Building on Schnackenberg & Tomlinson's (2016) transparency definition, big data practices for environmental sustainability have a positive effect on organization stakeholder relationships by enhancing accuracy directly and disclosure and clarity indirectly (Figure 9). Consequently, ship owner's ability, integrity and benevolence with regards to his environmental sustainability were positively impacted. The concept of transparency was overall identified to enable more aware and coherent decision making for external stakeholders.

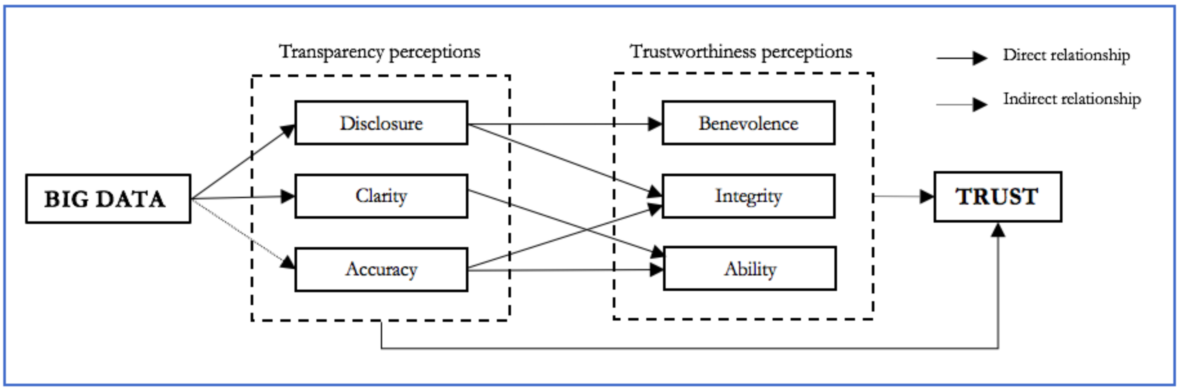

Figure 9: Visual representation of big data effect on Schnackenberg & Tomlinson's (2016) transparency model

7.3. Concluding Remarks

Moving beyond the dynamics of the shipping industry, the conducted research revealed some key aspects with regards to the two questions areas. First, big data practices for sustainability are enabled by key stakeholders through different processes. These primarily include regulatory pressure. It appears that in the light of difficult economic conditions, regulation is the primary driver of big data practices. The presence of global competition further underlines the role of regulation. If competition is strong and global, the need for regulation to advance big data practices is reinforced. Advancement is however always subject to the status quo of regulated entities. The enforced level of accuracy has to be sufficient to boost digital maturity across the industry. If this is not ensured, a prosperous combination of leadership and ownership can be an alternative way to enable implementation beyond regulatory requirements. As for customers, demand for monitoring can be a first step towards an active customer demand for green practices, consequently affecting customer satisfaction. This indicates a growing role of customers in the future.

Secondly, this study demonstrated the relationship between big data and transparency as a dimension of organization-stakeholder relationships. Indeed, big data was shown to enhance accuracy, disclosure and clarity of the shared information. By doing this, trust is ultimately enhanced, consequently improving environmental performance by facilitating the integration of stakeholder's views (Marcus & Anderson, 2006). The dimension of accuracy also becomes the linking element between these two question areas. Regulators who demand a sufficient degree of accuracy in monitoring not only stimulate the digital development of an industry. They also support big data enabled transparency in stakeholder relationships.

8. Conclusion

The shipping industry is a multi-facetted example of the dynamics surrounding the implementation of big data practices for environmental sustainability. It brings together a fascinating combination of tradition and worldwide operation.

In line with the first research question, a number of relevant factors were identified. In the absence of a strong customer demand for big data practices, economic conditions cause regulators to be the primary driver of big data practices. This however is true only for a minimum level of implementation. Every action taken beyond regulatory obligations, is generally motivated by financial incentives or the personal commitment of an owner. Consequent improvements of environmental performance are then driven by successful employee involvement and training. Within interactions between ship owners and its stakeholders, big data practices were shown to support transparency by affecting its core perceptions. Big data directly enhanced accuracy of information and indirectly supported disclosure and clarity. Through Schnackenberg & Tomlinson's (2016) association between transparency, trustworthiness and trust this ultimately increases trust in the organization-stakeholder relationships. These conclusions ultimately allowed to fulfil the initial purpose of this thesis, which was to reveal the dynamics supporting big data practices for environmental sustainability in shipping.

A two-folded picture of the industry can be painted to summarize the colourful spectrum of actors. The positioning of ship owners within this spectrum also affects the strength of the above outlined factors. At one end, owners turn out to be extremely advanced compared to their peers. They understand and value the benefits of big data practices, be it the environmental value or, if present, the financial value. Companies such as ferry operators, liner companies or owners operating with voyage-charters are naturally more prone to be part of this group. In these cases, financial benefits are harnessed by those making investments in monitoring technologies. Regulation therefore does not play a significant role, as requirements can be fulfilled with existing means. Big data practices are rather driven by financial incentives and owners' leadership. On the other end of the spectrum are less digitally mature ship owners. Big data practices for environmental sustainability are seen as unnecessary burden in the everyday business. Monitoring devices stand for superfluous investments that do not generate financial benefits. Further, their room to act upon these insights is limited by commercial interests and specifications of charter contracts. Regulatory requirements are negatively perceived as trigger of increased operational costs but are however the primary driver besides competitive pressure. In between these two stereotypical groups, is a group of industry actors whose reality lies somewhere between these two situations.

Despite these variances, competitors, customers and regulators treat ship owner as a homogenous group, applying identical standards independently of the apparent heterogeneity. Consequently, firm related factors offered a first explanation on the origin of these differences. Digitally mature companies have often been led to this state by a management that believed in the potential of big data practices early on and had the necessary resources available. This leadership can be particularly efficient in family-owned companies that can engage in long-term planning. Moreover, these actors were characterized by efficient employee involvement.

Finally, shipping should be seen as a part of a larger transportation network. Its environmental sustainability should therefore be evaluated with this aspect in mind. It remains the most efficient way of transportation on a kilometre basis. During the process of this thesis, the IMO issued a proposal to address GHG emissions from shipping. The aim is to cut emissions by at least 50% until 2050 compared to 2008 levels. Ship efficiency should consequently improve by 40% until 2030 and by 50-70% until 2050 (IMO, 2018d). Academic Dr. Tristan Smith described it as historical moment for the industry: "The world's shipping industry has now, for the first time, defined its commitment to tackle climate change, bringing it closer in-line with the Paris Agreement." (A. Corbett, 2018). Contrasting the pace of modern technological developments with the decision speed of regulatory bodies makes this an extremely positive development (N. Smith, 2018). Indeed, pushing the industry to embrace the expectations of the 21st century should not be left to regulators alone. Customers should take their fair share of responsibility. New technologies will certainly play an important role in reaching these goals.

9. Contributions and Outlook

The following section of this thesis will outline the managerial implications (9.1.) as well the theoretical implications (9.2) from the conducted research. It furthers discusses the limitations (9.3.) of its conclusions and gives a brief overview of potential future research (9.4.).

9.1. Managerial Implications

The findings of this study allow to formulate a series of managerial recommendations. In order for a ship owner to successfully implement big data practices and consistently improve their environmental performance, some critical areas have to be managed carefully. First, management has to show commitment and leadership with regards to big data practices. Companies that were at the forefront of big data practices consistently connected this to the foresight and engagement of their management. Moreover, employees have to be efficiently involved in trained throughout the implementation of big data practices. This is an important step to enable fuel savings. Management teams further have to overcome their focus on short-term financial returns in order for innovation to take place. Big data practices might not be highly demanded today but many factors are indicating a change in this trend for the future. Further, ship owners are advised to maintain a close and regular dialogue with the regulator. As an important stakeholder in the area of environmental sustainability in shipping, it is important for ship owners to ensure that their voice will be heard. This will increase the chances for future regulation to consider current technological standards and the commercial barriers faced by ship owners. Finally, as underlined by this study monitoring by various actors such as regulatory bodies and independent industry platform have become the common norm nowadays. Consequently, benchmarking information regarding energy efficiency and environmental sustainability are made available to whoever is interested. Ship owners are advised to embrace this new area of transparency. In times of digitalization and big data, secrecy does not appear as a sustainable policy. It seems rather recommendable to learn from competitors and share best practices in order to maximize the learning speed for the entire industry. This has the subsequent advantage that future regulatory requirements are more likely to be fulfilled at lower costs. Especially in the light of high fragmentation, collaboration among industry peers appears as a beneficial strategy.

9.2. Theoretical Implications

The theoretical implications of the current study take two forms. First, this study constructed a theoretical framework to evaluate the implementation of big data practices for environmental sustainability. Using this framework allowed a detailed analysis of factors driving the outlined process in the shipping industry and the role of transparency among the organization and its stakeholders. This contributed to the infant literature of big data, as it framed big data as change process and outlined its impact on perceptions of transparency. It further built a list of factors that could be placed in the organizational environment of the firm. With this regard, it also outlined a linking element between change factors and stakeholder relationships. Indeed, regulators can drive trust by requiring a sufficient degree of transparency.

Second, it highlighted the specificities of the shipping industry with regards to big data and environmental sustainability. In this process, the role of family-ownership was added as an important factor of the model. Additionally, the notion of training complemented the previously established definition of employee involvement.

9.3. Limitations

The results and conclusions from this study have to be evaluated with respect to certain limitations. First the reader has to remember, that although evaluated as one industry, ship owners' actually have very little in common. Tankers, ferries, bulkers and container ships although all being equally treated by the regulator can from an operational point of view can hardly be evaluated according to the same standards.

From a methodological point of view, the qualitative nature of the study limits the possibility to transfer the findings regarding big data practices for environmental sustainability to other transportation industries. This is further reinforced by the specificities of the shipping industry, which can hardly be found in any other industry.

9.4. Future Research

This study opens up a path to multiple further research opportunities. The variation between the different transportation segments, calls for a deeper analysis regarding segment specific dynamics. Indeed, some industries parts such as for example tanker operators are exposed to extremely stringent environmental regulation due to the environmental risk associated with their cargo. Hence, it would be interesting to get a more precise understanding of segment specific dynamics as they are exposed to many more influences than there could be outlined in the current study.

Moreover, the implementation of big data practices within organizations could only insufficiently be described in this study. The firm-related aspects only cover parts of the change processes that accompany this innovation. Consequently, organization centred studies are required to shine the light on these internal dynamics. Leadership literature and innovation management could further provide insights to the theoretical development in this field.

All of these could consequently provide a better understanding to the academic world regarding on why ship owners differ considerably in their degrees of digital maturity. Finally, research should consider integrating a more technical perspective including views of suppliers and equipment manufacturers.

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11.Annexes

Annex 1: Constructs of WCSM framework and their indicators from Dubey et. al (2016)

Factors	Indicators
Leadership	• Well-defined environmental policy • Awareness about environmental policy • Top management support • Top management has approved special fund for investment in cleaner technologies • Top management positive attitude toward green practices • Senior managers motivate and support new ideas received from junior executives • Recognition of employees
Regulatory pressures	• A regional pollution control board pressurizing the firm to adopt green practices • Government regulations provide clear guidelines in controlling pollution level • Pollution control board strictly monitors the pollution level of firms on a periodic basis • Green practices decrease incidence of penalty fee charged by pollution control board
Customer relationship management	• Green practices improve customer satisfaction • Firm recovers end of life products from customers • Customers appreciate eco-friendly products
Employee involvement	• Strategic participation • Organizational participation • Task discretion

Annex 2: Sample Interview Guide

Organization & Industry	• What is your position within *"company name"*? • What activities does this position entail? • Have these activities changed in the last 5 years? If yes, how? • What do you think are the main current challenges for your company?
Environmental regulation & sustainability	• When did you first come into contact with the concept of environmental sustainability? • Which parts of the company have been affected by environmental sustainability? • Has environmental sustainability created value for your company? • Has environmental sustainability influenced your relationship with external stakeholders? • What are the barriers to engage in environmental sustainability? • How has regulation affected your focus on environmental sustainability? o What has been the impact of the MRV regulation? o What have been the problems and opportunities related to MRV? o What are the regulation's strength and weaknesses? • How do you think will environmental regulation affect your activities in the future? • How do you think will environmental regulation affect the shipping industry in the future?
Digitalization & Big Data	• What are your biggest challenges in promoting digitalization? • How have you reacted to these challenges? • Are there any specific ways that have helped you work towards the use of big data? • How are you currently using big data within your company? • What are the motivations to engage in the use of big data? • Have any of these been connected to complying with environmental regulation? o How was the MRV regulation implemented within your company? o What has been the role of digital tools? If at all o Did you collect any similar data before the implementation of MRV? o Do you think that MRV has encouraged the use of big data in your company? o Has big data increased your awareness about environmental sustainability? • What other stakeholders are involved in your use the use of big data within your company? • Do you see digitalization as a threat or as a possibility? Why? • Do you actively look search for ways to use big data within your company? • Have you encountered change resistance when promoting the use of big data?
Future Outlook	• What kind of changes do you expect to be seen in the next 10 years in shipping? • Do you think that ship owner's role is the same after 10 years? If not, what kind of role it would have? • What are the things that will not change in shipping? • What kind of challenges does your industry set that you haven't been able to respond yet? • What is expected from shipping companies in 10 years from now? • How do you think the relation with shipping and other industries will develop in the next 10 years?

Annex 3: Overview of Interviewees

Interviewee	Position	Organization	Sample	Located in	Mode	Date	Time	Type of operation
Pia Berglund	Vice VD	Sveriges Redareförening	Pre-study	Stockholm, Sweden	Face-to-face (Stockholm)	25.01.18	40	Ship owners association
Florian Bollongino	Innovation Manager	DNV GL Maritime	Pre-study	Hamburg, Germany	Phone	25.01.18	30	Classification Society
Claus Brandt	Partner	PWC Hamburg	Pre-study	Hamburg, Germany	Phone	09.02.18	60	Auditing - Consulting
Fredrik Larsson	Senior Policy Advisor, Safety & Environment	Svensk Sjöfart	Study	Stockholm, Sweden	Face-to-face (Stockholm)	22.02.18	90	Ship owners association
Andrus Vaher	Environmental protection and working environment specialist	Tallink - Ship owner	Study	Tallin, Estonia	Skype	28.02.18	45	Ferry
Peter Knudsen	CEO	Blueflow	Study	Sollentuna, Sweden	* Face-to-face (Sollentuna)	13.03.18	120	Provider of monitoring solutions
Christian Tokola	IT Developer	Blueflow	Study	Sollentuna, Sweden	* Face-to-face (Sollentuna)	13.03.18	120	Provider of monitoring solutions
Fredrik Larsson	Environmental protection and working environment specialist	Sveriges Redareförening	Study	Stockholm, Sweden	* Face-to-face (Sollentuna)	13.03.18	120	Ship Owners Association
Claes Berglund	Director Public Affairs and Sustainability	Stena Lines - Ship owner	Study	Gothenburg, Sweden	Face-to-face (Stockholm)	15.03.18	50	Ferry - Tankers – Offshore - Bulk
Daniel Schmode	Fleet Performance Project Manager	DNV GL Maritime	Study	Hamburg, Germany	Phone	16.03.18	40	Classification Society
Carolina Ulff	Shipbroker	Tore Ulff AB	Study	Stockholm, Sweden	Face-to-face (Stockholm)	16.03.18	45	Broker
Ann-Kathrin Diercks	Responsible for Insurance claims & Crewing	Vega Reederei - Ship owner	Study	Hamburg, Germany	Phone	19.03.18	30	Container - Bulk - Tanker

Interviewee	Position	Organization	Sample	Located in	Mode	Date	Time	Type of operation
Jens Wagner	Head of ICT	F. Laeisz - Ship owner	Study	Rostock, Germany	Phone	20.03.18	65	Container - Bulk - Gas carrier - PCTC - Research
Frank Paleokrassas	Corporate Manager Fleet Performance	Bernhard Schulte Shipmanagement	Study	Athens, Greece	Phone	23.03.18	45	Ship Management
Wilke Briese	CEO	Reederei Briese – Ship owner	Study	Leer, Germany	Phone	27.03.18	43	Multipurpose - Heavylift - Research
Susanna Airola	Environmental coordinator	Viking Lines - Ship owner	Study	Stockholm, Sweden	Phone	29.03.18	63	Ferry
Capt. Pär Brandholm	Environmental & Nautical Manager	Laurin Maritime - Ship owner	Study	Gothenburg, Sweden	Phone	09.04.18	36	Tanker
Dietrich Scheder-Bieschin	Managing Director	MACS - Ship owner	Study	Hamburg, Germany	Phone	19.04.18	42	Multipurpose - Liner
Christopher Pålsson	Managing Director maritime-insight, Head of consulting	Lloyd's List Intelligence - Maritime intelligence	Study	Gothenburg, Sweden	Phone	26.04.18	22	Consulting

** Group interview*