Responsible shipping for sustainable development: adoption and performance value

Abstract

Responsible shipping is attracting increasing attention in shipping industry, but a systematic analysis of its concept is scanty. Different stakeholders ranging from shippers and carriers to government and non-government associations have expressed worries and expectations about responsible consumption and production in shipping industry. This paper aims to advance the knowledge by exploring the adoption and performance value of responsible shipping practices. Using the concept analysis approach, we first construct a two-folder conceptual framework with strategic folder and practical folder considering the dual-role of shipping industry in servicing trade activities of the global economy. Accordingly, we carry out a two-way interpretation of responsible shipping in economic, environmental, social performance dimensions as well as supporting measures in resources and technological aspects at the strategic folder, and five processes (design, operations, management, governance, finance) at the practical folder. To examine the adoption and performance value of responsible shipping, we develop propositions concerning its implementation elements as well as the favorable conditions for adoption and the performance value. The framework provides insights to guide managers in shipping industry to design, plan, and implement responsible practices to meet the escalating public expectations for shipping operations in servicing international trade and global supply chain activities.

Keywords: Responsible Shipping; Sustainability; Maritime Studies; Responsible consumption and production; Shipping management

1 Introduction

As the most efficient mode of transport, shipping is the key facilitator of international trade carrying 90% volume of the world trade (UNCTAD, 2020). Along with the growth of international trade, the expanding shipping industry caused extensive and significant damage to the environment, resources, social, health, and life quality of humans, which highlights the need for responsible shipping to revert the situation. The past decades have seen a growing emphasis by shipping industry to implement responsible shipping in achieving sustainability goals (Tran et al., 2020). Moreover, the United Nations have identified responsible consumption and production as the 12th Sustainable Development Goal (SDG 12) with the aim to advocate responsible ways of consumption and production. There has also been a surge in business, policies, and research, devoted to addressing the related issues (Liu et al. 2021). Furthermore, tightening regulations and the public's growing quest for sustainable development have drawn attention to responsible shipping. Playing the role of transportation intermediary in servicing the global supply chain, shipping firms have begun their sustainability journey by embracing responsible shipping in their operations.

Upon a cursory investigation of the literature, we find a serious lack of consensus on the concept of responsible shipping despite its strategic importance for sustainability improvements in shipping industry. As a manifestation of sustainable shipping, responsible shipping has appeared in the sustainability reports of many shipping firms. Related topics are generally viewed as sustainable shipping or green shipping. More often, responsible shipping is considered environmental responsibility management, or social responsibility management, or quote it with corporate social responsibility (CSR) issues of shipping firms directly. Indeed, scholars have investigated these issues and their performance benefits for shipping firms to reflect the value of responsible shipping, but not much has been done to conceptualize, identify, and adopt responsible shipping in research and practice.

Given that shipping is instrumental in supporting the world's economic growth by completing economic transactions in production and consumption with physical

delivery (Wong et al., 2009), responsible shipping is the necessary path to responsible production and consumption. Moreover, shipping serves as a pillar industry for many cities or countries such as Hong Kong and Singapore. Lack of understanding of responsible shipping is unfavorable for cities/countries to develop their economic growth in a responsible way. As sustainable development is increasingly emphasized by international organizations such as the United Nations, countries may risk their economic growth and previous achievements due to sustainability-related trade barriers (e.g., higher tariffs or even embargoes for shipping environmentally non-compliant cargoes). Despite that shipping firms and policymakers have acknowledged some responsible shipping practices, such as responsible ship recycling and responsible procurement executed by Maersk, MSC, and COSCO, the elements of responsible shipping are indistinct. To advance knowledge on responsible shipping requires research efforts to improve and standardize the practices. Knowing what, why (or why not), and how (and how much) to adopt responsible shipping can enable shipping firms to grasp the responsible shipping elements for their sustainability development. Doing so can also lay a foundation for policymakers to formulate plans and actions to guide shipping operations in responsible ways.

This study contributes to the stock of knowledge by investigating responsible shipping which plays a crucial but neglected part in responsible consumption and production in support of the continued growth and sustainability development of international trade activities. Specifically, this paper is guided by the following research questions: (1) How to conceptualize and understand responsible shipping? (2) What are the elements of responsible shipping? (3) How to adopt and improve the performance value of responsible shipping? Answers to these research questions provide the first systematic interpretation of responsible shipping. The finding provides insights to guide managers in shipping industry to design, plan, and implement responsible practices to meet the escalating public expectations for shipping operations in servicing international trade and global supply chain activities.

The remainder of the paper is structured as follows. Section 2 builds a conceptual framework for responsible shipping, based on which we conduct a concept analysis of

responsible shipping. Section 3 identifies the elements of responsible shipping. Section 4 investigates the adoption conditions and performance value of responsible shipping. Finally, the paper is concluded by discussing and suggesting further research issues on this topic of shipping studies.

2 Concept and understanding of responsible shipping

2.1 Concept framework

Responsible shipping, an important but hidden development goal extracted from responsible consumption and production (SDG 12) for shipping industry, drives us to progressively move our shipping industry towards a more sustainable future. SDG 12 requires ensuring sustainable consumption and production (SCP) patterns (UNADG, 2021). As the UN explains, SCP is about "promoting resources and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all." Consistently, SCP can be summarized as "doing more and better with less", which underlines an essential principle of "decouple economic growth and environmental degradation, increasing the efficiency of resources, and promoting sustainable lifestyles" (UNEP, 2010). This principle is applicable to guide responsible shipping activities regarding SCP patterns, yet it is generic without a comprehensive analysis of the concept, adoption, and performance value of responsible shipping. Hence, after reviewing the relevant studies, a framework is proposed to understand the concept of responsible shipping. The representative studies are summarized in Table 1.

Table 1 Representative studies to understand the concept of responsible shipping

Topics	Representative research studies
Key components	*Shipping*: Lai et al., 2004; Goulielmos, 2010; Papandreou et al., 2021 *Responsible*: Jussila, 2015; Wu et al., 2016; Roy et al., 2017; Wang et al., 2018; Gasper et al., 2019; Liu et al., 2021 *Relevant concept of sustainable/green shipping*: Lai et al., 2011; Chang and Danao, 2017; Yuen et al., 2017; Pang et al., 2021
Strategic folder	Lodro et al., 2018; Magsi et al., 2018; Schinas et al., 2018; Wang et al., 2018; Tran et al., 2020; Firmansyah et al., 2021
Economic	Lun and Browne, 2009; Lun et al., 2010; Tang et al., 2020;

Environmental	Lai et al., 2011; Mansouri et al., 2015; Lirn et al., 2014; Lister, 2015; Andersson et al., 2016; Wan et al., 2016; Kumar et al., 2019; Tang and Gekara, 2020; Wang et al., 2020
Social	Hetherington et al., 2006; Thai, 2009; Acciaro, 2012; Roe, 2013; Ducruet et al., 2015; Sampson and Ellis, 2015; Yliskyla-Peuralahti et al., 2015; Doyle et al., 2016; Xu and Xia, 2017; Parviainen et al., 2018; Tong et al., 2019; Yuen et al., 2019; Tang et al., 2020; Lai et al., 2020
Resources	Jussila, 2015; Formentini and Taticchi, 2016; Wang et al., 2018; Magsi et al., 2018; Lodro et al., 2018; Yuen et al., 2019
Technological	Lai et al., 2011; Schinas et al., 2018; Yuen et al., 2019; Tran et al., 2020a; Tran et al., 2020b; Bao and Wang, 2020; Firmansyah et al., 2021;
Practical folder	Porter and Kramer, 2006; Colbert and Kurucz, 2007; Khaled et al., 2021
Design	Lai et al., 2011; Lai et al., 2013; Lin and Chang 2018; Ameln et al. 2021; Gerakoudi-Ventouri, 2022; Gavalas et al., 2022
Operations	Wang and Meng, 2012; Xia et al., 2015; He et al., 2015; Chang and Danao, 2017; Kang and Kim 2017; Wang et al., 2020
Management	Chang and Danao, 2017; Yuen et al., 2017; Tran et al., 2019; Yuen et al., 2019; Li et al., 2019; Tran et al., 2020b
Governance	Lister et al., 2015; Van Leeuwen, 2015; Giannakopoulou et al., 2016; Gritsenko, 2017
Finance	Alexandridis et al., 2018; Barreiro et al., 2022; Jian et al., 2022

The components of "responsible shipping" are found in various databases and websites. For instance, "Shipping" as defined by Lai (2004) deals with activities that involve the movement of cargoes to, from, and between different parties of a transportation chain comprising shippers, carriers, and consignees, such as cargo tracking, equipment booking, cargo loading/unloading, issuance of bill-of-lading, carriage of goods, etc. There are various kinds of shipping arrangements, including sea transport, air transport, rail transport, highway transport, pipeline transport, etc. Moreover, driven by the tide of global supply chains, more and more shipping companies are transforming into general logistics companies with expanded service menu rather than shipping companies. This trend highlights the role of shipping as the bloodline of the global supply chain, and the fundamental engine for supporting international production and marketing activities. Given the uncertainty of global supply chains, such as shock from the international trade tensions, COVID-19, and natural disasters, shipping plays an essential role in mitigating the disruption of the

global supply chain by bridging the gaps between shipping and port, port and hinterland, shipping and land transport, shipping and air transport, etc. In addition, providing essential support for completing economic transactions in trade, shipping is not only the connection between production and consumption but also an economic sector in its own rights (Goulielmos, 2010; Papandreou et al., 2021). Another component "Responsible", in the Oxford English Dictionary, is a practice or activity that is carried out in a morally principled or ethical way. Following SDG 12, "responsible" refers to "ensuring SCP", which is explained by the UN that "Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty." Consequently, "responsible" means systemic solutions to unsustainable issues arising from the interaction of humans and the environment along with economic growth.

Putting these two components together, "responsible shipping" covers the implementation of SDG 12 in shipping industry context. Essentially, "responsible shipping" is an operation mode for shipping industry, which refers to ensuring SCP in shipping industry. In the framework of the sustainable development agenda developed by the UN, sustainable shipping is about implementation of sustainable development in shipping industry concerning the 17 SDGs. Given that SDG 12 is an important one in the 17 SDGs, responsible shipping is an important part of sustainable shipping accordingly, as shown in Figure 1. Specifically, responsible shipping is the part of sustainable shipping that connects responsible production and consumption activities by providing responsible shipping services, so as to support sustainable development.

Accordingly, responsible shipping can be interpreted through applying "responsible" in "shipping", in which shipping industry involves the carrier and practitioner, and "responsible" undertakes the requirements, objectives, and guidance strategically to align with the SDG 12. In other words, the concept of "responsible shipping" covers both strategic and practical perspectives.

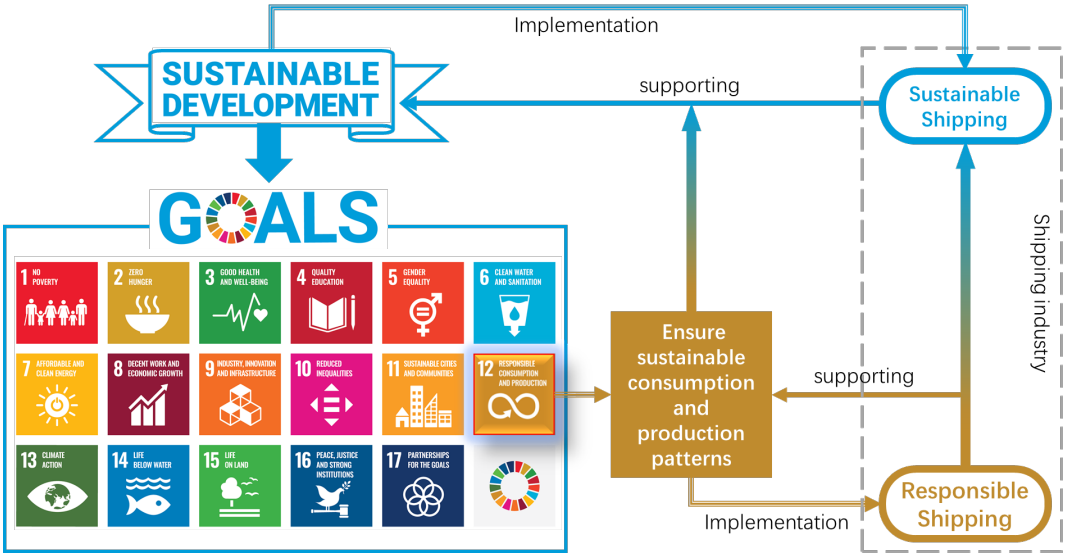

Fig 1 The relationship between sustainable shipping and responsible shipping

On strategic side, "responsible" requires "meeting customers' needs and expectations while implementing production and development that considers economic, environmental, and social aspects without generating risks that threaten sustainability for future generations" (Wang et al., 2018). It appears that "responsible" has three basic dimensions: economic, environmental, social, which are commonly described as the triple bottom line (TBL). However, these three aspects are far from sufficiently covering every responsible consideration (Wu et al., 2016). SDG 12 has an essential faith in human ability of technological innovation and cooperation, efficient resources use, cleaner production process to deal with the complex relationship between the adverse environmental impacts of endless economic growth (Gasper et al., 2019). Hence, apart from the TBL, resources and technologies are parts of the "responsible" framework. Shifting towards SCP requires reduction in resource consumption, limited waste, generation of eco-friendly environment, enhancement of reuse and recycling of resources (Jussila, 2015), highlighting that responsible shipping involves the measures in improving resource efficiency. Meanwhile, sustainable technologies such as new vessel designs, alternative energy resources, radio frequency identification, collaborative planning, forecasting, and replenishment, and mobile tool-enabled services are crucial means for shifting shipping towards sustainable patterns (Wang et al., 2018; Magsi et al., 2018; Lodro et al., 2018). The innovation and adoption of sustainable technologies can improve shipping firms' performance outcomes by

alleviating their pressure to comply with environmental regulations (Schinas et al., 2018; Tran et al., 2020; Firmansyah et al., 2021). Consequently, the concept analysis and understanding of responsible shipping cover the dimensions of economic, environmental, and social, which can be categorized as the dimension layer, and the supporting measures in resources and technological aspects, which can be categorized as the supporting layer.

On practical side, guided by SDG 12, shipping industry has taken some measures to shift towards responsible patterns. For example, *Responsible Shipping Initiative* (*RSI*), a non-profit organization, was formed in 2019 by some of Sweden's largest dry cargo shipping buyers (e.g., EFO, Lantmännen, and Stockholm Exergi–Södra) to promote responsible shipping in dry cargo vessels operating in the Baltic and North Sea, with the aim to improve working conditions, health and safety, and the environmental performance onboard. These measures demonstrate that responsible shipping is embedded in the operations of shipping activities. In November 2019 in Singapore, a multi-stakeholder roundtable "responsible shipping from shipyard to scrapyard", the beginning of the "Responsible Shipping Dialogue", was held in which participants (the Institute for Human Rights and Business (IHRB), the Rafto Foundation for Human Rights, the Danish Institute for Human Rights (DIHR), Anglo American and Maersk) discussed the awareness of and adherence to human rights standards. The responsible shipping issues discussed in the seminars concentrated on human rights and risks of workers from shipyards and docks to seafarers around the globe and shipbreakers on the beaches of South Asia, spanning the entire life cycle of the ship to cover the process of design, finance, and ordering, building and operations, breaking/recycling. Consistent with SCP, the core of SGD 12, responsible shipping requires the participants in shipping industry to focus on higher processes, people, and planet gains (Porter and Kramer, 2006; Colbert and Kurucz, 2007). Simply put, as the ESG is a subset of the SDGs for enterprises to measure their performance in the aspects of environmental, social, governance (Khaled et al., 2021), shipping companies could incorporate SCP into their daily business by using ESG factors. Apparently, responsible shipping involves the design of shipping activities to execute the cargo movement processes, as

well as the governance, management, and finance to support the shipping operations. Consequently, the concept analysis and understanding of responsible shipping must encompass the whole process including shipping design, shipping operations, and shipping governance, shipping management, and shipping finance.

Given the different perspectives and focus on responsible consumption and production in shipping, it appears that some streams of literature and practices focus on single or two dimensions (e.g., environmental management (Lai et al., 2011; Wang et al., 2020); security (Tong et al., 2019)), or one or two parts of the entire process (e.g., shipping network design (Ameln et al. 2021), shipping routing (Lin and Chang 2018), port operations (Kang and Kim 2017), ship recycling (Wang et al., 2020), etc.) of responsible shipping. Broadly, responsible shipping comprises a series of activities involving multiple dimensions and the interaction between them, covering the entire shipping process. A systematic analysis of responsible shipping should address both the strategic and practical sides of shipping operations. Simply put, responsible shipping should clarify what shipping practices and the consequences in the shipping process, including shipping design, shipping operations, shipping management, shipping finance, and shipping governance, can conform to the requirements of SCP addressing the economic, environmental, social performance dimensions as well as the measures in resources and technological aspects. Accordingly, we propose a framework explaining responsible shipping in two folders: strategic folder and practical folder. The strategic folder of responsible shipping comprising the dimension layer and supporting layer not only clarifies the requirements and motivations for responsible shipping activities to align with SCP, but also the consequences of performing shipping activities responsibly. Practical folder of responsible shipping concerns the execution of the strategic folder, which is a dynamic process from shipping design and shipping operations through to shipping governance and its performance improvements based on the governance. The elements of the two folders and their relationship are illustrated in Figure 2.

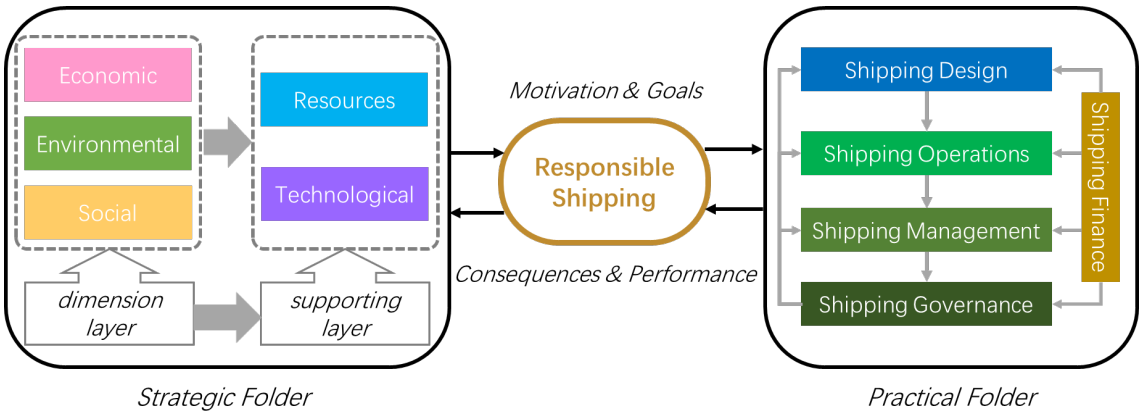

Fig 2 The conceptual framework of responsible shipping

In conjunction with the foregoing analysis, we define responsible shipping as a series of long-term arrangements/actions to ease unsustainable problems in the entire shipping process of shipping design, shipping operations, shipping management, shipping finance, and shipping governance. It aims to close the gap between shipping practices and the sustainable development goals in the economic, environmental, and social performance as well as the measures in resources and technological aspects. By doing so, it supports the target of shipping industry for sustainable development and facilitates cost-effective connection between SCP activities by transporting cargoes responsibly and safeguarding the stability of global supply chain. Details of responsible shipping in its strategic folder and practical folder under this framework are elaborated below.

2.2 Responsible shipping in strategic folder

The elements of responsible shipping in strategic folder highlight its principles and requirements from the economic, environmental, social performance dimensions and the supporting measures in resources and technological aspects, which are the guidepost to adopting responsible shipping practices.

2.2.1 Dimension layer

(1) Economic dimension

The economic dimension is the foundation of responsible shipping as shipping is fundamental to completing economic transactions in trade by physically moving cargoes all over the world (Lun and Browne, 2009; Lun et al., 2010). Given that shipping is the physical link facilitating cargo flows between production and

consumption, responsible shipping is essential to connect production and consumption activities responsibly to sustain the global supply chain and bolster sustainable development. Accordingly, it provides cost-effective cargo movements to support responsible production and responsible consumption in shipping operations. The pursuit of economic growth is fundamental for responsible shipping to benefit society, which means the economic dimension of responsible shipping is maintaining profitability to sustain the shipping operations by providing more cost-effective shipping services with fewer burdens caused to society. Specifically, economically responsible shipping focus on long-term profits instead of short-term cost reductions that often undermine environmental, resources, or social impacts.

(2) Environmental dimension

Environmental issues are the core concern of responsible shipping, while the balance between environmental and economic performance has always been the major focus of the discussion of sustainability (Mansouri et al., 2015). Environmental issues in shipping concentrate on the outputs of shipping activities, especially the negative outputs such as excessive emissions of ships and ports (e.g., CO2, SOX, NOX, etc.), ballast water, domestic waste, oil spill, noise, light, space occupation (Lirn et al., 2014; Lister, 2015; Tang and Gekara, 2020), as well as the damages caused by these undesirable outputs, including marine/land pollution, invasive species, habitat loss, etc (Andersson et al., 2016; Wan et al., 2016). These damages are exacerbated by the blooming of the international trade and shipping industry, which causes serious risks to the health of the environment and sustainability development. As such, environmentally responsible shipping focuses on dealing with these negative issues for the benefit of the resources recovery and protection of the environment, so that it supports the development of shipping industry, even human existence in the long run.

(3) Social dimension

Social issues in responsible shipping include security of cargoes (e.g., cargo theft and loss, piracy and vessel loss, traffic congestion, etc.) (Hetherington et al., 2006; Thai, 2009), and safety of people (e.g., working conditions, health issues, stress, and fatigue levels, social isolation, training, and education, etc.) (Doyle et al., 2016; Yuen et al.,

2019; Tang et al., 2020), impacts on communities, transparency of operations (Acciaro, 2012; Roe, 2013; Yliskyla-Peuralahti et al., 2015; Parviainen et al., 2018), and regulatory compliance (Sampson and Ellis, 2015), etc. These social issues relate to every actor in the entire shipping process including shippers, ports, carriers, consignees, representing potential risk factors to compromise cost and service quality in the shipping industry (Lai et al., 2020). Handling these social issues and the potential risks is crucial to uphold the cost and quality performance of shipping services. Consequently, social responsible shipping concerns the arrangements or actions aimed at improving the safety and security aspects of handling shipping activities, employees' welfare, and shipping chain in both upstream and downstream operations so that shipping activities are fully compliant with various regulatory requirements and meeting, even exceeding public expectation in the society.

2.2.2 Supporting layer

(1) Resources measures

Resources, including tangibles or intangibles such as capital, manpower, knowledge, information technology, equipment, etc. (Formentini and Taticchi, 2016), are the basis of shipping operations, which makes resources measures a core concern of responsible shipping together with the environmental dimension. The difference is that resources measures focus on inputs of shipping activities including the resources and their allocation (Yuen et al., 2019), while the environmental dimension focuses on outputs. Consistent with the SDG 12, resources measures focus on sustainable management and efficient use of resources (UNDP, 2020). Broadly, there are two choices for using resources efficiently: conservation of resources and new resources. The former can be realized by operations and implementation of new technologies. Meanwhile, new renewable energies (i.e., solar energy, tidal energy, wind energy, etc.) are replacing fossil fuels gradually, which also depend on technologies. Hence, resources measures of responsible shipping focus on using less and cleaner fuels by improving resources efficiency of shipping industry to maximize the use of resources and avoid their depletion.

(2) Technological measures

Technologies are the supporting and driving force of responsible shipping, in which the development and deployment of breakthrough technologies combined with the adoption of revolutionary management is the core element of developing long-term sustainability for shipping operations (Yuen et al., 2019). Technological issues refer to the innovation, accumulation, and adoption of sustainable technologies in shipping industry with a focus on reducing cost and improving productivity through effective use of resources while minimizing shipping activities' adverse impacts (Lai et al., 2011; Tran et al., 2020). For instance, these include scrubber technology for reducing sulfur emission, wastewater treatment technology, new bulbous bows, new propellers and engine modifications for decarbonization, twin-skeg propulsions system for improving energy efficiency and reducing environmental damages (Bao and Wang, 2020). Recently, digital technologies (i.e., artificial intelligence, blockchain, cloud computing, etc.) are growingly applied in shipping activities for greater achievement of sustainability in economic, environmental, resources, and social aspects. In sum, the technological measures of responsible shipping refer to the innovation and application of advanced sustainable technologies in shipping activities, which contribute to the improvement of shipping performance.

2.3 Responsible shipping in practical folder

In practice, shipping functions on two chains (Figure 3): one is the shipping service chain following the physical movement of cargoes, and the other is the shipping equipment supply chain following their life cycles. Along with these two chains, responsible shipping plays its role in connecting responsible production and responsible consumption, as well as the responsible economic sector in its own rights. Responsible shipping in the sub-framework of practical folder elaborates its understanding in shipping design, shipping operations, and shipping governance on the practical side focusing on these two chains. Accordingly, it is the practical folder to execute responsible shipping activities.

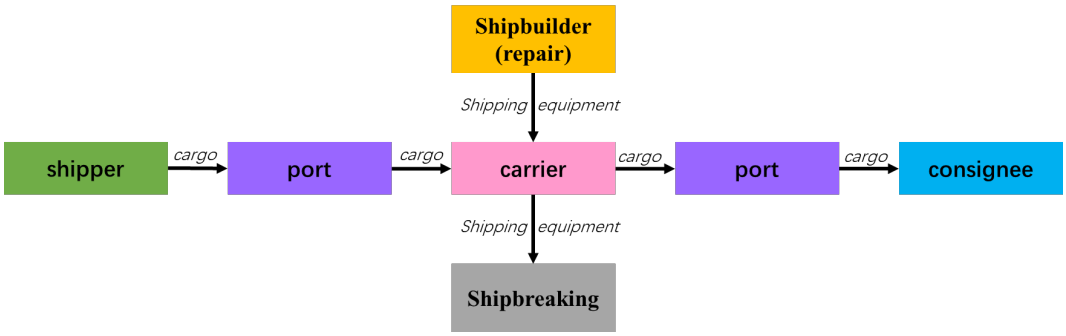

Fig 3 Shipping functions on two chains

2.3.1 Shipping Design

Shipping design complying with the concerns of environmental protection in cargo transport is one of the green efforts undertaken by shipping firms (Lai et al., 2011). Consequently, shipping design with compliance, including design of equipment and operations, forms an operational basis that facilitates environmental regulations of shipping activities, in which the compliance includes shipping equipment reuse, energy-saving, waste recycling, resources recovery, and mitigating environmental damages caused by shipping activities (Lai et al., 2013). Consistently, responsible shipping design is also the gatekeeper to ensure SCP in shipping industry. It mainly covers the design of shipping equipment and shipping operations in conformance with its strategic folders concerning SCP. They advocate a focus on operational and resources efficiency enhancement in the shipping process. Specifically, responsible shipping equipment design focuses on improving resources efficiency in shipping equipment, such as the ships' engines powered by cleaner energy, hulls in eco-materials. Responsible shipping operations design focuses on improving the operational efficiency in shipping services, including the optimization of routing and scheduling, recycling of wastes, fleet deployment, shipping procedures, and documentation. In sum, responsible shipping design enables shipping industry to better respond to the quest for sustainable development, lessen economic and social costs, and reduce damages caused to the environment by performing shipping activities.

2.3.2 Shipping Operations

Responsible shipping operations refer to the conduct of shipping activities guided by the principles of responsible shipping strategic folder through putting the responsible

design into practice. Specifically, in shipping service chain, responsible shipping operations refer to the carriage of cargoes from shippers to consignees cost-effectively through responsible procedures. For example, scheduling handling equipment (i.e., quay cranes, internal trucks, yard cranes) at container terminals to minimize the total departure delay of ships, so as the energy consumption and emissions (He et al., 2015); appropriate response to disasters or accidents for the safety of cargoes and employees; allocating capacity according to cargo flow distribution and transshipments to satisfy customers' preference (Wang and Meng, 2012), optimizing the speed of vessels to balance cost-saving and emission control (Xia et al., 2015), etc. In shipping equipment supply chain, responsible shipping operations refer to dealing with the recycling of used shipping resources to reduce costs and improve shipping operations. For instance, using eco-designed equipment; selling excess equipment and facilities rather than idling them in storage place; collecting used oil and shipping materials (i.e., packaging, cartons, etc.) for reusing or selling rather than throwing them as garbage (Chang and Danao, 2017).

2.3.3 Shipping Management

Drawing on the experiences of sustainable shipping management (Yuen et al., 2017; Tran et al., 2019), responsible shipping management involves addressing the needs of the present for shipping at minimal costs without compromising the ability of future generations to meet their own needs. Accordingly, responsible shipping management requires integration of the elements of responsible shipping by shipping firms into their daily shipping operations in a comprehensive and integrated approach. It covers the practices to acheive optimization of responsible shipping operations. Specifically, it requires shipping firms to take actions striking the balance in their economic, environmental, social, resources, and technological performance outcomes. Shipping firms adopt a bundle of organizational activities and principles to promote their operations (Yuen et al., 2019). In sum, responsible shipping management is a valuable organizational capability that can be strengthened to address the needs of stakeholders by accumulating internal, external technology and resources, as well as strategically deploying them (Tran et al., 2020), while achieving their economic, environmental, social performance goals.

2.3.4 Shipping Governance

Responsible shipping governance refers to the efforts of regulating shipping activities to ensure SCP in shipping industry (Van Leeuwen, 2015). It is a mix of arrangements that have fragmentary, multilevel, and overlapping structures of shipping governance, to improve the compliance and transparency of shipping activities, thereby improving the sustainability of shipping industry. There are four principles to develop shipping governance: 1) promote institutional diversity; 2) target shipping sectors; 3) use subsidiarity as a criterion for policy implementation; 4) democratization of information design (Gritsenko, 2017). Broadly, there are internal and external governance mechanisms. The internal governance is carried out by shipping operators, including their corporate culture, business philosophy, monitoring of top management by boards of directors, etc. (Giannakopoulou et al., 2016). Since 2016, shipping companies started to release annual sustainability reports to proactively disclose their efforts on sustainability to the public. The external governance is mainly carried out by international organizations, governments, industry associations, news media, etc. For example, IMO adopted the Ship Energy Efficiency Management Plan (SEEMP) and developed Energy Efficiency Design Index (EEDI) as a technical measure to encourage responsible efforts from the design phase by estimating the energy efficiency of shipping equipment (Lister et al., 2015). All of these governance mechanisms aim to identify the consequences of the responsible efforts, find and correct the irresponsible parts in shipping activities by disclosing information to parties involved quickly, truthfully, and transparently. Consequently, responsible shipping governance not only clarifies the progress in shipping industry towards SDG 12, but also provides a basis for adjusting and optimizing responsible shipping design, operations and management.

2.3.5 Shipping Finance

As a typical capital intensive industry, shipping industry cannot survive without shipping finance (Alexandridis et al., 2018), especially for responsible shipping. Responsible shipping finance refers to the financial services and financial resources that are provided to support the shipping firms to implementing responsible shipping business, including the design, operations, management, governance. Specifically, it

can provide financing for the construction, purchase, sale, chartering, operations, and dismantling of ships that are used in responsible shipping business, such as shipping loans, financial leasing, bonds, etc. A good example of responsible shipping finance is Poseidon Principle (Barreiro et al., 2022). It is a global initiative for shipping finance launched in June 2019 by eleven banking institutions around the world. This initiative proposes a common benchmark for quantitatively evaluating and disclosing the compliance of financial institutions' loan portfolios with climate targets. By providing incentive-based loans, it aims to encourage shipowners to buy or build low carbon emitting ships. Meanwhile, shipping insurance contracts are necessary risk management tools for mitigating the risks generated from responsible shipping activities (Jian et al., 2022).

3 Elements of responsible shipping

As analysed above, responsible shipping is a systemic issue that is embedded in every part of shipping process, concerning multiple aspects with complex interactions. Policies and management practices affecting one or two dimensions of responsible shipping activities will indubitably affect the remaining dimensions, so as the shipping process. For instance, the growing use of containers is helpful for shipping companies to achieve scale economies and improve their environmental performance while reducing the route's resilience against external shocks and causing social issues (Ducruet et al., 2015; Xu and Xia, 2017). Similarly, providing training opportunities not only boosts employees' commitment but also benefits the shipping companies' reputation, which is favorable to their economic sustainability (Tang et al., 2020). From the process perspective, shore power, a typical example of responsible shipping, requires ports and ships to redesign or rebuild for installing new equipment, and their operations also need to be adjusted accordingly. Furthermore, the high cost of renovation of ships' shore connection capacity reduces its financial performance even though it benefits the environmental performance (Kumar et al., 2019). As such, responsible shipping has dual attributes corresponding to the dual role of shipping. Specifically, responsible shipping requires effective shipping activities that support

responsible production and responsible consumption, while enabling shipping firms/industry to improve their performance in environmental, resources, social, economic, technological aspects, etc.

Furthermore, it is desirable to identify the elements underpinning the concept of responsible shipping. The study by Lai et al. (2011), in which they identify six dimensions of environmental management for green shipping practices (GSPs), lays a foundation for concept analysis of responsible shipping. Built on their framework to reflect responsible shipping practices, we identify seven elements of ensuring SCP patterns in shipping activities (7Rs) to explain responsible shipping operations. These responsible shipping elements and the corresponding examples are summarized in Table 2 below.

Table 2. Elements of responsible shipping (7Rs)

7Rs	*Descriptions*	*Responsible shipping operations examples*
Responsible policy and procedure	Corporate commitment to a vision or culture of responsible consumption and production covering shipping practices.	Identification and support for responsible shipping from the managers, integration of the concept and vision into shipping operations and management, coordination with other missions, cross-functional cooperation for responsible shipping, sustainable development policy, system implementation.
Responsible documentation	Paperless and all-in-one documents involved in shipping practices including booking requests, booking confirmation, shipping instructions, payment, invoice, and remittance advice.	Use EDO platform (Electronic Delivery Order) /block technology to provide a series of online services including order matching, online payment, electronic invoice, and online reservation.
Responsible procurement	Manage suppliers' risk and strengthen sustainability development of the supply chain.	Supplier selection, purchasing decisions, monitoring, and addressing sustainability risk in the supply chain.
Responsible services and products	Shipping cargoes cost-effectively.	Use effective shipping equipment and facilities to ship cargoes on time with the least losses, response efforts in case of disasters, use environmentally friendly equipment and facilities, use cleaner energy.
Responsible shipping design and compliance	Less environmental damage and resources consumption of shipping activities by efforts on compliance with regulatory requirements on responsible production and consumption.	Design ships with green technologies that are powered by cleaner energy or reduce burning fuels with heavy pollution, design of shipping activities for saving fuel consumption, design shipping equipment for recycling and reuse of used materials, arrangement of shipping schedules, and design shipping activities in compliance with regulations.

Responsible recycling	Recovering from used shipping equipment, facilities, and resources to reduce the costs, waste, and pollution, as well as improving the resources efficiency, operations, the benefits of workers, yards, and shipowners.	Equipment recycling including ships and containers, waste management, recycling and reuse of used oil and packages, proper disposal of excessive equipment and facilities.
Responsible report	Transparency and accountability through timely disclosure of information.	Honest preparation and timely issue of detailed sustainability reports with key responsible performance indicators for evaluation, as well as the roadmap to implement responsible shipping including the objectives, desired outcomes, and interrelated milestones to be achieved along the responsible shipping journey.

As shipping activities connect with production and consumption, integrating the supply chain with the upstream shippers and downstream consignees, responsible shipping is an integrative part that requires cross-functional cooperation (Lai et al., 2002; Lai et al., 2011). Shipping firms should embrace responsible shipping as unique cooperative resources to strive for performance as the international trade community growingly demands responsible operations. Especially, being the physical linkage between production and consumption, responsible shipping is the bridge that connects responsible production and responsible consumption. Accordingly, shipping firms allocate responsible shipping elements mentioned above to provide responsible shipping services and support the progress of responsible production and consumption. With the increasing uncertainty generated from the business, climate, and environment, as well as changing relevant regulations, it will serve shipping firms' advantage to formulate and act on promising responsible shipping strategies, which will persist in the future.

4 Adoption and performance value of responsible shipping

Since SDGs are proposed and adopted, responsible shipping is also practiced around the world. Although scholars or practitioners may have a general understanding of the adoption conditions of responsible shipping, there is a void of systematic discussion of the concept and its adoption and performance value. Further to our framework explaining the concept, we develop several propositions regarding the

adoption and performance value of responsible shipping to advance knowledge in the field.

4.1 Adoption conditions of responsible shipping

As shipping activities are characterized as a complex system with multiple parties involved and are affected by various factors to operate successfully at low cost and good service quality, the institutional theory is a suitable theoretical lens to explain the adoption of responsible shipping through an institutional process shaped by a variety of driving forces. Adopting responsible shipping practices can be a result of regulatory requirements, customer pressure, market competition, and multiple benefits in economic, environmental, resources, and social aspects.

4.1.1 Regulatory requirements

The literature on responsible production and consumption and the history of its practices highlight the driving forces of regulatory policies on ensuring SCP (Lin and Ho, 2011). Responsible shipping is similar in its development. Various regulatory policies work as a systematic guideline to direct shipping firms to conduct various responsible practices in shipping operations.

On the one hand, shipping firms are required to take various measures in support of responsible production and consumption. For example, Air China Cargo issued "Notice on Prohibition of Transportation of Shark Fins" in 2017, announcing a ban on shark fin shipments, which is consistent with Animal Welfare Institute (2015) and (WWF-HK, 2016). A total of 36 international airlines and 17 international shipping firms have pledged to ban shark fins worldwide. On the other hand, shipping firms are required to take action on governing the performance of shipping activities in sustainable ways like other industries, including environmental protection, resources conservation, etc. For instance, to deal with air pollution, the relevant legislation adopted by IMO includes setting limits on emissions of SOx, NOx, CO2, the mandatory EEDI for new ships, and the SEEMP for all ships, the "Greenhouse Gases Emissions Strategy". Moreover, the EU Commission announced its Green Agreement and package "Fit for 55" with the extension of its Emissions Trading System to include shipping, which is a new regulation for shipping emissions. From the perspective of regulatory

control, the enforcement of regulations is more important than formulating regulations. The regulatory control with loose enforcement is unlikely to lead firms effectively to behave as stipulated according to the regulations (Economy and Lieberthal, 2007). Instead, enforced regulations play a necessary role in promoting firms to take actions conforming to regulatory requirements actively (Ding et al., 2021).

Proposition 1. Compliance with enforced regulatory requirements is one of the favorable conditions for responsible shipping adoption. Specifically, it not only requires the recognition of enforced regulatory requirements by shipping firms, but also their response and implementation of responsible shipping voluntarily and timely.

4.1.2 Customer pressure

As the users of shipping services provided by shipping firms. customers (shippers) are regarded as the most crucial parties in shipping activities. The demand and expectations of customers influence shipping firms' cargo movement operations directly, especially on the issues of safety, reliability, speed, helpfulness, communication, flexibility, and fault recovery (Carter and Carter, 1998; Tontini et al., 2017). Apparently, customer pressure affects shipping firms' decisions on conducting environmental management strategies, including the adaption of responsible shipping activities (Zhang et al., 20).

On the one hand, customer demands for different types of products with various requirements for shipping services motivate shipping firms to improve their equipment and operations by adopting responsible shipping practices. For instance, the distribution of perishable products requires cold chain logistics management to ensure product quality with the least loss (Li et al., 2019). To satisfy customer requirements and reduce cost and waste, Maersk has built integrated cold chain logistics with digital innovations and reefer technology, offering effective end-to-end visibility of conditions inside the box for customers to track and trace the cargo status. This responsible shipping adoption can close major information gaps in the supply chain with increased information transparency.

On the other hand, the growing customer awareness of responsible consumption requires business partners to conduct responsible production and consumption more

proactively. Shippers with this awareness will prefer shipping firms emphasizing responsible shipping to couple with their business value for responsible operations. Furthermore, the awareness of end consumers can also be voiced to influence shipping firms' responsible shipping activities via shippers. Meanwhile, most of the customers check the efforts made by shipping firms to provide responsible shipping services, as well as the comments from previous customers before they arrange their shipping activities. In case a shipping firm is accused of discharging substandard waste which is deemed as irresponsible production behavior, the shippers may abandon the cargo consignment services to keep their responsible corporate image in front of their consumers. Thus, shipping firms with a reputation for being responsible are more preferred by shippers for continued business. From the view of institutional theory, shipping firms are motivated to pursue responsible shipping as expected by shippers and consignees for the sake of legitimacy and prospects of continued business.

Proposition 2. Usefulness is another favorable condition for responsible shipping adoption. Specifically, shipping firms adopting responsible shipping are considered to be beneficial to transport cargoes in a responsible way that is quickly and accurately without losses and excessive pollution to satisfy customer requirements and gain customers' loyalty as well as corporate reputation.

4.1.3 Industrial norms

Shipping industry builds institutionalized norms to constrain and regulate shipping activities to ensure that they are compliant with various requirements such as environmental protection, social responsibility, resources conversation, as well as to fulfill the shipping demands in a cost-effective manner. Many industrial associations and shipping firms are actively building and implementing such industrial norms. An example to illustrate such responsible shipping practices is *Responsible Shipping Initiative* (*RSI*), a non-profit organization, that advocates sustainability requirements against which ship owners are evaluated. Such requirements aim to promote responsible shipping by incentivizing ship owners to proactively raise the standard for vessels to enhance working conditions, health and safety, and environmental protection. Similarly, *Sustainable Shipping Initiative (SSI)* offers a roadmap to guide the development of a

sustainable shipping industry that lays out the pathways and milestones to direct shipping firms to adopt sustainable operations. From the view of shipping firms, most of them are members of industrial associations in which they have their visions. For instance, as required by industrial associations, e.g. Marine Environmental Protection Committee (MEPC) and INTERTANKO, members are encouraged to take action on reducing the carbon footprint of shipping industry. One typical example is that Maersk has been launching a responsible ship recycling project to improve the recycling ratio of materials. Due to industrial institutionalized responsible shipping norms, more and more shipping firms are adopting responsible shipping practices to strengthen their ability for market competition.

Proposition 3. Compliance with industrial institutionalized responsible shipping norms is one of the favorable conditions for responsible shipping adoption. Specifically, the development of industrial institutionalized norms accelerates the adoption of responsible shipping practices by providing shipping firms with guidelines of legitimation in shipping industry.

4.1.4 Multiple Benefits

As the practitioner of shipping activities, shipping firms must cope with the institutional pressure of ensuring responsible consumption and production in a way that would be compliant without harming their own business. Except for the driving forces mentioned above including regulatory requirements, customer pressures, industrial norms, the performance benefits are incentives for shipping firms to adopt responsible shipping in their operations. As an innovative approach for shipping management, responsible shipping offers not only the opportunity for shipping firms to provide responsible shipping services to support responsible production and consumption in other industries but also helps shipping firms achieve sustainable growth for themselves.

On the one hand, responsible shipping operations are helpful for shipping firms to reduce undesirable outcomes such as excessive emissions, loss of cargoes, untreated waste, and waste of used oil and materials. Improvements in these performance aspects would bring shipping firms more business from those lacking responsibility awareness. On the other hand, responsible shipping operations accelerate the process of responsible

production to responsible consumption by cutting off irresponsible ones. As shippers' and customers' desire for being responsible is fulfilled, the business relationships with them are strengthened. Moreover, thanks to the inter- and intra- relationships among shipping industry, regional economy, and other industries, sustainable development of shipping operations is the direction advocated by the community in international trade, regional economy, and global supply chains. It provides convenience for shipping firms recognized for responsible shipping to transport higher volumes of cargo around the world because responsible shipping is increasingly welcome by more economies. Even though responsible operations may incur high investment costs for the innovation and organizational changes in short run, the upgrade of effective technologies and operations can contribute to cost and resources reduction, thereby improving multiple benefits in economic, environmental, social, and resources aspects. In sum, the adoption of responsible shipping is valuable for shipping firms due to the generated multiple performance benefits in economic, environmental, and social dimensions.

Proposition 4. Shipping firms can obtain multiple benefits in productivity, social, environmental, and resources from the implementation of responsible shipping; and in turn, these benefits motivate responsible shipping adoption by shipping firms.

In Figure 4, we present a path diagram that illustrates the conditions favorable for responsible shipping adoption according to the stated propositions. First, enforced regulatory requirements from governments are one of the conditions favorable for responsible shipping adoption, highlighting that compliance with these regulations is beneficial for responsible shipping adoptors. Second, the preferences of customers for SCP is another condition favorable for responsible shipping adoption. Accordingly, improving the usefulness of shipping services in response to the pressures are benefiting from adopting responsible shipping. Third, industry norms driven by enforced regulatory requirements and customer pressures are also favorable conditions for responsible shipping adoption, highlighting that compliance to industry norms also benefits the adoptors. Taken in sum, shipping firms can gain from the implementation of responsible shipping including such benefits as improved economic, social, environmental performance outcomes, as well as the measures in resources and

technological aspects. Meanwhile, the multiple benefits motivated shipping firms to adopt responsible shipping.

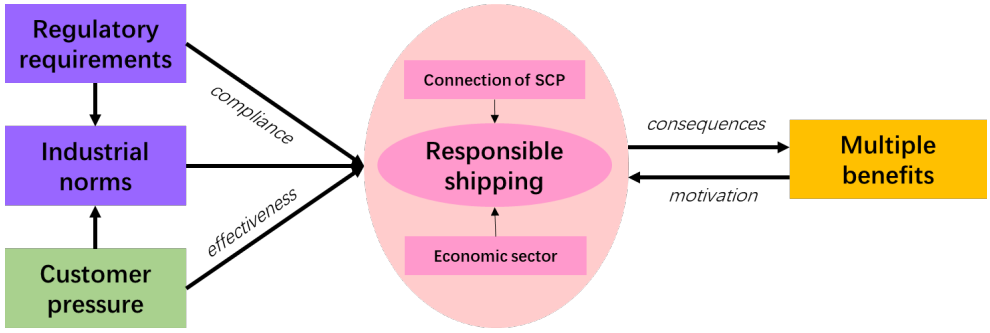

Fig 4 The path diagram of favorable conditions and benefits of adopting responsible shipping

4.2 Performance value of responsible shipping

Performance values are a concrete manifestation of multiple benefits. Responsible shipping can support responsible production and consumption, as well as the sustainable development of shipping operations. Specifically, responsible shipping is associated with firm performance, customer performance, and others.

Firm performance of responsible shipping can be divided into two groups: financial performance and non-financial performance. Financial performance mainly covers commonly used evaluation criteria such as ROA, profitability ratios, market value ratios, etc. Non-financial performance mainly focuses on the usefulness and efficiency of shipping operations concerning the dimension layer and supporting layer in the strategic folder. Specifically, it involves tangible performance outcomes including operational efficiency, environmental sustainability, resources sustainability, quality of shipping services, market share, social welfare, sustainable technology innovations and adoption, risk management concerning the potential risk in operational, financial, institutional sources, etc. In addition, there are also some intangible performance outcomes, such as corporate reputation, brand value, market image (Yang et al., 2013; Mansouri et al., 2015; Chang and Danao, 2017).

Customer performance of responsible shipping is mainly derived from the customers' response to its implementation. It covers customers' loyalty, customer satisfaction, and willingness to cooperate. In addition, government and non-government associations' satisfaction, stakeholders' satisfaction, job satisfaction of employees, and

the collaboration of upstream and downstream parties are also performance values of responsible shipping.

5 Discussion

As one specific implementation part of responsible consumption and production, responsible shipping has attracted growing attention from scholars, shipping firms, industry associations, and policymakers. Although the concept and attributes of responsible production have been discussed in previous literature, most of them considered corporate practices with a focus on CSR (Skouloudis et al., 2015; Roy et al., 2017; Liu et al., 2021) giving less attention to shipping industry which is a neglected economic sector for environmental protection. Even though there are some studies investigating the effects of institutional forces on the environmental management of shipping firms in adopting green/sustainable shipping practices, none of them has discussed shipping practices concerning responsible consumption and production. Furthermore, a definition of responsible shipping can lay a foundation for shipping industry to evaluate and improve their shipping operations for sustainability, which is still absent from the literature. Issues on the conceptualization, identification, adoption conditions, and performance values of responsible shipping are still under-explored. To fill these knowledge gaps, guided by SCP, this paper conducted a systematic analysis of responsible shipping and offered useful references about the concept, elements, adoption conditions, and performance values of responsible shipping.

Unlike the previous relevant concept analysis of sustainable/green shipping (Lai et al., 2011; Chang and Danao, 2017; Yuen et al., 2017; Pang et al., 2021), this study explores the concept of responsible shipping from the perspective of its dual roles, which is not only the connection between production and consumption activities, but also an economic sector in its own rights. With this in mind, we develop a conceptual framework comprising a strategic folder and a practical folder to explain the concept of responsible shipping. Holistically, responsible shipping is the bridge to ensure SCP in facilitating global trade activities. On the one hand, responsible shipping is the backbone of responsible production and responsible consumption by undertaking cargo

movements to physically fulfill the economic exchange of involved parties in trade transactions. On the other hand, responsible shipping refers to the effective shipping activities that enable shipping firms/industry to improve their performance.

Considering that responsible shipping is realized through practices, we have identified seven elements of shipping activities where responsible shipping can be adopted to facilitate cargo flows with performance enhancements. These elements include responsible policy and procedure, responsible documentation, responsible procurement, responsible services and products, responsible recycling, responsible design and compliance, responsible report. These elements characterizing responsible shipping provide shipping firms with directions for improving shipping operations towards responsible shipping while they need to be further quantified for clarity to guide implementation. A step towards responsible shipping needs key performance indicators for evaluating responsible shipping with practicality and clarity. Hence, how to evaluate responsible shipping practices is a question worthy of future research efforts.

Further, this study examines the adoption conditions and performance values of responsible shipping initiatives driven by various institutional forces, including regulatory requirements, consumer pressure, industry norms, and multiple benefits. The findings provide a theoretical basis for policymakers and professional associations to develop regulations and norms, which can guide the achievement of responsible shipping for sustainability. Meanwhile, they also enable shipping firms to examine and promote their shipping activities towards better performance and productivity as the multiple institutional forces require. Future studies should acknowledge the complexity of responsible shipping and establish scientific and efficient regulations and norms. Especially, the fields worthy of further investigation include the relationship between responsible shipping practices and the performance value for shipping industry, the game among multiple stakeholders, how to design the regulations and norms, and the impact of digital adoption on responsible practices in the shipping industry (Gerakoudi-Ventouri, 2022; Gavalas et al., 2022). Answers to these questions will be helpful for shipping industry to reach the responsible consumption and production goal of improving and supporting sustainable development for our future.

6 Conclusions

This study advances knowledge on responsible shipping. We explain the concept of responsible shipping, and interpret it holistically through the two-folder framework with strategic folder and practical folder. Based on the interpretation, we identify seven responsible shipping elements (7Rs) embodied in the shipping practices towards ensuring SCP, including responsible policy and procedure, responsible documentation, responsible procurement, responsible services and products, responsible recycling, responsible design and compliance, responsible report. These elements provide shipping firms/industry with practical reference for improving their operations towards responsible shipping. Furthermore, we develop propositions concerning its adoption conditions and performance values, as well as the path by which they interact. It appears that shipping firms adopt responsible shipping intensively to improve their performance, to encounter regulatory requirements, customer pressure, and industrial norms. Meanwhile, the multiple benefits shipping firms reaped from responsible shipping operations drive them to adopt responsible shipping operations proactively. This study is the first attempt to define and interpret responsible shipping systematically. On the academic side, the concept analysis and the findings provide a general picture of responsible shipping including the definition, elements, adoption conditions, and performance values. It also provides a guidepost to facilitate future studies in this area of shipping studies. On the practical side, this study offers an overview of the multiple stakeholders involved in the shipping industry to implement responsible shipping. Both the shipping firms and the policymakers are advised to implement responsible shipping practices to meet the regulatory requirements, norms, public expectations while earning multiple performance benefits. Targeting to embrace responsible consumption and production, this study is helpful for shipping industry to reach the goal of improving and balancing their productivity with environmental, social, resources, technological performance outcomes in shipping operations, as well as satisfying the escalating public expectations for shipping operations in servicing international trade and global supply chain activities.

This study has the following limitations, as well as some opportunities for future studies. The context of responsible shipping as discussed focuses on large shipping companies that are resourcesful to address their environmental and social responsibilities. Taking actions for these responsibilities may incur huge financial burden for small and medium-sized shipping companies, which are the majority of shipping companies around the world. For these smaller-sized shipping companies, responsible shipping may not be the priority in their business focus. It is promising for future studies to generate more in-depth knowledge examining the integration and adoption of responsible shipping practices at small and medium-sized shipping companies. Moreover, this paper presents a framework of responsible shipping with emphasis on conceptual development. Future research can enrich this framework with empirical evidence to compare the characteristics and adoption extent of responsible shipping at large versus small shipping companies.

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