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The influence of green SCM on SCM utilization in the shipbuilding and shipping industries: the mediating role of ESG management awareness

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Abstract

Purpose – This study explores how green supply chain management (GSCM) practices influence supply chain management (SCM) utilization in the shipbuilding and shipping industries, focusing on the mediating role of environmental, social and governance (ESG) management awareness. It aims to assess whether higher levels of ESG awareness enhance the effectiveness of GSCM in driving sustainable operational outcomes.

Design/methodology/approach – A survey targeting professionals in the shipbuilding and shipping sectors was conducted, and the collected data were analyzed using Hayes' PROCESS Macro Model 4. The analytical process included normality checks, reliability assessment and correlation analysis to ensure methodological robustness and transparency.

Findings – ESG awareness acts as a partial mediator, enhancing the impact of GSCM on SCM by facilitating resource efficiency, emission reductions and sustainable waste practices. These findings emphasize ESG awareness as a strategic lever for achieving both regulatory compliance and long-term competitiveness.

Originality/value – This study provides a clear and industry-specific contribution by empirically analyzing the relationship between ESG management awareness, green supply chain management (GSCM) and supply chain management (SCM) utilization in the shipbuilding and shipping sectors. This research highlights how ESG awareness functions as a critical enabler of GSCM effectiveness in highly regulated, resource-intensive environments.

Keywords Green supply chain management (GSCM), SCM utilization, ESG management awareness, Sustainability, Shipbuilding and shipping industries

Paper type Research article

1. Introduction

Approximately 70% of worldwide trade by value and 80% by volume is accounted for by the shipping industry, which is an essential part of the global transportation network that keeps the global economy running smoothly (UNCTAD, 2021). As a critical infrastructure supporting the global exchange of goods, the shipping industry serves as the logistical backbone that ensures the efficient functioning of the international economic system. Two essential elements of the shipping industry are the shipbuilding and maritime transportation industries. The two industries are strongly and directly dependent on the performance of global markets, notwithstanding their notable distinctions (Legorburu *et al.*, 2022). The shipbuilding and shipping industries are deeply embedded in global trade networks, making them highly responsive to economic fluctuations. As trade expands, the strategic role of maritime logistics and production systems becomes increasingly pronounced. This growth underscores the

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critical importance of these sectors in supporting global commerce. However, the accelerated development of marine transport has brought unintended environmental consequences. Shipping activities significantly contribute to greenhouse gas (GHG) emissions. This raises growing concerns over the industry's impact on global climate change and environmental sustainability (Guo *et al*., 2023).

With almost 99% of total energy consumption coming from petroleum, the shipping industry is unique in its reliance on fossil fuels to meet its energy demands (IEA, 2023). As a result, there has been a significant increase in global regulatory frameworks and public pressure to reduce the environmental effects of climate change and air pollution from shipping (Englert and Losos, 2021). The International Maritime Organization (IMO) responded by enacting a number of environmental rules to lower greenhouse gas emissions in the industry. One of the most significant of these was IMO 2020, which lowered the maximum amount of sulfur that can be present in marine fuel from 3.5% to 0.5% worldwide (Park, 2021).

As sustainability becomes a central concern, ESG management awareness has emerged as a key driver of GSCM implementation and SCM efficiency in the shipbuilding and shipping sectors (Knudsen, 2021). International environmental regulations, such as the EU's 2030 emission targets and IMO's MARPOL Annex VI, further accelerate this shift. For example, Denmark's deployment of sniffer drones to enforce IMO 2020 standards demonstrates how heightened ESG awareness promotes proactive environmental practices and enhances supply chain performance (Hong, 2024).

The shipbuilding and shipping industries, which account for a significant share of international freight, have caused substantial damage to marine ecosystems due to increasing maritime traffic (She *et al*., 2023). As a result, global initiatives to strengthen carbon emission regulations and prevent marine pollution have accelerated (Raman *et al*., 2023). These efforts not only ensure long-term industrial competitiveness but also support corporate social responsibility. In this context, interest in Green Supply Chain Management (GSCM) has grown, as it integrates environmental sustainability into supply chain operations. ESG (Environmental, Social, and Governance) management awareness has become a key factor in driving the adoption of GSCM and improving Supply Chain Management (SCM) utilization (Lee, 2021; Ryu and Chang, 2019). For instance, Denmark's sniffer drone monitoring system and Maersk's green methanol initiatives exemplify how heightened ESG awareness fosters proactive environmental practices (Hong, 2024). While prior studies acknowledge the potential link between ESG awareness and sustainable supply chain performance, empirical analysis on the mediating role of ESG awareness between GSCM and SCM utilization remains limited. Therefore, this study investigates (1) whether GSCM directly enhances SCM utilization in the shipbuilding and shipping industries, and (2) whether ESG management awareness mediates this relationship. The findings aim to provide practical insights into how ESG-driven GSCM practices can help firms respond to regulatory pressures while strengthening environmental accountability and long-term competitiveness (Lee, 2021). In response to environmental imperatives, international organizations such as the EU and IMO have introduced regulations to reduce emissions, including the EU's 2030 target of a 55% reduction from 1990 levels and IMO's MARPOL Annex VI, which guides air pollutant limits to support ESG goals.

Although prior research has explored Green Supply Chain Management (GSCM) and ESG management in various industrial contexts, few studies have examined the mediating role of ESG management awareness in the link between GSCM and supply chain performance. Particularly in the shipbuilding and shipping industries—sectors with high environmental externalities and growing regulatory oversight—this relationship has been largely underexplored. This study addresses this gap by focusing on how ESG awareness functions as a key mechanism that enables the effective implementation of GSCM, ultimately enhancing SCM utilization.

Moreover, with increasing global emphasis on decarbonization and green logistics, the academic and policy relevance of GSCM has grown substantially in recent years. In this context, investigating ESG awareness as a mediating variable provides deeper insights into the

internal organizational conditions that facilitate sustainable supply chain transitions. This research thus contributes to the literature by offering industry-specific empirical evidence based on primary data from maritime firms and applying PROCESS Macro-based mediation analysis. The findings are expected to inform both theory and practice, particularly in guiding ESG-aligned operational strategies in environmentally intensive sectors.

As maritime traffic continues to increase, threats to marine ecosystems have become more frequent (She *et al*., 2023), contributing to a growing consensus on the necessity of enhancing ESG awareness and implementing GSCM practices. Accordingly, it is essential to empirically investigate the impact of ESG awareness on the adoption of GSCM practices and the utilization of SCM. This study seeks to examine how ESG awareness influences corporate sustainability and competitive advantage through the implementation of GSCM. In addition, by analyzing real-world cases—such as Denmark's deployment of sniffer drones and Maersk's strategic partnership in green methanol—this study aims to offer both theoretical and practical insights into the ESG–GSCM linkage. It empirically demonstrates that ESG awareness promotes eco-friendly management practices, enhances SCM utilization, and contributes to the attainment of sustainable competitive advantage.

2. Literature review

2.1 Environmental impact of the shipbuilding and shipping industries and international regulations

Strict worldwide environmental laws apply to the shipbuilding and shipping industries because of their significant environmental impact. The shipping industry is a major source of a number of pollutants, such as carbon dioxide (CO_2), sulfur oxides (SOx), nitrogen oxides (NOx), ozone-depleting substances (ODS), and volatile organic compounds (VOC), as it is an industry that emits large quantities of airborne pollutants during vessel operation (Ytreberg *et al*., 2021). These emissions contribute to climate change and have a negative impact on coastal air quality as well as marine ecosystems. Notably, one of the main causes of global warming is greenhouse gases (GHGs), such as CO_2, which pose serious risks to the atmosphere and marine habitats (Ytreberg *et al*., 2021).

The International Maritime Organization (IMO) has put in place a number of regulations and policies in response to these environmental issues. For example, MARPOL Annex VI, which sets stringent requirements for major emissions from ships, was created to prevent ship-related air pollution (International Maritime Organization, n.d.). By limiting airborne pollutants and implementing distinct emission requirements according to operating zones, this law helps to safeguard the environment. The regulation has gradually tightened standards for particular zones in an effort to further reduce SOx and NOx emissions. Measures like the Ship Energy Efficiency Management Plan (SEEMP) and the Energy Efficiency Design Index (EEDI) have been introduced to improve the energy utilization of vessels (International Maritime Organization, n.d.).

All vessels must maintain a fuel sulfur content of 0.5% or less, with an additional tougher restriction of 0.1% in Emission Control Areas (ECA), as part of a global sulfur quota implemented by the IMO since 2020 (Park, 2021). According to Jee (2020), the shipping industry has been forced to minimize harmful emissions as a result of these rules. Common compliance practices include the use of low-sulfur fuels, the installation of scrubbers, and the adoption of alternative fuels such as LNG. For instance, installing scrubbers lowers SOx emissions from ships, but they are expensive to install and maintain. As a result, some businesses choose to promote ecologically friendly operations by using alternative fuels like LNG or low-sulfur fuel (Jee, 2020).

With the introduction of the "European Green Deal," which aims to cut greenhouse gas emissions by at least 55% from 1990 levels by 2030, the European Union (EU) has further strengthened IMO restrictions. The EU encourages even foreign manufacturers to use environmentally friendly production practices through programs like the Carbon Border Adjustment Mechanism (CBAM), which strengthens the shipping industry's environmental

duty (European Commission, n.d.). The implementation of GSCM is greatly aided by these regulations, which are crucial in forcing shipping companies to embrace environmentally friendly management methods. It is becoming more widely acknowledged that adhering to these rules can result in long-term financial savings and show corporate social responsibility (Englert and Losos, 2021).

2.2 GSCM and SCM utilization level

The integration of eco-friendly Green Supply Chain Management (GSCM) practices has become a strategic imperative for industries facing increasing environmental regulations and societal pressure to operate sustainably. In particular, the shipbuilding and shipping sectors—responsible for significant carbon emissions and resource-intensive operations—have been at the forefront of adopting GSCM practices to enhance operational efficiency and regulatory compliance (Wang and Dai, 2018; Alexandrou *et al*., 2022).

GSCM refers to the adoption of environmentally conscious practices across the supply chain, encompassing product design, sourcing, production, distribution, and waste management (Srivastava, 2007). It aims not only to reduce environmental impact but also to improve the overall performance of supply chain operations by minimizing waste and optimizing resource utilization. As highlighted by Yoon *et al*. (2018), organizations implementing GSCM often experience improved environmental performance alongside enhanced supply chain performance and utilization.

The relationship between GSCM and Supply Chain Management (SCM) utilization is reinforced by the role of ESG (Environmental, Social, and Governance) management awareness. ESG-oriented firms tend to adopt proactive environmental strategies such as GSCM, which enables them to streamline operations, reduce emissions, and achieve cost savings while aligning with global regulatory standards (Fasoulis *et al*., 2019; Englert and Losos, 2021). This integration of ESG and GSCM strengthens a firm's ability to meet both compliance and performance goals.

Moreover, evidence from high-emission industries like maritime transport shows that companies with strong ESG frameworks are more likely to implement GSCM initiatives that yield tangible improvements in SCM utilization (Awan *et al*., 2016; Knudsen, 2021). For example, Maersk's adoption of green methanol through international partnerships exemplifies how GSCM facilitates both environmental performance and supply chain efficiency (Grzelakowski *et al*., 2022). Similarly, ISO 50001-certified shipping firms have significantly reduced fuel consumption and carbon output through energy-efficient engine systems and waste heat recovery, demonstrating the operational impact of GSCM on SCM performance (Alexandrou *et al*., 2022).

Research also supports the idea that GSCM adoption is driven by institutional pressures and goal-oriented strategies. According to Lange and Cummins (2021), companies with clear sustainability goals—guided by frameworks such as Goal-Setting Theory (Latham, 2023)—are more likely to embed GSCM practices into their supply chain operations to enhance organizational performance. Chhetri *et al*. (2020) further argue that technological innovation and structural change, often catalyzed by ESG and GSCM integration, are essential for managing supply chains in the context of the Fourth Industrial Revolution.

The COVID-19 pandemic further illuminated the relevance of GSCM in enhancing SCM utilization. During the crisis, many firms in the shipping industry faced significant operational disruptions; however, those that had already implemented sustainable SCM practices were able to maintain resilience and continue operations more efficiently (Shang *et al*., 2023). This illustrates that GSCM not only supports sustainability but also reinforces operational robustness.

In addition, policy developments such as the EU's Carbon Border Adjustment Mechanism (CBAM) and IMO 2020 sulfur cap regulations are pushing companies toward greater environmental accountability, thereby accelerating the adoption of GSCM as a means to maintain competitiveness (Hoang *et al*., 2022; Knudsen, 2021). Bosi *et al*. (2022) also note that as ESG and CSR disclosures remain largely voluntary and heterogeneous across firms, GSCM

serves as a mechanism to standardize sustainable operational practices and enhance SCM efficiency across industries. Empirical studies show that GSCM contributes to financial and non-financial outcomes by supporting innovation, lowering risk, and improving stakeholder trust (Dubey *et al*., 2018; Ioannou and Serafeim, 2017). Furthermore, ESG-driven practices such as information sharing and technology integration facilitate supply chain coordination and effectiveness, further amplifying the benefits of GSCM (Sundram *et al*., 2020; Fraser *et al.*, 2022).

Taken together, the literature demonstrates that implementing eco-friendly GSCM practices leads to improved SCM utilization by enhancing resource efficiency, regulatory compliance, and operational performance—especially in environmentally sensitive and logistically complex sectors like shipbuilding and shipping. Therefore, this study proposes the following hypothesis:

H1. The implementation of eco-friendly GSCM enhances SCM utilization levels.

2.3 ESG awareness level and SCM utilization level

A company's level of awareness regarding Environmental, Social, and Governance (ESG) management is increasingly recognized as a critical internal factor influencing its sustainability strategy and supply chain effectiveness. ESG awareness encompasses an organization's recognition of its responsibilities beyond short-term profit—specifically its environmental obligations, social accountability, and governance practices. According to Fasoulis *et al*. (2019), firms with higher ESG awareness are more likely to embed sustainable values into core business functions, including supply chain operations. In this context, Green Supply Chain Management (GSCM) becomes a key operational manifestation of such values, facilitating resource optimization, emission reductions, and compliance with international environmental standards (Kim *et al*., 2021; Knudsen, 2021).

In industries such as shipbuilding and shipping—which are highly carbon-intensive, technologically complex, and subject to increasingly stringent global regulations (e.g. IMO 2020 sulfur cap, CBAM)—GSCM alone may not be sufficient to achieve meaningful improvements in Supply Chain Management (SCM) utilization. ESG management awareness serves as the cognitive and strategic foundation that enables the translation of GSCM initiatives into measurable operational outcomes. It is through ESG-conscious leadership and employee engagement that firms choose to invest in clean fuel alternatives, real-time monitoring tools (e.g. sniffer drones), and collaborative logistics platforms that enhance the functionality and sustainability of their supply chains (Grzelakowski *et al*., 2022; Hoang *et al*., 2022). Government support, organizational commitment, strategy alignment, relationship management, awareness management, technology adoption, and performance evaluation are all important success elements for sustainable shipping management, according to research. The goal to enhance organizational performance and institutional pressures are the driving forces behind these management practices. Although they can result in improved non-financial and financial performance, the results can differ based on internal and external factors (Chua *et al*., 2023).

Despite growing interest in ESG and GSCM individually, prior literature has often treated them as separate constructs, lacking an integrated empirical framework that shows how ESG awareness can serve as a mediator in the relationship between GSCM and SCM utilization. Conceptual discussions have highlighted the potential role of ESG in driving green innovation and compliance behavior (Eccles *et al*., 2014; Alexandrou *et al*., 2022), but few studies have empirically tested this linkage—particularly in maritime industries, where supply chain decisions are deeply intertwined with environmental responsibility and operational risk.

This study fills that gap by proposing and testing a mediation model where ESG awareness is positioned as a pivotal variable that links eco-friendly GSCM practices to higher SCM utilization. Specifically, companies with greater ESG awareness are more inclined to develop sustainable

procurement policies, invest in environmentally adaptive upstream logistics technologies, and establish information-sharing protocols with downstream partners—thus translating green strategies into tangible improvements in SCM efficiency (Sundram *et al.*, 2020; Lee, 2021). Furthermore, evidence from smart port developments and pandemic-era resilience strategies (Praharsi *et al.*, 2022; Makkawan and Muangpan, 2021) suggests that ESG-driven supply chain adjustments are increasingly regarded as strategic assets rather than compliance tools.

In this context, ESG awareness acts not only as an antecedent to GSCM but also as a mediator that amplifies the effects of GSCM on SCM utilization. It enhances organizational readiness, facilitates cross-functional alignment, and motivates firms to adopt long-term, sustainability-oriented supply chain practices. Therefore, based on this theoretical reasoning and empirical rationale, the following hypothesis is proposed:

H2. ESG management awareness mediates the relationship between eco-friendly GSCM and SCM utilization.

3. Research methodology

3.1 Research model

This study investigates the mediating role of ESG management awareness in the relationship between SCM utilization levels and the direct impact of GSCM. The suggested correlations between GSCM, ESG awareness level, and SCM utilization are illustrated by the proposed study model, which is shown in Figure 1. According to Hypothesis 1 (H1), GSCM has a direct, beneficial impact on SCM use. According to Hypothesis 2 (H2), the association between GSCM and SCM utilization is mediated by ESG management awareness, meaning that greater ESG awareness amplifies the effect of GSCM on SCM utilization.

The proposed research model is illustrated in Figure 1.

3.2 Research subjects and data collection

The present study conducted a survey targeting executives and employees in the shipbuilding and shipping industries to examine the impact of ESG management awareness on GSCM and SCM utilization levels. The period of data gathering was December 5–December 13, 2022. To encourage participation, each respondent received an email with a link to the survey. They were then called to discuss the goals and purpose of the study. An effective response rate of 96.5% was achieved, with 83 valid responses from 100 questionnaires distributed. This high response rate indicates strong interest from industry participants.

3.3 Variables and measurement instruments

GSCM was the independent variable, ESG management awareness was the mediating variable, and SCM usage level was the dependent variable in this study. We used a 5-point

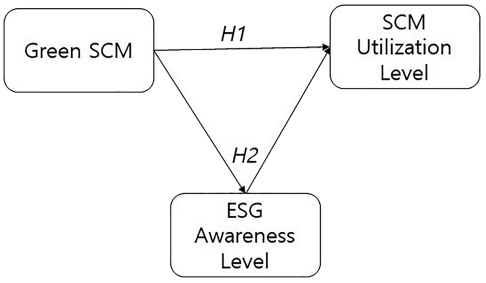

Figure 1. Research model. Source: Authors' elaboration

Likert scale (1 being strongly disagree and 5 being strongly agree) to measure each variable, based on measuring scales that have been proven to be reliable and valid in previous studies.

(1) Green Supply Chain Management (GSCM):

Sustainable supply chain practices, such as waste reduction and resource conservation, are measured by GSCM. The items, which covered initiatives to adhere to environmental policies, hold eco-friendly seminars and education, implement air pollution reduction devices, and enhance customer satisfaction and company image, were based on Zhu *et al*. (2004).

(2) ESG management awareness:

Organizational recognition of environmental, social, and governance responsibilities is measured by ESG management awareness. The Korea Chamber of Commerce and Industry (2021) and related material served as the basis for the development of items that highlighted the significance of ESG management, its impact on customer and business performance, and its connection to environmentally friendly shipbuilding.

(3) SCM utilization level:

The effectiveness of resource allocation and the results of strategic execution within the supply chain are assessed by SCM usage. The following ideas were taken from Kannan and Tan (2002) and Frohlich and Westbrook (2002), with an emphasis on increasing customer service, cutting down on delivery times, and improving product quality.

The detailed measurement items and their sources, based on Zhu *et al*. (2004), Korea Chamber of Commerce and Industry (2021), Frohlich and Westbrook (2002), and Kannan and Tan (2002), are summarized in Table 1.

We determined Cronbach's Alpha for every variable to make sure each build was reliable. With Cronbach's Alpha values of 0.86 for GSCM, 0.91 for ESG management awareness, and 0.91 for SCM utilization level—all above the generally recognized cutoff of 0.7—the results showed strong internal consistency and satisfactory reliability for each measurement (Hair *et al*., 2006).

Table 1. Setting of measurement items and variables

Variables	Items	Source
Green SCM	• Efforts to comply with government environmental policies • Activities encouraging employee participation in environmental initiatives through eco-friendly training and seminars • Measures to reduce emissions and waste, such as installing air pollution reduction devices • Efforts to enhance customer satisfaction and corporate image improvement during production processes	Zhu *et al*. (2004)
ESG Management Awareness	• Understanding the importance of ESG management • Contribution of ESG management to customer and corporate performance • Awareness of the relationship between ESG management and eco-friendly ship production	Korea Chamber of Commerce and Industry (2021)
SCM Utilization	• Ability to reduce processing time by utilizing SCM • Achievement in shortening delivery lead times via SCM • Role of SCM in improving customer service	Frohlich and Westbrook (2002), Kannan and Tan (2002)

Source(s): Authors' elaboration based on Zhu *et al*. (2004), Korea Chamber of Commerce and Industry (2021), Frohlich and Westbrook (2002), Kannan and Tan (2002)

3.4 Analytical methods

Frequency analysis and descriptive statistics were used at the beginning of the analysis to describe the study participants' organizational and demographic traits. The links between the important variables were then found and measured using correlation analysis, which evaluated both positive and negative associations. All statistical analyses in this study were performed using IBM SPSS Statistics 26.0 and Hayes' PROCESS Macro version 4.2. PROCESS Model 4 was employed to test the mediating effect of ESG management awareness on the relationship between GSCM and SCM utilization. Model 4 is widely recognized as a robust approach for testing single-mediator models using ordinary least squares regression. It also enables the use of bootstrapping, which offers more accurate estimates of indirect effects without assuming normality of the sampling distribution. This model is particularly appropriate for single-mediator analysis. In this study, 5,000 bootstrapping resamples and a 95% confidence interval were applied to evaluate the statistical significance of mediation effects. Given the relatively modest sample size ($n = 83$), PROCESS was selected over more complex structural equation modeling techniques due to its suitability for small to moderate samples and its wide acceptance in contemporary mediation research. This methodological choice enhances both the transparency and statistical rigor in the context of small-sample research.

4. Results

4.1 Data collection

Participant demographics included factors including department of employment, company type, years of service, and year of company founding. A strong representation of shipbuilding companies of both industries was ensured by the sample composition, which included 80.7% of respondents from shipbuilding companies and 19.3% from shipping companies. The study's representativeness is improved by the respondents' varied backgrounds, which offer a thorough understanding of the target industries. Table 2 summarizes the detailed demographic characteristics of the survey participants.

4.2 Correlation analysis

Significantly positive correlations between the variables were found by the correlation analysis. Higher adoption of GSCM practices is linked to higher SCM use, as evidenced by the positive correlation between GSCM and SCM utilization level ($r = 0.612$, $p < 0.01$). Likewise, there was a positive correlation between SCM utilization level and ESG management awareness ($r = 0.620$, $p < 0.01$), indicating that more ESG awareness leads to more efficient SCM utilization. The association between ESG awareness and the adoption of GSCM practices was further demonstrated by the positive correlation between ESG management awareness and GSCM ($r = 0.712$, $p < 0.01$).

There is little chance that multicollinearity will have an impact on the findings since none of the correlation coefficients were higher than $r = 0.80$. This indicates that the variables are sufficiently distinct to avoid issues of multicollinearity, thus supporting the robustness of the model. The detailed correlation results are presented in Table 3.

4.3 Mediation effect of ESG management awareness on the relationship between green SCM and SCM utilization level

To verify whether ESG management awareness mediates the relationship between GSCM and SCM utilization, a bootstrapping analysis was conducted using Process Macro Model 4. The results indicate that the direct impact of ESG management awareness on SCM utilization was statistically significant ($\beta = 0.3713$, $p < 0.01$). Additionally, the direct effect of Green SCM on SCM utilization ($\beta = 0.3879$, $p < 0.01$) and the effect of ESG management awareness on GSCM ($\beta = 0.8051$, $p < 0.01$) were also statistically significant. Furthermore, the indirect effect of GSCM on SCM utilization ($\beta = 0.2989$, $p < 0.01$) was observed, and the total effect in

Table 2. Demographic characteristics of the survey participants

Category	Subcategory	Frequency	Percentage
Company Establishment Year	Before 1970	4	4.8
	1971–1980	25	30.1
	1981–1990	6	7.2
	1991–2000	9	10.9
	After 2001	39	47.0
Company Type	Shipbuilding Companies	67	80.7
	Shipping Companies	19	19.3
Company Classification	Large Enterprise	53	63.9
	Medium-sized Enterprise	16	19.3
	Small-sized Enterprise	12	14.5
	Startup	1	1.2
	Other	1	1.1
Department of Employment	Administrative Department	23	27.7
	Design Department	20	24.1
	Production Department	13	15.7
	Quality Control Department	6	7.2
	Research Department	4	4.8
	Other Departments	17	20.5
Tenure (Years of Service)	Less than 5 years	23	27.7
	6–10 years	6	7.2
	11–15 years	38	45.8
	16–20 years	14	16.9
	More than 21 years	2	2.4
Partnership Duration	Less than 6 months	1	1.2
	6 months–1 year	1	1.2
	1–2 years	1	1.2
	2–3 years	13	15.7
	Over 3 years	67	78.3
Awareness of Environmental Regulations	Yes	65	78.3
	No	18	21.7

Source(s): Authors' elaboration

Table 3. Correlation analysis results

	Green SCM	ESG management awareness	SCM utilization level
Green SCM	1	0.712**	0.612**
ESG Management Awareness	0.712**	1	0.620**
SCM Utilization Level	0.612**	0.620**	1

Source(s): Authors' elaboration

the Green SCM → ESG management awareness → SCM utilization path ($\beta = 0.6868$, $p < 0.001$) was found to be greater than the direct effect. Notably, higher levels of ESG management awareness resulted in more significant direct and indirect effects on SCM utilization. This suggests that ESG management awareness not only provides a partial mediating effect in the relationship between GSCM and SCM utilization but also enhances SCM utilization more effectively as the level of ESG awareness increases.

To verify the statistical significance of the mediating effect, bootstrapping was performed with 5,000 samples, and the lower limit (BootLLCI) and upper limit (BootULCI) of the 95%

confidence interval did not include zero. The detailed mediation analysis results are shown in Table 4. These findings support that GSCM not only has a direct impact on SCM utilization but also positively influences SCM utilization indirectly by enhancing ESG management awareness.

The findings confirmed that GSCM practices positively influence SCM utilization (H1: $\beta = 0.3879$, $p < 0.001$). Furthermore, ESG management awareness was found to partially mediate this relationship (H2: indirect effect = 0.2989, 95% CI [0.1103, 0.5006]). Table 5 summarizes the results of hypothesis testing. The total effect ($\beta = 0.6868$, $p < 0.001$) was larger than the direct effect, partially confirming the mediating role of ESG management awareness, supporting the hypothesis that firms with higher ESG awareness are more likely to implement GSCM strategies that lead to effective SCM use.

These results align with prior research indicating that internal sustainability awareness strengthens organizational commitment to eco-friendly practices (Knudsen, 2021; Raman *et al*., 2023). The significant indirect effect highlights the importance of ESG awareness as a cognitive mechanism that enables the successful translation of green supply strategies into operational improvements. In the context of the shipbuilding and shipping industries, where regulatory pressure is high and environmental impacts are significant, ESG awareness may serve as a catalyst for implementing GSCM initiatives more rigorously and effectively.

5. Discussion

5.1 The impact of green SCM on SCM utilization level

The empirical support for Hypothesis 1 confirms that applying Green Supply Chain Management (GSCM) practices leads to a notable increase in Supply Chain Management (SCM) utilization. This outcome suggests that sustainability-driven strategies—such as minimizing operational costs, optimizing resource use, and improving overall logistics processes—can effectively strengthen SCM functions (Lange and Cummins, 2021). In this context, GSCM provides a dual benefit: meeting regulatory environmental demands and enhancing internal supply chain capabilities (Hendijani and Saeidi Saei, 2020).

Table 4. Mediating effect of ESG management awareness on the relationship between green SCM and SCM utilization level

Variables	β	S.E.	*t*	*p*	LLCI	ULCI
Mediating variable: ESG management awareness						
Constant	0.7123	0.3368	2.1149	0.0375	0.0422	1.3824
Green SCM	0.8051	0.0833	9.1220	0.0000	0.6295	0.9807
Dependent variable: SCM utilization level						
Constant	0.6441	0.3672	1.7543	0.0832	−0.0866	1.3740
Green SCM	0.3879	0.1334	2.9082	0.0047	0.1225	0.6533
ESG Management Awareness	0.3713	0.1179	3.1483	0.0023	0.1366	0.6059

Source(s): Authors' elaboration

Table 5. Results of hypothesis testing

Effect	β	S.E.	LLCI	ULCI
Total Effect (Green SCM →SCM Utilization Level)	0.6868	0.0987	0.4904	0.8831
Direct Effect (Green SCM →SCM Utilization Level)	0.3879	0.1334	0.1225	0.6533
Indirect Effect (Green SCM → ESG Management Awareness →SCM Utilization Level)	0.2989	0.1007	0.1103	0.5006

Source(s): Authors' elaboration

Grzelakowski *et al*. (2022) underscore this dual role through Maersk's example, where international cooperation for green methanol adoption illustrates the integration of environmental goals with long-term supply chain optimization. Numerous studies have reinforced this pattern by demonstrating that GSCM implementation improves resource efficiency and strengthens business performance through more sustainable operational models (Srivastava, 2007; Noh *et al*., 2014).

Operational elements linked to ESG awareness—such as asset allocation, scheduling accuracy, and equipment maintenance—play an instrumental role in improving SCM application, as observed by Lin *et al*. (2020). Similarly, Sha *et al*. (2021) show that equipment upgrades at logistics terminals, when combined with ESG strategies, contribute significantly to productivity and supply chain effectiveness.

Firms with elevated awareness of ESG principles are more proactive in embedding GSCM into their business models, which in turn promotes more extensive and effective SCM use (Hendijani and Saeidi Saei, 2020). Additionally, a heightened focus on ESG fosters better information sharing and quality control, which are essential for seamless supply chain integration (Kim *et al*., 2021).

Broader industry trends also support this link. For instance, Knudsen (2021) notes that the IMO 2020 sulfur cap regulations have accelerated GSCM application and enhanced SCM efficiency. Ardianto *et al*. (2023) identify similar improvements in logistics performance across Belt and Road Initiative (BRI) countries following GSCM implementation. In the Indonesian context, Praharsi *et al.* (2022) applied Lean Six Sigma using the DMAIC method to build pandemic resilience in maritime supply chains, further highlighting the relevance of green operations.

Lastly, Wang and Wang (2023) argue that environmentally driven investments and collaborative strategies between ports and shipping firms are effective in lowering emissions and improving supply chain outcomes. This view resonates with Goal-Setting Theory (Locke and Latham, 1990), which posits that clearly defined environmental targets—such as carbon neutrality or cleaner energy adoption—can strengthen organizational alignment and operational performance. In the maritime sector, characterized by high energy consumption and significant carbon emissions.

5.2 The mediating effect of ESG management awareness

The results supporting Hypothesis 2 indicate that ESG management awareness serves as a pivotal mediating variable that strengthens the positive association between Green Supply Chain Management (GSCM) and Supply Chain Management (SCM) utilization. Firms with heightened ESG awareness are significantly more inclined to adopt GSCM practices, thereby enhancing their operational effectiveness and long-term sustainability performance (Fasoulis *et al*., 2019).

This mediating effect underscores ESG awareness not merely as a compliance mechanism, but as a strategic asset that facilitates the execution of environmentally conscious supply chain strategies (Knudsen, 2021; Wagner and Wisnicki, 2022). As ESG consciousness increases within organizations, so does their capability to integrate infrastructure and sustainability into their logistics, leading to more efficient resource allocation and elevated SCM outcomes. Several studies provide empirical validation for this mechanism. For instance, Makkawan and Muangpan (2021) emphasize how ESG-centric practices in smart ports contribute to measurable improvements in GHG reductions, renewable energy usage, and energy efficiency. Similarly, Sundram *et al*. (2020) highlight the role of ESG-led technology adoption and information-sharing in advancing supply chain performance.

Grzelakowski *et al*. (2022) illustrate these dynamics through Maersk's deployment of green methanol partnerships, where ESG awareness drives both innovation and SCM optimization. In the Dutch maritime sector, ESG awareness fosters a balance between technological advancement and regulatory alignment, reaffirming the strategic significance of ESG in managing sustainable logistics operations.

Furthermore, scholars have observed that ESG awareness enhances data quality and information management—critical levers in effective SCM utilization (Kim *et al*., 2021). Operationally, ESG initiatives such as dynamic fleet allocation, scheduling efficiency, and predictive maintenance (Lin *et al*., 2020) further increase SCM productivity when combined with GSCM strategies.

In high-emission industries such as shipping and shipbuilding, where environmental regulations are increasingly stringent, ESG management awareness becomes even more consequential. Ardianto *et al*. (2023) and Sha *et al*. (2021) confirm that GSCM integration—fueled by ESG consciousness—amplifies logistics efficiency in large-scale infrastructure initiatives like the Belt and Road Initiative. Wang and Wang (2023) further show that collaborative green investments between ports and carriers yield substantial supply chain gains.

The application of Lean Six Sigma through the DMAIC framework in maritime settings, as demonstrated by Praharsi *et al*. (2022), also provides evidence that ESG-linked process innovation contributes to operational resilience during external shocks such as pandemics.

These findings collectively affirm that ESG management awareness functions as a catalyst for unlocking the full potential of GSCM in enhancing SCM utilization. Especially within the maritime sector, where sustainability targets are intertwined with strategic competitiveness, ESG awareness empowers firms to operationalize green goals, promote innovation, and maintain long-term resilience (Sundram *et al*., 2020; Hong, 2024; Lee, 2021; Fan *et al*., 2023; Jee, 2020).

Aligned with Goal-Setting Theory (Locke and Latham, 1990), setting ambitious environmental objectives—such as reducing carbon emissions and adopting green fuels—guides firms to achieve higher SCM performance and contributes to the institutionalization of eco-friendly management practices.

6. Implication and future study

6.1 Theoretical implication

From a theoretical perspective, this study contributes to the sustainable supply chain management literature by empirically demonstrating the mediating role of ESG management awareness in the relationship between GSCM and SCM utilization. By focusing on the shipbuilding and shipping industries—characterized by high energy consumption and significant carbon emissions (Ytreberg *et al*., 2021; Englert and Losos, 2021)—this research addresses a critical gap in existing studies, which have often overlooked industry-specific dynamics.

The findings provide empirical evidence that ESG awareness serves as a cognitive mechanism through which GSCM initiatives translate into improved operational outcomes, such as enhanced resource efficiency and supply chain performance (Lange and Cummins, 2021; Kim *et al*., 2021).

Furthermore, the study supports the theoretical notion that ESG-oriented practices are not merely tools for regulatory compliance but also function as strategic levers to build competitive advantage and organizational resilience in environmentally sensitive sectors (Wagner and Wisnicki, 2022; Hendijani and Saeidi Saei, 2020). By integrating ESG awareness into the conceptual framework of GSCM effectiveness, this research expands the understanding of how firms operationalize sustainability management capabilities.

6.2 Managerial implication

This study provides several differentiated managerial implications for firms in the shipbuilding and shipping industries navigating intensifying sustainability demands. The findings demonstrate that ESG management awareness is not only correlated with GSCM implementation but also functions as a strategic enabler that directly enhances SCM utilization efficiency.

First, companies with high ESG awareness are more likely to integrate environmentally responsible practices into their supply chain operations, thereby gaining a sustainable competitive advantage (Park, 2021; Hong, 2024). This includes adopting eco-friendly fuel alternatives, installing emission control technologies such as scrubbers and LNG conversions, and aligning procurement and logistics policies with carbon reduction goals (Jee, 2020; Knudsen, 2021). These practices also serve as early compliance measures in response to tightening global regulations such as IMO 2020 and CBAM.

Second, ESG awareness enhances organizational readiness for technological innovation. As exemplified by firms deploying sniffer drone technologies for real-time emissions monitoring, proactive ESG engagement enables firms to respond to regulatory demands while positioning themselves as industry leaders in green transformation (Knudsen, 2021).

Third, ESG-aligned GSCM practices increase stakeholder confidence, which is particularly critical in the capital- and trust-intensive maritime sector. Leading firms such as Maersk have successfully demonstrated this through partnerships focused on green methanol adoption to lower Scope 3 emissions across global supply chains (Grzelakowski *et al*., 2022). Building ESG credibility thus contributes not only to compliance but also to brand reputation and supply chain resilience.

Finally, the study suggests important policy implications. As global environmental regulations such as the European Union's CBAM and the International Maritime Organization's decarbonization targets continue to intensify, policy makers should actively promote ESG awareness through institutional incentives and standardized ESG reporting frameworks (Englert and Losos, 2021; Bosi *et al*., 2022). Public support for green R&D, tax credits for sustainable logistics investments, and capacity-building programs for ESG integration in SMEs can further accelerate the adoption of GSCM and improve industry-wide SCM efficiency. In sum, ESG awareness should be recognized not only as a managerial capability but also as a policy-relevant lever that, when aligned with regulatory initiatives, can optimize SCM utilization and drive sustainable competitiveness.

6.3 Limitation and future research

This study focuses exclusively on the shipbuilding and shipping industries, which, due to their high energy intensity and carbon emissions, are uniquely positioned within the ESG and GSCM discourse (Hong, 2024). While this industry-specific focus offers in-depth insights, it also limits the generalizability of the findings. The relationship between ESG management awareness and GSCM implementation may vary significantly depending on industry-specific characteristics such as environmental exposure, stakeholder pressure, and regulatory context. Future studies should therefore conduct comparative analyses—including cross-industry sectors such as manufacturing, logistics, and services—across different national contexts to uncover sector-specific ESG dynamics and supply chain practices (Lange and Cummins, 2021).

In addition, this study relies on cross-sectional data, which limits its ability to capture the dynamic evolution of ESG awareness and regulatory responses over time. Since ESG management and environmental regulations are not static but continuously evolving in response to global climate imperatives, longitudinal or panel data analysis would be more appropriate to assess causal inferences and temporal trends in the GSCM–ESG–SCM utilization relationship (Wagner and Wisnicki, 2022).

Finally, this study would benefit from a more comprehensive examination of the influence of policy frameworks on corporate ESG strategies and SCM practices. Given that many firms' ESG initiatives are shaped or accelerated by national policy instruments—such as carbon taxes, disclosure mandates, and emissions trading schemes—future research should incorporate regulatory intensity and international compliance mechanisms as contextual variables. Doing so would allow for more nuanced and actionable policy recommendations for both corporate decision-makers and public institutions aiming to foster sustainable supply chain ecosystems.

References

Alexandrou, S.E., Panayides, P.M., Tsouknidis, D.A. and Alexandrou, A.E. (2022), "Green supply chain management strategy and financial performance in the shipping industry", *Maritime Policy and Management*, Vol. 49 No. 3, pp. 376-395, doi: 10.1080/03088839.2021.1883141.

Ardianto, R., Chhetri, P., Oktarina, B., Lee, P.T.W. and Lee, J.Y. (2023), "Modelling spatio-temporal patterns of Chinese foreign direct investment under the Belt and Road Initiative", *Journal of International Logistics and Trade*, Vol. 21 No. 4, pp. 220-254, doi: 10.1108/jilt-03-2023-0019.

Awan, M.U., Kamal, M. and Qureshi, M.N. (2016), "Supply chain integration and firm performance", *Journal of International Business*, Vol. 7 No. 7, pp. 403-412.

Bosi, M.K., Lajuni, N., Wellfren, A.C. and Lim, T.S. (2022), "Sustainability reporting through environmental, social, and governance: a bibliometric review", *Sustainability*, Vol. 14 No. 19, 12071, doi: 10.3390/su141912071.

Chhetri, P., Gekara, V., Li, S. and Lee, J.Y. (2020), "Changing global production network and its implication on Belt and Road Initiative", *Journal of International Logistics and Trade*, Vol. 18 No. 1, pp. 13-14, doi: 10.24006/jilt.2020.18.1.013.

Chua, J.Y., Wang, X. and Yuen, K.F. (2023), "Sustainable shipping management: definitions, critical success factors, drivers and performance", *Transport Policy*, Vol. 141, pp. 72-82, doi: 10.1016/j.tranpol.2023.07.012.

Dubey, R., Altay, N., Gunasekaran, A., Blome, C., Papadopoulos, T. and Childe, S.J. (2018), "Supply chain agility, adaptability, and alignment: empirical evidence from the Indian auto components industry", *International Journal of Operations and Production Management*, Vol. 38 No. 1, pp. 129-148, doi: 10.1108/ijopm-04-2016-0173.

Eccles, R.G., Ioannou, I. and Serafeim, G. (2014), "The impact of corporate sustainability on organizational processes and performance", *Management Science*, Vol. 60 No. 11, pp. 2835-2857, doi: 10.1287/mnsc.2014.1984.

Englert, D. and Losos, A. (2021), "Charting a course for decarbonizing maritime transport: summary for policymakers and industry".

European Commission (n.d.), "Climate action and the European green deal", available at: https://commission.europa.eu

Fan, L., Yu, Y. and Yin, J. (2023), "Impact of Sulphur Emission Control Areas on port state control's inspection outcomes", *Maritime Policy and Management*, Vol. 50 No. 7, pp. 908-923, doi: 10.1080/03088839.2022.2057609.

Fasoulis, I., Kurt, R.E. and Poutos, E.I. (2019), "Corporate social responsibility and sustainability developments in international shipping".

Fraser, J., Schwarzkopf, J. and Müller, M. (2022), "Exploring energy efficiency potentials in ports: identifying drivers and barriers to standardization", *Sustainability*, Vol. 12 No. 19, p. 8223.

Frohlich, M.T. and Westbrook, R. (2002), "Demand chain management in manufacturing and services: web-based integration, drivers, and performance", *Journal of Operations Management*, Vol. 20 No. 6, pp. 729-745, doi: 10.1016/s0272-6963(02)00037-2.

Grzelakowski, A.S., Herdzik, J. and Skiba, S. (2022), "Maritime shipping decarbonization: roadmap to meet zero-emission target in shipping as a link in the global supply chains", *Energies*, Vol. 15 No. 17, p. 6150, doi: 10.3390/en15176150.

Guo, Q., Wu, Z., Ding, C., Akbar, M.W. and Guo, B. (2023), "Unveiling the nexus between marine energy consumption, seaborne trade, and greenhouse gases emissions from international shipping", *Environmental Science and Pollution Research*, Vol. 30 No. 22, pp. 62553-62565, doi: 10.1007/s11356-023-26537-w.

Hair, J., Black, W., Babin, B., Anderson, R. and Tatham, R. (2006), *Multivariate Data Analysis*, 6th ed., Pearson Prentice Hall, Upper Saddle River, NJ.

Hendijani, R. and Saeidi Saei, R. (2020), "Supply chain integration and firm performance: the moderating role of demand uncertainty", *Concept Business and Management*, Vol. 7 No. 1, 1760477, doi: 10.1080/23311975.2020.1760477.

Hoang, A.T., Foley, A.M., NißltiW, S., Huang, Z., Ong, H.C., Ölçer, A.I. and Nguyen, X.P. (2022), "Energy-related approach for reduction of CO_2 emissions: a critical strategy on the port-to-ship pathway", *Journal of Cleaner Production*, Vol. 355, 131772, doi: 10.1016/j.jclepro.2022.131772.

Hong, S.W. (2024), "A study on ESG activities of shipping companies", *Journal of Navigation and Port Research*, Vol. 48 No. 1, pp. 55-61.

IEA (2023), "Tracking clean energy progress 2023", available at: https://www.iea.org

International Maritime Organization (n.d.), "Initial IMO strategy on reduction of GHG emissions from ships", available at: https://www.imo.org

Ioannou, I. and Serafeim, G. (2017), "The consequences of mandatory corporate sustainability reporting", Harvard Business School Research Working Paper (11-100).

Jee, J. (2020), "Comparative economic analysis on SOx scrubber operation for ECA sailing vessel", *Journal of Korean Society of Marine Environment and Safety*, Vol. 26 No. 3, pp. 62-268, doi: 10.7837/kosomes.2020.26.3.262.

Kannan, V.R. and Tan, K.C. (2002), "Supplier integration with environmental management: a study of supply chain management practices", *International Journal of Production Research*, Vol. 40 No. 2, pp. 1-20.

Kim, J., Lee, J. and Kim, B. (2021), "Has the US-China trade war caused trade decoupling?", *Journal of International Logistics and Trade*, Vol. 19 No. 4, pp. 211-222, doi: 10.24006/jilt.2021.19.4.211.

Knudsen, D.B. (2021), "Is the shipping industry still suffering? A study of compliance factors from the IMO 2020 sulfur cap".

Korea Chamber of Commerce and Industry (2021), "ESG management: trends and strategies".

Lange, M. and Cummins, V. (2021), "Stakeholder perceptions and engagement in marine energy governance in a decarbonising world", *Renewable and Sustainable Energy Reviews*, Vol. 152, 111740, doi: 10.1016/j.rser.2021.111740.

Latham, G.P. (2023), "Motivate employee performance through goal setting", in *Principles of Organizational Behavior: The Handbook of Evidence-Based Management*, 3rd ed., pp. 83-111.

Lee, H.Y. (2021), "Changing paradigms in US and EU supply chains: focusing on sustainability issues", *Journal of International Logistics and Trade*, Vol. 19 No. 4, pp. 223-236, doi: 10.24006/jilt.2021.19.4.223.

Legorburu, I., Johnson, K.R. and Kerr, S.A. (2022), "Shipping, shipbuilding and maritime transportation", in *Building Industries at Sea-Blue Growth and the New Maritime Economy*, River, pp. 257-283.

Lin, C.W., Hsu, W.C.J. and Su, H.J. (2020), "Subjective and objective analysis of schedule delaying factors for container shipping lines", *Journal of International Logistics and Trade*, Vol. 18 No. 4, pp. 181-192, doi: 10.24006/jilt.2020.18.4.181.

Locke, E.A. and Latham, G.P. (1990), *A Theory of Goal Setting and Task Performance*, Prentice-Hall, Englewood Cliffs, NJ.

Makkawan, K. and Muangpan, T. (2021), "A conceptual model of smart port performance and smart port indicators in Thailand", *Journal of International Logistics and Trade*, Vol. 19 No. 3, pp. 133-146, doi: 10.24006/jilt.2021.19.3.133.

Noh, M., Jang, S. and Ahn, H. (2014), "The analysis of the relationships between environmental factors and environmental performance of distribution companies", *Journal of Korea Port Economic Association*, Vol. 30 No. 3, pp. 141-161.

Park, J.-H. (2021), "Changes in the air quality of port areas following the implementation of the IMO 2020 sulfur regulations", *Journal of Environmental Science International*, Vol. 30 No. 3, pp. 141-967, doi: 10.5322/jesi.2021.30.11.967.

Praharsi, Y., Jami'in, M.A., Suhardjito, G. and Wee, H.M. (2022), "Sustainable smart port development: a systematic literature review", *Sustainability*, Vol. 14 No. 5, p. 2956.

Raman, R., Sreenivasan, A., Ma, S., Patwardhan, A. and Nedungadi, P. (2023), "Green supply chain management research trends and linkages to sustainable development goals", *Sustainability*, Vol. 15 No. 22, 15848, doi: 10.3390/su152215848.

Ryu, Y.S. and Chang, M.H. (2019), "Shipping industry's response for IMO sulfur cap 2020", *Proceedings of the Korean Institute of Navigation and Port Research Conference*, pp. 11-113.

Sha, M., Notteboom, T., Zhang, T., Zhou, X. and Qin, T. (2021), "Simulation model to determine efficiency between quay, yard and intra-terminal transfer equipment in an integrated container handling system", *Journal of International Logistics and Trade*, Vol. 19 No. 1, p. 1, doi: 10.24006/jilt.2021.19.1.001.

Shang, F., Teng, X. and Park, M. (2023), "Quantifying the impact of COVID-19 on Chinese ports", *Journal of International Logistics and Trade*, Vol. 21 No. 4, pp. 255-272, doi: 10.1108/jilt-03-2023-0020.

She, S., Zhu, J., Yi, K. and Wang, X. (2023), "Active response from managers: green marine supply chain empathic response mechanism", *Ocean and Coastal Management*, Vol. 245, 106878, doi: 10.1016/j.ocecoaman.2023.106878.

Srivastava, S.K. (2007), "Green supply-chain management: a state-of-the-art literature review", *International Journal of Management Reviews*, Vol. 9 No. 1, pp. 53-80, doi: 10.1111/j.1468-2370.2007.00202.x.

Sundram, V.P.K., Chhetri, P. and Bahrin, A. (2020), "The consequences of information technology, information sharing and supply chain integration towards supply chain performance and firm performance", *Journal of International Logistics and Trade*, Vol. 18 No. 1, pp. 15-31, doi: 10.24006/jilt.2020.18.1.015.

UNCTAD (2021), "Review of maritime transport", available at: https://unctad.org

Waemer, N. and Wisnicki, B. (2022), "The importance of maritime emerging technologies in the increasing of corporate sustainability in shipping companies", *Sustainability*, Vol. 14 No. 19, 12475, doi: 10.3390/su141912475.

Wang, J. and Dai, J. (2018), "Sustainable supply chain management practices and performance", *Industrial Management and Data Systems*, Vol. 118 No. 1, pp. 2-21, doi: 10.1108/imds-12-2016-0540.

Wang, C. and Wang, L. (2023), "Green investment and environmental value in the maritime supply chain", *Environment, Development and Sustainability*, Vol. 25 No. 7, pp. 6657-6687, doi: 10.1007/s10668-022-02322-6.

Yoon, S., Lee, M. and Jang, I. (2018), "A study on the impact of internal green SCM implementation on external green SCM implementation and the performance of domestic manufacturing companies", *Journal of the Korean Society of Maintenance Engineering*, Vol. 23 No. 4, pp. 5-19.

Ytreberg, E., Åström, S. and Fridell, E. (2021), "Valuating environmental impacts from ship emissions—the marine perspective", *Journal of Environmental Management*, Vol. 282, 111958, doi: 10.1016/j.jenvman.2021.111958.

Zhu, Q., Sarkis, J. and Lai, K.H. (2004), "Green supply chain management implications for 'closing the loop'", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 40 No. 1, pp. 1-28, doi: 10.1016/j.tre.2006.06.003.

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