Carbon Accounting for Decarbonization Disclosure to SDG7: Content analysis of major shipping companies' reports

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ABSTRACT: ***(CARBON ACCOUNTING FOR DECARBONIZATION DISCLOSURE TO SDG7: CONTENT ANALYSIS OF MAJOR SHIPPING COMPANIES' REPORTS)*** *"This study investigates the decarbonization practices implemented by shipping companies to meet SDG7 - Target 7.2, included in the United Nations 2030 Agenda. The International Maritime Organization aims to reduce or zero shipping emissions by regulating shipping companies, who are increasingly quantifying and accounting their commitment to decarbonization to prove responsibility and transparency to stakeholders. This study highlights that while shipping companies have made efforts to report on decarbonization practices and outcomes, the use of carbon accounting frameworks to guide accountability and reinforce responsibility needs further investigation. Likewise, the content of non-financial reports depends on the methodologies and metrics used for measurement. To fill this gap, this study analyses 60 reports published between 2018 and 2023 by the ten major shipping companies. The analysis uses a double-level content analysis with Leximancer v5 software and manual content analysis to explore themes, concepts, and measures to meet SDG7-Target 7.2. The results highlight the increasing attention of shipping companies on decarbonizing their value chains, particularly concerning Scope 3 emissions. However, the difficulty of collecting primary qualitative data and the need for close collaboration with stakeholders are still matter not resolved. As a result, there is a need to clarify in companies' reports the role and extent to which carbon accounting supports the reporting of their contributions to the SDGs, especially SDG 7, Target 7.2. This lack of clarity could be seen as a limitation to effective carbon disclosure for meeting SDGs. This study claims the need for an integrated decarbonization process that addresses direct and indirect emissions in complex logistics chains, leveraging international carbon accounting frameworks (e.g. Greenhouse Gas Protocol, Science Based Target Initiative, Carbon Disclosure Project) to quantify emissions and enhance accountability and legitimacy, supported by tailored training on carbon accounting tools to ensure high reporting standards. To the best of our knowledge, this is the first study that explores, through the analysis of shipping companies' external reports, how carbon accounting tools are key sources in the decarbonization disclosure of these companies, especially for disclosing SDG7-Target 7.2."*

KEYWORDS: carbon reporting, decarbonization practices, sustainable development goals (SDGs).
DOI: 10.17408/RIREAADVEVESP010203042025- ISSN: 1593-9154
Ricevuto: 09-12-2024 – Accettato: 25-02-2025

1. Introduction

The reduction of carbon emissions is a priority for stakeholders and policymakers working towards the creation of a sustainable economic model (POUDYAL et al., 2012; PIZZI et al., 2020; DHANDA et al., 2021; DI VAIO et al., 2024d).

The Paris Agreement, signed at the Conference of the Parties (COP21) on December 12, 2015, and ratified by 194 parties on November 4, 2016, establishes a global, legally binding framework to address climate change. The Katowice Climate Package, adopted at United Nations Climate Change Conference (COP24) in December 2018, establishes the essential standards, procedures, and guidelines required to implement the Paris Agreement effectively, facilitating the shift towards a low-emissions and climate-resilient future (UN, 2019a). The agreement is central to achieving the 17 Sustainable Development Goals (SDGs) and 169 targets outlined in the action plan for people, planet, and prosperity, signed by the governments of 193 United Nations (UN) member countries in September 2015 and effective from January 1, 2016. Therefore, the UN 2030 Agenda represents an

intergovernmental action plan for mitigating climate change (UN, 2015a), but the Paris Agreement and its operational package provide the clearest commitments for all stakeholders regarding reducing greenhouse gas (GHG) emissions, utilizing green and climate-friendly technologies, and ensuring transparency (UN, 2015b). The package highlights the significance of the Enhanced Transparency Framework by the United Nations Framework Convention on Climate Change (UNFCCC) to foster trust among parties regarding global climate efforts. This framework includes developing common reporting tables for national GHG inventories, which are essential for tracking and reporting climate change progress (UN, 2019b).

In this framework, firms are encouraged to take actionable steps that contribute to both profits, as well as environmental and social pillars of sustainability (BEBBINGTON and UNERMAN, 2018). Likewise, the depletion of natural capital by companies represents a serious concern for the international community due to the negative impact on the environment and the inevitable exhaustion of non-renewable resources (CAPRANI, 2016). When companies choose to re-invest the returns of artificial capital aimed at adopting sustainability strategies and decarbonizing their processes, they are significantly contributing to a carbon neutral future (DALY, 2017; BLIGNAUT et al., 2014).

Maritime transport is one of the sectors called upon to contribute to the mitigation of climate change. According to the Energy Transition Commission (2020), the sector has contributed to the 3% of global carbon emissions. Its carbon footprint needs to be reduced (DENG and MI, 2023). The International Maritime Organization (IMO), which is the specialized UN agency responsible for the safety and security of international shipping and to prevent pollution from ships regulates, set a target for the international shipping sector to reduce its carbon intensity by at least 40% by 2030 (IMO, 2023). Therefore, shipping companies are exploring different solutions to reduce their carbon emissions and consequently their carbon footprint, i.e. adoption of new technologies, including digital and green technologies (MALLOUPPAS and YFANTIS, 2021; DI VAIO et al., 2023b; HOANG et al., 2023), and/or renewable resources, increasingly recognized by companies as a valid alternative to fossil fuels (BALCOMBE et al., 2019; ISSA et al., 2022; SHI et al., 2023; CURRAN et al., 2024).

In line with Katowice Climate Package, the extension of the European Union (EU) Emission Trading System (ETS) to the shipping sector represents a significant step towards decarbonization goals. It also highlights the importance for shipping companies to measure and report their emissions, demonstrating transparency and responsibility to stakeholders (WANG et al., 2020; ZHOU et al., 2021). Shipping companies are very close to increase the sharing of renewable energy in final energy consumption by 2030 by contributing to SDG7 Ensure access to affordable, reliable, sustainable and modern energy for all, mainly to one of its targets i.e. Target 7.2 "By 2030, increase substantially the share of renewable energy in the global energy mix" (henceforth SDG7-Target 7.2). Therefore, decarbonization needs to be implemented, measured and reported not only for internal information needs through internal reporting but also for external ones through external reporting.

In the last ten years, companies have increasingly disclosed their non-financial information through different forms of external reporting due to the increased demand driven by stakeholders with different interests (DI VAIO et al., 2021a; ZAMPONE et al., 2023; NICOLÒ et al., 2024). Consequently, numerous reporting standard bodies have emerged, each advocating for different frameworks and reporting solutions (DE VILLIERS et al., 2022). From this standpoint, non-financial reporting (NFR) provides information which

are not usually displayed in traditional financial reporting practices and offer stakeholders a broader overview of essential areas that create value in a company (PwC, 2024). Among these reporting practices, integrated reporting (IR) consolidates essential information and enhances the accountability of a company, providing an overview of organization's strategy, governance, performance, and viewpoint, aligning it with the commercial, social, and environmental aspects (DI VAIO et al., 2021a; DE VILLIERS and DIMES, 2023). He et al. (2021) argue that decarbonization efforts made by companies must be well described in their reporting practices. Specifically, the authors believe that the narrative about carbon emissions reduction data strengthens corporate transparency and accountability for environmental goals. Therefore, the details of what to describe and how to execute it should align with Katowice's operational package.

Some scholars view carbon accounting as a managerial tool for capturing and analysing a company's direct and indirect carbon emissions. Carbon accounting highlights target achievements by measuring the emissions levels generally referred to as Scope 1, 2, and 3 emissions. It allows to create an inventory for calculating the three scopes of GHG emissions and, once aggregated, they form GHG emissions footprint to be reported to stakeholders to get legitimacy and credibility about the companies' sustainability efforts (SCHALTEGGER and CSUTORA, 2012; STECHEMESSER and GUENTHER, 2012; ZHANG et al., 2022; OLIVERWYMAN, 2024).

Scholars and practitioners note that the lack of a standardized framework between managerial accounting for decarbonization and non-financial disclosure leads to discrepancies between the actual practices implemented by companies and what is reported in their disclosures (ERNEST AND YOUNG (EY), 2021; DI VAIO et al., 2023b; PRICEWATERHOUSECOOPERS (PWC), 2024). On the other hand, the existing literature has revealed how a well-defined NFR framework could encourage and enable the sharing of relevant data (DI VAIO et al., 2021a), and enhance shipping companies' credibility and legitimacy for stakeholders (FREEMAN, 1984; SUCHMAN, 1995; SOLOMON and LEWIS 2002; SAVAGE et al., 2010; DI VAIO et al., 2023a; DI VAIO et al., 2024b). It seems under-researched the contribution of carbon accounting to NFR practices, particularly in enhancing the legitimacy of data provided by shipping companies to feature the efficacy of their decarbonization practices, especially regarding the implementation of new technologies and the use of renewable resources (DI VAIO et al., 2021a; KASPERZAK et al., 2023; TSATSARONIS et al., 2024). The theoretical foundations of this study are supported by stakeholder and legitimacy theories that better help to understand the extent of the phenomenon.

This study aims to fill the existent gap in the literature formulating the research question (RQ): *How does carbon accounting assist information on decarbonization practices for SDG7 - Target 7.2 in shipping companies' reports?*

To provide an adequate answer to this RQ, this study conducts a two-level content analysis, through Leximancer software (ver. 5) and manually, of the 60 reports published between 2018 and 2023 by the ten major shipping companies identified accordingly to the Alphaliner Top 100 Classification (2024). Scholars have recognized content analysis as a valid research method due to its effectiveness in drawing accurate inferences from texts, which holds significant promise for analysing reports used to communicate the results of accounting activities (GUTHRIE et al., 2004; STEENKAMP and NORTHCOTT, 2007; DI VAIO et al., 2024b).

This study seems to be among the first to investigate the linkages between carbon accounting, decarbonization practices, and NFR in the frame of the sustainability transition, under the lens of the stakeholder and legitimacy theories, providing a systematic overview that takes into account the fragmented and evolving nature of the sustainability reporting standards process.

This study is structured as follows. The second section presents the theoretical background of the study. The third section illustrates the methodology. The fourth section highlights the results of this study. The fifth section presents the discussion, as well as the theoretical and practical implications. The final section offers the conclusions reached.

2. Theoretical Background

2.1 The Shipping Industry in the International regulatory and policy framework for climate change

In the last three decades, the debate around sustainable development has intensified, highlighting the negative impact of the industry on the depletion of natural resources (BARILE et al., 2024). The concept of sustainable development finds its first conceptualization in the UN Conference on Human Environment of 1972, also known as Conference of Stockholm, focusing on the importance of managing, measuring and assessing the environment (UN, 1972; DUBOSE et al., 1995; DI VAIO et al., 2024d). In 1978, the UN Environment Programme (UNEP) review combined the terms "ecology" and "development" into the innovative concept "eco-development", highlighting institutions' focus on environmental preservation aimed at responding to the arisen global concern on the consistent reduction of resources (MEBRATU, 1998). The growing attention dedicated to sustainability was later confirmed by the 1987 Brundtland Report, which firstly defined the notion of "Sustainable Development" (UN, 1987). The 1992 Earth Summit in Rio de Janeiro and the 1997 Kyoto Protocol highlighted this commitment, marking the first global initiatives aimed at regulating and stabilizing carbon concentrations in the atmosphere, establishing binding emission targets to mitigate negative environmental impacts (UN, 1992; UN, 1997). The 2012 UN Conference on Sustainable Development which is known as Rio+20 set the framework for sustainable development implementation (UN, 2012). However, the turning point in the global commitment towards sustainability transition was reached with the signature of the Paris Agreement (2015a) and the consequent adoption of the Katowice Climate Package (2019a) functioned as operational framework to effectively facilitate the shift towards low-emissions and the mitigation of climate change effects, highlighting also the importance of UNFCCC in enhancing the transparency and reporting of climate change progress (UN, 2019b). The agreement, which includes binding aspects for the signatories, gives concreteness to the objectives of the UN 2030 Agenda and its 17 SDGs which represents the interrelated action plan for sustainable development (LE BLANC, 2015). In this frame, institutions have been focused their attention on the environmental impact of industry in general, encouraging different sectors to reduce the depletion of natural capital in order to produce a positive impact on the environment and avoid the exhaustion of non-renewable resources (CAPRANI, 2016). Among these sectors, shipping certainly is under continuous institutional pressure due to its critical impact on climate change, despite having extensive regulation on emissions at the heart of which is the International Convention for the Prevention of Pollution from Ships (MARPOL)

(YANG, 2018; SERRA and FANCELLO, 2020). According to the UNEP (2024), the transport sector is among the major contributors of carbon emissions, including road and trail transport, air travel and shipping. According to the Energy Transition Commission (2020), shipping sector represents the 3% of total carbon emissions. The 76th session of the Marine Environment Protection Committee (MEPC76) of the IMO (2021) represented a turning point in the path towards decarbonization of the sector, resulting in a further amendment of MARPOL Annex V "Regulations for the prevention of air pollution from ships" to the International Convention for the Prevention of Pollution from Ships (MARPOL) (PSARAFTIS, 2021; JEONG et al., 2022). The MEPC76 introduced gradual measures to reduce shipping carbon intensity by at least 40% by 2030, that is a goal set by the 2018 Initial IMO Strategy (IMO, 2018) and confirmed later on by the 2023 IMO Strategy to reduce GHG emissions from ships (IMO, 2023). Hence, the IMO is currently engaging a pathway towards the decrease of carbon emissions and the improvement of energy efficiency of ships, supporting shipping companies through technical cooperation and capacity-building programs (IMO, 2024).

The IMO, UN Trade and Development (UNCTAD), and other international bodies, including the International Labor Organization (ILO) and the MEPC, play a pivotal role in regulating the shipping industry towards the goals of the 2030 Agenda for Sustainable Development (UN, 2015a). These pressures push shipping companies to fit their operations with environmental sustainability goals. To comply with these regulations, shipping companies must invest in decarbonization efforts, adopting green technologies and renewable resources. This transition needs a significant financial investment, often leading to liquidity challenges (YANG, 2018; DRAGOMIR et al., 2023; DI VAIO et al., 2024d). Likewise, many companies are increasingly integrating sustainability into their Corporate Social Responsibility (CSR) framework, addressing both environmental and social concerns. This approach is becoming a key component of their strategic design (FERNANDO and LAWRENCE, 2014; DI VAIO et al., 2022; KARAGIANNIS et al., 2022). As a result, shipping companies continuously strive to balance the demands of sustainability, especially environmental issues, with the need for stakeholder legitimacy about the shipping business (FERNANDO and LAWRENCE, 2014).

Therefore, shipping companies have revised their strategies to prioritize actions that minimize environmental impact by seeking various technical solutions to reduce their reliance on fossil fuels and their carbon emissions. On one hand, new technologies, including green and digital technologies, are decisive for the decarbonization process of shipping companies (MALLOUPPAS and YFANTIS, 2021; DI VAIO et al., 2023b; HOANG et al., 2023; SINGH et al., 2023). Green technologies encourage and integrate sustainable practices and innovation across various fields to reduce the environmental impact (DEWI et al., 2022, BARBIERI et al., 2023), i.e. retrofitting ships in the maritime industry to significantly decrease emissions (WU et al., 2022). Digital technologies also contribute to a more sustainable management of shipping operations, improving their resources' efficiency, storage and acquisition, i.e. Data Management, Big Data (ZHENG et al., 2023). On the other hand, the advantages of cleaner energy sources, including renewables resources, are increasingly recognized not only due to the consistent improvement of environmental impact but also due to the rising costs of bunker fuel caused by a volatile global market, making renewable solutions increasingly attractive for companies (BALCOMBE et al., 2019; ISSA et al., 2022; SHI et al., 2023; CURRAN et al., 2024). Hydrogen, ammonia, liquified natural gas (LNG), and methanol are among the renewable resources

that could facilitate the achievement of IMO targets to reduce the future carbon emissions of the sector (ZAMBONI et al., 2024). However, shipping companies should not face the challenges of decarbonization and energy efficiency alone, as achieving these targets requires the collective efforts of multiple value chains. For instance, shipyards play a significant role in emissions throughout a ship's life cycle. Likewise, the ship has a core role in the ship-liner combination, and any attempt to decarbonize maritime services is closely tied to the ship's technical aspects (DI VAIO, 2011). While shipping companies can reduce emissions during operations at the ship-port interface, emissions generated by the ship's operation, both at the quay and at sea, are not exclusively defined by the ship management. This highlights the need for a trans-disciplinary approach to meet the IMO targets. This approach encourages shipping companies to act responsibly and collaborate across the supply chain with various stakeholders, driving collective decarbonization efforts (VAKILI et al., 2022; DI VAIO et al., 2023b).

The increasing sustainability pressures that the shipping sector is experiencing, stem from the expectations that institutions, stakeholders and society have in terms of accountability of the shipping companies, where accountability refers to the responsibility of companies to act transparently, ensuring that their actions and decisions are held accountable to stakeholders (MCGRATH and WHITTY, 2017; DILLARD and VINNARI, 2019). The concept of accountability refers to organizations and individuals responsible for their actions and who report this way of acting, but also of thinking, to recognized authorities (EDWARDS et al., 1996; RAHIM et al., 2016) i.e. IMO, and are held accountable to stakeholders. According to DEANE et al. (2019) accountability involves being answerable for one's actions or omissions and includes the concept of "justification of the action" i.e. answerability and the concept of "punishment of the failure to act" i.e. enforceability. The authors (2019: p. 260) believe that answerability is an expression of "relations (who is accountable and to whom), standards, and judgments (the assessment process)". Therefore, the accountability of shipping companies lies in a systemic framework that connects actions and decisions conveyed through transparency mechanisms. These mechanisms reveal the companies' adherence to environmental regulations and policies, thereby demonstrating the companies' commitment to decarbonize their operational processes. Consequently, the accountability passes through the concept of transparency and is compromised by the information content of environmental reports. Although some authors (RAHIM et al., 2016) have acknowledged that the mere publication of a sustainability report does not necessarily equate to the fulfilment of accountability, the report's content serves as the "voice" of companies, reflecting their stated contributions to reducing both direct and indirect emissions, including Scope 3 emissions. Hence, shipping companies are increasingly focusing on managing sustainability and its disclosure, considered one of the major challenges to generate value and growth opportunities, as well as increase their competitiveness (DI VAIO et al., 2021b; BACH and HANSEN, 2023).

2.2 Carbon Accounting for decarbonization disclosure in the shipping industry

The achievement of IMO's targets to decarbonize the shipping sector depends in part on the shared commitment of shipping companies to uphold their responsibility and accountability to stakeholders, institutions, and society (DI VAIO et al., 2021b). To prove their responsibility, shipping companies are increasingly disclosing information concerning their sustainability initiatives, quantifying and accounting their commitment towards

decarbonization to prove their transparency and accountability to stakeholders, as well as legitimizing their decarbonization practices (WANG et al., 2020; ZHOU et al., 2021).

Since the adoption of the EU Monitoring, Reporting and Verification (MRV) Maritime Regulation in 2018 (EUROPEAN COMMISSION, 2015) and the extension of Emission Trading System (ETS) to the shipping sector in 2024 (EUROPEAN COMMISSION, 2024), shipping companies are increasingly paying attention to their carbon emissions, disclosing information concerning their carbon emissions' data in their NFR (WANG et al., 2020; ZHOU et al., 2021).

The existent literature highlights the importance of carbon accounting for the reporting practices of companies (ABHISHEK et al., 2024). Carbon accounting is a managerial tool that collect and analyse information concerning both direct and indirect carbon emissions, enabling companies to demonstrate progress toward emission reduction targets by measuring and report Scope 1, 2, and 3 emissions (SCHALTEGGER and CSUTORA, 2012; CORPORATE FINANCE INSTITUTE, 2023). Carbon accounting provides a comprehensive approach to collect information related not only to the reduction of emissions, but also to the processes implemented to achieve the decarbonization goals, strengthening the accountability of the companies (DI VAIO et al., 2024d).

Shipping companies often face pressures from stakeholders to provide quality services, decarbonize their processes and improve transparency of their disclosures (KARAGIANNIS et al., 2022). Stakeholders well understand that the benefits of decarbonization – and the consequent increased legitimacy that derives – are shared across the entire value chain and not exclusively for the individual company. Hence, the increasing focus on sustainable shipping highlights not only the need for effective reporting practices, but also for a multi-stakeholder approach to ensure the decarbonization of the shipping sector (PARVIAINEN et al., 2018). According to FREEMAN (1984), stakeholders include all groups essential for the existence of a company. For shipping companies, there is a vast range of stakeholders, including internal stakeholders, i.e. shareholders, managers and employees, and external stakeholders, i.e. customers, port authorities, terminal operators, suppliers, classification entities, governments and international organizations, shipyards (KIM et al., 2020; DI VAIO et al., 2023a). Stakeholder theory highlights the importance of incorporating the interests of all stakeholders in the value creation process of companies, contributing to the analysis of the phenomenon through three main approaches (BAILUR, 2006; STEURER, 2006). First, the descriptive approach improves the knowledge of companies' relations with their stakeholders. Second, the normative approach focuses on the moral responsibility of companies to align their core strategies to the interests of all their stakeholders. However, this perspective faces criticism from scholars, who contend that a company cannot consistently prioritize the interests of all stakeholders, as its main goal and responsibility are profit maximization (TREVIÑO and WEAVER, 1999). Likewise, "the business of business is business" (3B) according to FRIEDMAN (1970) criticizes the normative view (BAILUR, 2006). Third, the instrumental approach prioritizes key stakeholders, recognizing their role in providing a competitive advantage to companies (BAILUR, 2006; DI VAIO et al., 2023a). Hence, the adoption of carbon accounting should support shipping companies in meeting stakeholders' expectations by reducing their carbon footprint, thereby improving the legitimacy of their decarbonization actions (YUEN et al., 2017; DI VAIO et al., 2023a; ABHISHEK et al., 2024). Some scholars agree that legitimacy theory is one of the most applied theories to investigate NFR issues and to explain CSR practices in various context (TILLING, 2004; FERNANDO and LAWRENCE, 2014; DI VAIO et al., 2024d). According to

legitimacy theory, companies are driven to operate in the limits of social value and to have social norms to gain legitimacy from public opinion and stakeholders, and to avoid potential obstacles to their activities (DI VAIO et al., 2024b). The achievement of legitimacy represents a focal point for companies, where legitimacy refers to a globally recognized perspective that guides companies' activities to align with social norms, values, beliefs, and definitions, ensuring appropriateness, suitability, and relevance (SUCHMAN, 1995). Hence, the pressures of society and stakeholders to reduce shipping companies' carbon emissions can promote sustainability efforts in the shipping industry, as well as the improving of carbon information disclosure (PARVIAINEN et al., 2018; DI VAIO et al., 2024c).

The number of frameworks implemented by companies to clearly measure and report their emissions is vast and it encompasses the GHG Protocol (WORLD RESOURCE INSTITUTE AND WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT, 2004), the GHG Inventory Guidance (EPA, 2024), the ISO Standard 14064 (ISO, 2018), the Science Based Target Initiative (SBTi, 2023), the Carbon Disclosure Project (CDP, 2024). Hence, a comprehensive overview of the emissions produced results crucial to efficiently describe the decarbonization practices adopted by shipping companies (DI VAIO et al., 2021b). The adoption of carbon accounting should extend beyond simply measuring emissions and periodically disclosing emissions scores. It should also encompass the overall decarbonization process. This also means including the actions taken by shipping companies to reduce their carbon footprint. Therefore, this includes the use of green technologies and renewable resources, i.e. hydrogen. By doing so, carbon accounting shifts from merely quantifying emission reductions to managing the decarbonization process itself. This full approach not only addresses the outcomes of decarbonization but also supports progress toward achieving SDG 7 – Target 7.2. Hence, the carbon accounting system serves as a fundamental pillar in the decarbonization strategies of shipping companies, that form part of the environmental strategies adopted by these companies. It enables the shipping companies to demonstrate what this study refers to as "carbon accountability" through the transparency in the reporting of decarbonization efforts, the company provides stakeholders with clear, documented information about its actions. These stakeholders, in turn, assess and validate the companies' commitment to reducing their carbon footprint, holding the companies accountable for its environmental efforts (ABHISHEK et al., 2024; DI VAIO et al., 2024b).

The increasing attention dedicated by shipping companies to decarbonization is also demonstrated by their continuous efforts to increase the sharing of renewable energy at global level, positively contributing to the reduction of carbon emissions. Specifically, shipping companies are contributing to the SDG7-Target 7.2 <By 2030, increase substantially the share of renewable energy in the global energy mix> and its indicator 7.2.1 <Renewable energy share in the total final energy consumption> by reducing the exploitation of fossil fuels, and promoting the investments in clean energy technologies aimed at improving the energy efficiency and contributing to the increase of renewable energy share in the global final energy consumption by 2030 (TAY and KONOVESSIS, 2023; TRINH and CHUNG, 2023; UN, 2023). According to Le Blanc (2015), there are SDGs which are critically connected to others through multiple targets, i.e. SDG12 <Ensure sustainable consumption and production patterns> and its targets. Le Blanc (2015) highlights how SDG12 is strongly interconnected with several other goals. Thus, the SDG12-Target 12.6 <Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle> clearly aims

to enhance the disclosure of non-financial information among companies. In this frame, NFR practices could support shipping companies in establishing a clear reporting framework and enhancing their reputational image to stakeholders (DI VAIO et al., 2022b; REBER et al., 2022). NFR framework encompasses different forms of reporting, i.e. sustainability reporting (SR), integrated reporting (IR), environmental, social, governance (ESG) reporting, CSR reporting (STOLOWY and PAUGAM, 2018; TURZO et al., 2022). IR integrates the most relevant information within a common framework, aligning economic, social and environmental aspects and enhancing the accountability of a company (DI VAIO et al., 2021a; DE VILLIERS and DIMES, 2023).

The adoption of sustainability measures and the need to ensure accountability and transparency in shipping companies' decarbonization practices are also driven by the influence of society and stakeholders on their NFR practices (DI VAIO et al., 2023a). Legitimacy theory suggests that the inevitable connection between companies and society would ameliorate the level of information concerning sustainability disclosed by companies to satisfy stakeholders' expectations in terms of decarbonization targets (SOLOMON and LEWIS, 2002; DI VAIO et al., 2024c). In this frame, scholars highlight the need of adopting a standard reporting system to aid companies in effectively disclosing non-financial information (DI VAIO et al., 2024b). Hence, a clearer NFR framework could support companies to duly describe their decarbonization practices within their NFR (DE VILLIERS and DIMES, 2023; DI VAIO et al., 2024b). Therefore, standard boards play a pivotal role in defining what and how companies should disclose in terms of non-financial information, aiming to respond to the increasing stakeholders' demand of transparency and accountability by companies (DI VAIO et al., 2023b).

Among the standard boards that operate at international and European levels, there are Global Reporting Initiative (GRI), International Sustainability Standards Board (ISSB), Sustainability Accounting Standards Board (SASB), Environmental Social and Governance (ESG) Standards, UN Global Compact Network, European Sustainability Reporting Standards (ESRS). According to Zimon et al. (2022), the adoption of different NFR frameworks can be identified as a trend among companies to enhance their accountability and transparency in the eyes of stakeholders. However, scholars have highlighted that the lack of standardization in non-financial disclosure practices could deter companies from disclosing relevant data and could complicate the analysis of stakeholders. This emphasizes the need for a practical, industry-specific framework for NFR that could support companies in disclosing their non-financial information (ZHOU et al., 2021). Currently, different reporting standard boards are collaborating to ensure interoperability among these standards, i.e. ISSB and ESRS published an interoperability guidance in May 2024 (IFRS, 2024). However, a common ground has not yet been found, due to consistent differences among NFR frameworks (IFRS, 2024). In this frame, carbon accounting could represent a valid ally for shipping companies to clearly feature their decarbonization practices for SDG7-Target 7.2, and analyse their direct and indirect carbon emissions, also in the frame of measuring their impact on emission reduction target goals (DI VAIO et al., 2021b; DI VAIO et al., 2022b; DI VAIO et al., 2023a; DI VAIO et al., 2024a).

3. Methodology

This study conducts a content analysis of shipping companies' reports to better understand how carbon accounting systems assist in the disclosure of decarbonization efforts addressed for achieving SDG7-Target 7.2. The analysis highlights the decarbonization practices disclosed, emphasizing the adoption of new technologies and renewable resources to achieve environmental goals. Scholars widely recognize content analysis as an effective research method for analysing reports, as it enables the identification of themes and concepts, the counting of words and sentences related to specific topics, and the determination of relationships among concepts in reports (DRAGU and TIRON-TUDOR, 2013; MELLONI, 2015; STACCHEZINI et al., 2016; LEOPIZZI et al., 2019; DI VAIO et al., 2022a; HAMAD et al., 2023). Beck et al. (2010) distinguish between two main approaches of content analysis: on one side, the mechanistic approach which focuses on the quantitative aspect of the information, capturing data based on the frequency with which concepts and themes occur in a report; on the other side, the interpretative approach which focuses on the quality of the information provided, breaking down the reports into different sentences and analysing the content of each sentence separately to better understand what and how it communicates. Existent literature recognizes content analysis as an effective method to accurately analyse reports, supporting researchers in investigating its contents and reaching insightful conclusion (UNERMAN, 2000; GUTHRIE et al., 2004; STEENKAMP and NORTHCOTT, 2007; DI VAIO et al., 2024b). Hence, a two-level content analysis is conducted to provide an adequate reliability of the results achieved (DI VAIO et al., 2022a). As shown in Table 1, this study analyses the top 10 shipping companies ranked by Alphaliner TOP 100 as the top 100 largest container/liner operators in the world (ALPHALINER, 2024). The Alphaliner Classification sorts the major shipping companies based on the total TEU capacity of the ships deployed (ALPHALINER, 2012). As evidenced in Table 1, these companies represent a significant market share, with over 60% of the market.

Tabella 1 – The Top 10 Shipping Companies

Rank	Shipping Company	Country	TEU	Share
1	Mediterranean Shg Co	Switzerland	5.979.659	20,0%
2	Maersk	Denmark	4.330.262	14,4%
3	CMA CGM Group	France	3.762.033	12,6%
4	COSCO Group	China	3.230.299	10,8%
5	Hapag-Lloyd	Germany	2.159.023	7,2%
6	ONE (Ocean Network Express)	Japan	1.916.909	6,4%
7	Evergreen Line	Taiwan	1.680.658	5,6%
8	HMM Co Ltd	South Korea	854.044	2,8%
9	Zim	Israel	721.712	2,4%
10	Yang Ming Marine Transport Corp.	Taiwan	695.304	2,3%

Source: ALPHALINER (2004), "Top 100/05 May 2024" (Avaible at: https://alphaliner.axmarine.com/PubblicTop100/).

Table 2 shows the reports published by the 10 shipping companies and that constitute our dataset. Specifically, 60 reports were identified, including SR, IR, CSR Reports and ESG Reports published between 2018 and 2023. The year 2018 represents a turning point for sustainable development in the shipping sector. On one side, the adoption of the UN 2030 Agenda which represents a pivotal moment for industrial-level sustainability marking an increasing commitment of companies to achieve climate goals, reached a more mature stage of commitment among companies (BEBBINGTON and UNERMAN, 2018). On the other side, most of the selected shipping companies began publishing their reports in 2018, largely in response to the adoption of the MRV Maritime Regulation, which significantly influenced reporting practices not only within the EU but also on a global scale (ADAMOWICZ, 2022). The data collection began with a comprehensive online investigation of the selected companies' websites. These websites were meticulously examined to collect information on sustainable performance, emphasizing the adoption of new technologies, the use of renewable resources, and alignment with decarbonization objectives. Following this, the authors of this study downloaded and archived the relevant reports, creating a dataset of 60 documents for the analysis.

Tabella 2 – Shipping Companies' Reports

Rank	Shipping Company	Sustainability Reporting	Integrated Reporting	CSR Reports	ESG Reports	Years
1	Mediterranean Shg Co	5	1	N/A	N/A	2018 - 2023
2	Maersk	6	N/A	N/A	N/A	2018 - 2023
3	CMA CGM Group	N/A	N/A	6	N/A	2018 - 2023
4	COSCO Group	6	N/A	N/A	N/A	2018 - 2023
5	Hapag-Lloyd	6	N/A	N/A	N/A	2018 - 2023
6	ONE (Ocean Network Express)	6	N/A	N/A	N/A	2018 - 2023
7	Evergreen Line	1	N/A	5	N/A	2018 - 2023
8	HMM Co Ltd	2	N/A	N/A	3	2019 - 2023
9	Zim	3	N/A	N/A	3	2018 - 2023
10	Yang Ming Marine Transport Corp.	2	N/A	4	N/A	2018 - 2023
	Total for each category of reports	37	1	16	6	
	Total of reports		**60**			

Source: Authors' data collection of the Top 10 Shipping Companies' Reports published between 2018 and 2023.

A first automated content analysis, conducted through Leximancer Software (ver. 5), is instrumental to offer valuable perspectives on the occurrence, relevance and interconnections among concepts and terms utilized in the reports of the selected shipping companies. In fact, the use of Leximancer v5 adds value to the research through the identification of clusters of words and the automated coding of concepts, allowing an increased understanding of the selected text avoiding undue emphasis on unusual or incorrect semantic evidence (SMITH and HUMPHREYS, 2006; CROFTS and BISMAN, 2010; DI VAIO et al., 2024a). Before the analysis of the reports, the authors defined a specific analytical procedure for the extraction of concepts based on word proximity and correlation within the reports. The result emerged from the

software presents a conceptual map which highlights the major concepts in the reports and their correlation. After uploading and processing the selected sample in the software, dividing it into folders – one per selected shipping company - the authors manually excluded the generic terms and common function words generated in the concept seeds, to avoid useless concepts in the map, i.e. "and", "or", "million", "euro". Then, the singular and plural terms were merged, i.e. ship/ships, business/businesses, employee/employees, since they have analogous semantic values.

Notwithstanding Leximancer v5 reliable contribution to themes and concepts' analysis, it does not facilitate the examination of sentences' meaning. Hence, the manual content analysis, based on a set of identified keywords commonly utilized in the literature, is essential for advancing the understanding of how carbon accounting assists NFR to disseminate decarbonization through the use of new technologies and renewable resources to achieve SDG7 -Target 7.2 (DE GRAAF and VAN DER VOSSEN, 2013; DI VAIO et al., 2022b; ENGSTROM et al., 2022; ERIN et al., 2022). The keywords selected have been "new technologies", "green technologies", "digital technologies", "renewable resources", "alternative fuels", "clean energy", "SDG7", "target 7.2", "decarbonization", "carbon emissions", "CO2". Considering the time frame from 2018 to 2023 and the availability of reports from the 10 selected shipping companies, the authors chose to manually examine the content of the reports published in 2023. This choice is due to the increasing importance in recent years of disclosing decarbonization efforts and reporting Scope 1, 2 and 3 emissions in accordance with the different carbon accounting frameworks, i.e. GHG Protocol, SBTi, CDP, and the revised 2023 IMO GHG Strategy, which has become particularly significant for companies in this sector (DI VAIO et al., 2022a; IMO, 2023).

4. Results

4.1 Leximancer v5: Cluster of concepts and key themes

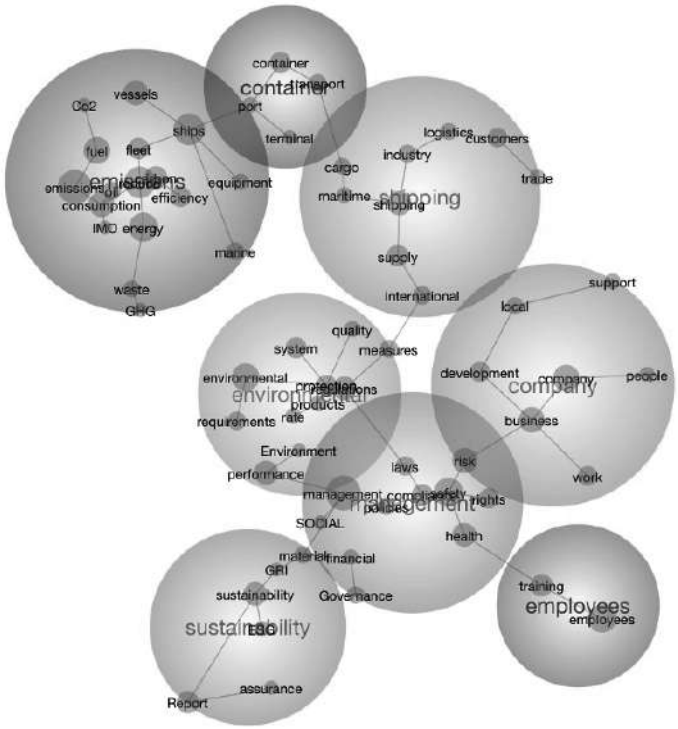
Leximancer v5 was utilized to identify and cluster common concepts and themes associated with decarbonization disclosures for SDG7-Target 7.2 included in the reports of the top 10 shipping companies. The 60 reports composing the sample produced: 8 key themes, 9 name-like concepts and 58 word-like concepts as evidenced in the Table 3, 4 and 5.

Tabella 3 – Themes and related concepts in Non-Financial Reports

All Shipping Companies with Concepts 100% and Theme size 37%			
Theme	**Hits**	**Connectivity**	**Concepts**
Emissions	19041	407408.00	ships, reduce, energy, fuel, consumption, carbon, fleet, efficiency, oil, marine, waste, equipment, CO2, GHG, IMO
Environmental	19835	217820.00	company, performance, regulations, system, protection, requirements, quality, products, rate, Environment
Management	18153	216920.00	safety, risk, health, compliance, rights, laws, policies
Shipping	16451	164675.00	supply, customers, international, measures, industry, logistics, cargo, maritime, trade
Business	14435	102316.00	development, work, local, support, people
Sustainability	9131	88337.00	Governance, material, financial, ESG, SOCIAL, GRI
Employees	10126	60197.00	training
Container	6781	53896.00	transport, port, terminal

Source: Authors' processing of the Top 10 Shipping Companies' Reports (201832023) using Leximancer (Ver.5).

Figura 1 – Concept map of the non-financial reports published from 2018-2023



Source: Authors' own creation from Leximancer.

The key themes emerged are emissions, environmental, management, shipping, business, sustainability, employees and container (Table 3, Figure 1), and they represent the concept that mostly occurred in a defined cluster. As shown in table 3, the "hits" and the "connectivity" column measure the relevance of a theme. The "connectivity" also determines its frequency alongside other identified concepts, while the final column and the conceptual map highlight the concepts linked to the key-themes.

The emission theme is the most relevant theme emerged from the analysis, and it is linked to concepts such as ships, reduce, energy, fuel, consumption, carbon, fleet, efficiency, oil, marine, waste, equipment, CO2, GHG and IMO, presenting the highest connectivity rating. The word "Energy" does not appear among the key themes, but within the concepts and it is related to consumption, efficiency, carbon, emissions, reduce, fuel.

Through this conceptual and relational analysis, the authors attempt to provide a first set of answers to research questions concerning the decarbonization practices of shipping companies described in their reports.

Tabella 4 – Non-Financial Reports

***Name-Like* Concept**	**Count**	**Likelihood (%)**
Report	5692	70
Governance	2076	26
ESG	1466	18
Co2	1011	12
IMO	918	11
SOCIAL	822	10
GHG	814	10
GRI	804	10
Environment	625	8

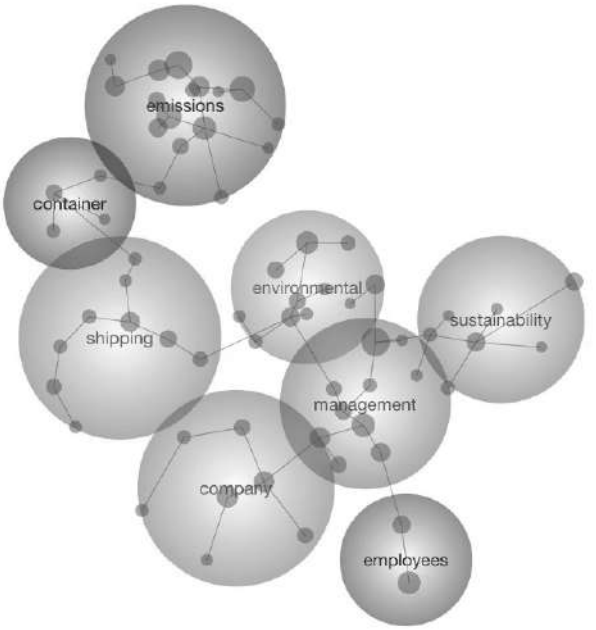
Source: Authors' analysis of the Top 10 Shipping Companies' Reports (2018-2023) using Leximancer (Ver.5).

Tabella 5 – Non-Financial Reports

Concept	Count	Likelihood (%)
Employees	8106	100
Management	7733	95
Ships	7100	88
Emissions	6743	83
Safety	5729	71
Report	5692	70
Business	5499	68
Risk	5177	64
Sustainability	4628	57
Training	4522	56
Environmental	4376	54
Energy	4294	53
Fuel	3924	48
Health	3845	47
Work	3660	45
Performance	3622	45
Container	3594	44
Customers	3522	43
Consumption	3406	42
Regulations	3351	41
Supply	3275	40

Source: Authors' analysis of the Top 10 Shipping Companies' Reports (2018-2023) using Leximancer (Ver.5).

Figura 2 – Analysis of the concepts related to the concept "Energy"



Source: Authors' own creation from Leximancer.

4.2 Leximancer v5: Concepts for decarbonization, new technologies and renewable resources

As evidenced in Table 5, the words "Decarbonization", "Technologies", "Renewable" and "Resources" do not appear as trend in the analysis. However, using Leximancer v5 function "Query", the authors established that the words "Renewable" and "Resources" matches 72 times with the concepts "Energy" and "Emissions" in the selected reports, the word "Technology" 56 times, and the word "Decarbonization" 41 times.

The content analysis highlights an increasing awareness of shipping companies on the importance of decarbonization, as well as on the achievement of the targets set by the SDG7, particularly Target 7.2 for an increased efficiency and sustainability of energy sources. The concept "Energy" is among the most relevant concepts, listed 4294 times with a 53% likelihood, linked to efficiency, reduction and environmental (Table 6).

Tabella 6 – Analysis of the Concepts related to the Energy concepts

Selected Concept (SC)	Concept related to the SC	Count	Likelihood (%)
Energy	Consumption	2503	73
Energy	Efficiency	1493	65
Energy	Carbon	1712	59
Energy	Fuel	2261	58
Energy	GHG	443	54
Energy	Reduction	2552	48
Energy	Oil	828	46
Energy	Emissions	3090	46
Energy	CO2	406	40
Energy	Fleet	1125	38
Energy	Equipment	413	27
Energy	Products	306	26
Energy	Vessels	1186	25
Energy	IMO	222	24
Energy	Waste	431	23
Energy	Terminal	221	22
Energy	Transport	484	22
Energy	Environmental	933	21
Energy	Ships	1480	21
Energy	Marine	406	19
Energy	GRI	143	18
Energy	ESG	113	8
Energy	Performance	656	18

Source: Authors' analysis of the Top 10 Shipping Companies' Reports (2018-2023) using Leximancer (Ver.5).

4.3 Manual content analysis

The manual content analysis of the selected reports supported the authors in gaining a clearer understanding of how carbon accounting can integrate the information provided in the NFR concerning the decarbonization practices adopted by shipping companies, also in consideration of the SDG7-Target 7.2. Notwithstanding the absence of the concept "decarbonization" in the automated content analysis conducted through Leximancer v5, decarbonization appears to be a common trend in the analysed reports, highlighting shipping companies' attention towards the reduction of carbon emissions. The decarbonization strategies embraced by the selected companies mainly focus on reduction of carbon emissions, increase in energy efficiency, green investments and R&D, alternative fuels, conservation of biodiversity, and optimal use of resources. The analysis of the reports evidenced the shipping companies' commitment to meet the expectations of IMO's Strategy 2023 (CMA CGM, 2024; HAPAG-LLOYD, 2024; MAERSK, 2024), and the IMO Energy Efficiency Index for Existing Vessels (COSCO, 2024; ONE, 2024; YANGMING, 2024). Hence, the manual content analysis demonstrated the tendency of shipping companies to quantify and report their carbon emissions through different carbon accounting frameworks, mainly GHG Protocol, SBTi, CDP. For instance, MSC (2024) describes its direct and indirect impact on the environment in accordance with the GHG Protocol, giving broader space to the description of its Scope 3 emissions and its calculation methodology, rather than Scope 1 and Scope 2 emissions, demonstrating a strong interest in extending the decarbonization process to its entire supply chain. ZIM's 2023 report states that its carbon emissions are calculated in accordance with the GHG Protocol and describes improvements in reducing direct and indirect emissions. However, while the report outlines how these improvements were achieved, it does not provide specific details on the calculation of Scope 1, 2, and 3 emissions (ZIM, 2024). The analysis of Maersk's report of 2023 also highlights a specific attention towards carbon accounting framework, with specific reference to the SBTi (MAERSK, 2024). Not only the report describes its achievement in terms of reduction of Scope 1, 2 and 3 emissions, but it also underlines that Maersk was the first shipping company to have its climate targets for 2030 and 2040 validated by SBTi, enhancing the legitimacy of its decarbonization strategies and data to stakeholders and society in general. Similarly, CMA CGM directly refers to CDP as carbon accounting framework, underlining that the group obtained a CDP's Score A for 2023, highlighting the value of their carbon reporting practices (CMA CGM, 2024). According to its report of 2023, Evergreen uses EPA's GHG Inventory Guidance as carbon accounting framework to measure and reports its carbon emissions. On the other side, COSCO Shipping Line reports its carbon emissions, without mentioning a specific carbon accounting framework, specifying that the "emission factor of GHG was mainly based on the Third IMO Greenhouse Gas Study 2014" (COSCO, 2024).

The manual content analysis of the reports supports the authors in enhancing their comprehension of the actions taken by shipping companies to reduce their carbon emissions. On one side, the reports highlighted that shipping companies implement preventive technological solutions, including green and digital technologies to reduce their carbon emissions, i.e. windshield (CMA CGM, 2024), SOx scrubbers (EVERGREEN, 2024), silicone paint (ZIM, 2024), fuel consumption monitoring systems (EVERGREEN, 2024), carbon emission calculator software (COSCO, 2024), digitalization of processes and operations (ONE, 2024; YANG MING, 2024). On the other side, the analysis also underlined that

renewable resources are also at the centre of shipping companies' decarbonization strategies i.e. biofuels (MSC, 2024; HAPAG LLOYD, 2024), LNG (MSC, 2024; ZIM, 2024), dual fuel engine with green methanol (CMA CGM, 2024; MAERSK, 2024), hydrogen (ONE, 2024). The analysis also highlighted the attention that reports dedicate to the compliance with different reporting standards and index, mainly GRI Indicators (CMA CGM, 2024; COSCO, 2024; EVERGREEN, 2024; HAPAG LLOYD, 2024; HMM, 2024; MSC, 2024; ONE, 2024; YANG MING, 2024; ZIM, 2024), ESG indicators (COSCO, 2024; HMM, 2024; MAERSK, 2024), SASB indicators (EVERGREEN, 2024; HMM, 2024; MAERSK, 2024; YANG MING, 2024; ZIM, 2024), as well as with the EU Non-Financial Reporting Directive (NFRD) (CMA CGM, 2023) and the Task Force on Climate-Related Financial Disclosures (TFCD) (HMM, 2024). The indicator GRI 305 – Emissions 2016 recurs multiple times, demonstrating the attention of shipping companies towards indicators, as well as carbon emissions' reduction targets.

Furthermore, the manual content analysis of the reports highlighted the attention dedicated by the selected shipping companies to the UN Agenda 2030 and its SDGs, often underlining the positive impact of shipping companies' actions on SDGs. The majority of the selected reports clearly evidenced the commitment to achieve the SDG7-Target 7.2, with the exception of MAERSK (2024) and ZIM (2024). EVERGREEN (2024) specifies the technologies implemented to achieve the SDG7-Target 7.2, namely the use of alternative maritime power (AMP), of anti-friction systems, anti-fouling coating, or air lubrification systems. ONE (2024) describes the strategy to achieve the SDG7-Target 7.2, i.e. through the development of an alternative fuel roadmap, the analysis and use of biofuels, ammonia, methanol, hydrogen, and the acquisition of 10 new large container ships with advanced technological equipment, i.e. Carbon Capture and Storage (CCS). The majority of the shipping companies analysed also contribute to the achievement of SDG12-Target 12.6 demonstrated by the increasing adoption of sustainable practices and the constant integrating of non-financial information within their reporting frameworks, also due to the institutional pressures exerted by IMO, resulting in an increasing number of sustainability reports published. However, the impact on SDG7-Target 7.2 and on SDG12-Target 12.6 is not directly described using carbon emissions' data, showing that carbon accounting has not been implemented in this context, but rather through the description of the actions implemented to achieve that specific target, i.e. adoption of innovative technologies or use of alternative fuels. Despite the absence of carbon emissions' data in describing the impact on SDGs, the manual content analysis provided a promising picture of shipping companies' implementation of different carbon accounting frameworks and disclosure of carbon emissions' data. The attention to compliance with different regulatory frameworks is also an indicator of shipping companies' commitment towards decarbonization targets, as well as their attention to stakeholders' expectations and interests, also demonstrated by the presence in the selected reports of a materiality matrix that highlight the relevance of companies' actions in terms of stakeholders' interest.

5. Discussion

The results analysed under the lenses of stakeholder and legitimacy theory provide a clear framework of the contribution of carbon accounting to the NFR practices of shipping companies to describe decarbonization practices for SDG7 – Target 7.2. The authors highlight the central role of sustainability targets in the shipping companies' strategies, underlined by their strong commitment to reduce carbon emissions and increase energy efficiency, using green and digital technologies, as well as renewable resources. The analysis evidenced also the commitment of shipping companies to the achievement of UN SDG7 – Target 7.2, to which most of the analysed shipping companies directly referred to. In fact, the energy efficiency improvement is among the priorities of the shipping sector, and of the analysed companies, as well as the use of cleaner energy sources. The majority of the shipping companies analysed also contribute to the achievement of SDG12-Target 12.6, demonstrating the strong interconnection among different SDGs as well as the interoperability of the SDG12 (LE BLANC, 2015). The manual content analysis evidenced a common commitment of shipping companies to decarbonize their processes and reduce their emissions, as well as those of their supply chains.

With reference to the RQ of this study, carbon accounting contributes to the quality of the information provided in the shipping companies' reports, providing a solid foundation to the impact of the decarbonization strategies adopted. The results highlight that shipping companies do not directly use carbon accounting to illustrate the impact of their decarbonization efforts on achieving SDG7-Target 7.2 and other related SDGs. The authors observe that the selected shipping companies implemented carbon accounting systems and standards to report their Scope 1, 2 and 3 emissions and measure the impact of the implemented technologies on their decarbonization strategies. In this frame, it emerged a key challenge for shipping companies which lies in the difficulty of collecting comprehensive and concrete information on Scope 3 emissions. In fact, the manual content analysis confirms the interest of shipping companies to include their entire value chain in their decarbonization strategy, as demonstrated by the MSC slogan "enable logistic decarbonization" (MSC, 2024). Also, MAERSK, in alignment with the SBTi targets, specifies that the company has invested to ameliorate "the methodology for calculating scope 3 emissions, increasing the share of emissions that is calculated based on activity data from 50% to 82%" (MAERSK, 2024). However, the collection of Scope 3 emissions' data might present some challenges in the implementation, i.e. the lack of qualitative primary data in the supply chain, the need of a strong collaboration between stakeholders which might be difficult since companies tend to prioritize reporting positive data to enhance their legitimacy (ELLRAM et al., 2022; DELOITTE, 2024). To increase the legitimacy on the "carbon accountability" and of the data provided, the majority of shipping companies make explicit reference to several carbon accounting frameworks implemented, i.e. GHG Protocol (MSC, 2024; ZIM, 2024), SBTi (MAERSK, 2024), CDP (CMA CGM, 2024). These frameworks were implemented not only to provide concrete and accountable data to stakeholders, but also to validate the decarbonization actions adopted by the shipping companies through specific awards provided by the frameworks, i.e. the SBTi recognition of MAERSK's climate commitments in 2023 (MAERSK, 2024). These awards contribute to improving the legitimacy of shipping companies' strategies to society and stakeholders. The manual content analysis highlights the shipping companies' awareness on the importance of adhering to social norms and values, underlined by their attention in demonstrating compliance with international and European regulations as well

as their dedication to deliver value to society, to enhance their legitimacy and credibility to stakeholders and society in general. Notwithstanding the absence of "stakeholder" as concept in the automated content analysis, the authors notice a strong commitment of shipping companies to achieve the expectations of stakeholders, as demonstrated by the presence of materiality matrix within the reports, aimed at describing the relevance of companies' actions in terms of stakeholders' interest. Moreover, shipping companies also dedicate a specific section of their reports to describe their actions in terms of stakeholders' engagement, demonstrating a clear commitment towards stakeholders. The analysed shipping companies provide detailed information concerning new technologies, including green and digital technologies, adopted to decarbonise their processes, and listed the renewable resources that are currently under exploration as potential alternatives to fossil fuels, highlighted as a mean to reduce carbon emissions. The impact of these emerging solutions will be proven in the long-term and require the continuous dedication of shipping companies to achieve the ambitious goals set by international and European institutions, as well as the contribution and collaboration of stakeholders who are part of shipping supply chain, i.e. shipyards (DEWI et al., 2022; VAKILI et al., 2022; TADROS et al., 2023; WÄRTSILÄ, 2024). With reference to the reporting framework used by the selected sample, the authors notice that the majority of shipping companies analysed do not use IR as reporting framework, despite IR recognized benefits for companies, i.e. offer a comprehensive view to stakeholders, contribute to enhance the perception of collaboration between different departments operating in the company, provide a more concise and clear communication framework on financial and non-financial aspects (EY, 2019; DELOITTE, 2022; DE VILLIERS and DIMES, 2023). The authors also highlight the different reporting frameworks implemented by the shipping companies, i.e. GRI, ISSB, SASB, evidenced also by different length and complexity of the analysed reports. The lack of common reporting standards and the heterogeneity of carbon accounting frameworks represents a further obstacle to shipping companies in comparing data and adopting standardized methodology, resulting in a low practical performance in the long-term (HAACK and RASCHE, 2021). Moreover, it represents a challenge for stakeholders, making the comparison of data and information provided more challenging (DI VAIO et al., 2024b). Since the adoption of the UN 2030 Agenda and the IMO Strategy on the reduction of ships' emissions at sea, scholars have increasingly investigated on responsible shipping practices (XUE and LAI, 2023). Existing literature has focused on international and European regulatory frameworks for the promotion of shipping companies' transparency (DEANE et al., 2019), and accountability for the reduction of their carbon emissions (RAHIM et al., 2016), analysing specific reporting frameworks that might support the sustainability prospects of the shipping industry (TSATSARONIS et al., 2024). Another strand of literature has highlighted the relevance of carbon accounting as a managerial tool within sustainable business models (DI VAIO et al., 2024d; ONAT et al., 2025), though without addressing the specificities of highly regulated sectors, as shipping. This study, supported by the stakeholders and legitimacy theories, contributes to the abovementioned academic scenario, by advancing the understanding on the correlation between carbon accounting, NFR, and decarbonization practices through the identification of common practices within shipping companies to enhance the legitimacy and validity of their actions to stakeholders.

Shipping companies are releasing non-financial information to respond to stakeholders' expectations, adopting different reporting standards, mainly GRI, ESG, UN Global Compact, SASB, that are widely recognized as legitimate and transparent frameworks (HAACK and RASCHE, 2021; DE VILLIERS and DIMES, 2023). In conclusion, the analysed

shipping companies describe a holistic decarbonization framework, with reference to new technologies and renewable resources, utilizing carbon accounting practices as a mean to improve the information provided in the NFR. However, the use of IR could be improved by shipping companies to provide a more comprehensive framework to stakeholders and increase the transparency and correlation of financial and non-financial information, enhancing their accountability to stakeholders and society.

5.1 Theoretical Implications

The theoretical implications of this study revolve around the understanding of carbon accounting's contribution to NFR practices, through a dual content analysis of NFR under the lenses of stakeholder and legitimacy theories. This study provides a valuable contribution to existing research (GODET et al., 2021; DI VAIO et al., 2024d) by offering an in-depth analysis of the NFRs published by selected shipping companies, examined through the perspectives of stakeholder and legitimacy theory. The choice of analysing the selected reports under two theoretical lenses was agreed among the authors since a single theoretical lens could result not sufficient due to the complexity of NFR practices. Thus, these two theoretical lenses are implemented in a complementarity perspective – rather than a competitive one – to provide a deeper understanding of carbon accounting practices (FERNANDO and LAWRENCE, 2014). This study highlights that shipping companies are currently reacting to the growing pressures from internal and external stakeholders, implementing and reporting their emission reductions and efforts to achieve SDG7-Target 7.2 to increase their legitimacy to stakeholders. In this context, carbon accounting emerges as a key tool, serving two crucial purposes: first, supporting shipping companies in addressing the stakeholders expectations by reducing their carbon footprint and supporting the transition to renewable energy sources in alignment with the SDGs; and second, enhancing the reliability and legitimacy of the data related to their decarbonization practices, thus building trust through accountability and transparency in disclosing their decarbonization efforts.

5.2 Managerial Implications

Shipping companies can benefit from the results of this study to achieve the targets set by the 2023 IMO GHG Strategy, as well as the SDG7-Target 7.2, for an increase share of renewable energy sources by 2030.

Shipping companies play a central role in reducing emissions and increasing the share of renewable energy in the global energy mix. Managers should recognize the significant impact their operations can have on climate goals and prioritize strategies that contribute to emission reductions and the integration of renewable energy sources. Due to the complexity of the logistics supply chain in which shipping companies operate, a comprehensive approach to decarbonization is necessary. Managers should involve the entire supply chain in the process, addressing not only direct emissions (Scope 1) but also indirect emissions (Scope 2 and Scope 3) through the collaboration with several stakeholders and a holistic view of emissions across the entire logistics network. In this frame, carbon accounting can represent an essential tool for tracking and reporting direct and indirect emissions with accuracy and consistency. This study also urges managers to rethink their carbon footprint measurement systems, that are the object of decarbonization choices and actions. This study suggests a holistic approach to

the decarbonization matter, trying to go beyond the concept of measurement and reporting of emissions scores, that is, managing the decarbonization process. On the other hand, the concept of management includes data collection, measurement or quantification of data, and reporting of information. Hence, shipping business needs to be managed according to a logic of "overall carbon accountability" led by managerial accounting systems, aware that the perspective of measurement of emissions and disclosure of emission scores goes beyond the boundaries of shipping companies for involving the entire supply chain responsible for Scope 3 emissions. Besides, shipping companies should invest in robust accounting systems that align with international frameworks (i.e. GHG Protocol, SBTi, CDP) to ensure precise measurement and reporting of emissions across all relevant scopes. To strengthen the credibility of decarbonization efforts, it is vital for shipping companies to ensure that their reporting teams are well-prepared. Managers should implement specialized training programs focused on carbon accounting tools and reporting standards to increase the knowledge and skills of the accountants responsible for emission data and sustainability reporting. By adopting these practices, shipping companies might align with global sustainability targets and demonstrate their commitment in the transition to a low-carbon economy, enhancing their legitimacy and ensuring long-term competitiveness in an increasingly environmentally conscious market.

5.3 Limitations and future research directions

This study might be potentially affected by a set of limitations. A first limitation might arise from the reliance on secondary data, which may affect the accuracy, and the interpretation of the information provided. In fact, the information provided in the NFR might not fully reflect the reality of the shipping companies' efforts (DI VAIO et al., 2024b). These limitations might be overcome through on-site interviews. Furthermore, it might be challenging to compare different shipping companies results due the lack of standardize sustainability measurement. This limitation might be overcome through the development of a sustainability standard regulatory process towards interoperability and alignments among different standards.

The representativeness of the sample might also constitute a limitation, since the analysis considered exclusively the top 10 shipping companies (GOBO, 2004). Notwithstanding the high market share of the selected shipping companies, future research might consider extending the sample in order to ensure a broader representativeness of the sample for the shipping sector (GOBO, 2004). With reference to the methodology implemented, while Leximancer v5 was effective in objectively identifying key themes and concepts, it required the implementation of a manual content analysis conducted by the authors to further explore and understand the emerged themes. In this frame, two main limitations might arise from the manual content analysis: on one side, it might be influenced by the authors' existing background on the shipping sector (KRIPPENDORFF, 2018); on the other side, it focused solely on the latest report published by the shipping companies, which may not fully capture trends or developments over time. Future research might choose a more extended timeframe for the manual content analysis. Finally, the study focused mainly on the environmental aspects of shipping companies' decarbonization strategies, leaving aside the social and governance aspects. In future research, the inclusion of these aspects in the analysis might highlight aspects that did not emerge from this first analysis.

6. Conclusion

This study analyses the decarbonization practices adopted by shipping companies to UN 2030 Agenda and SDG7-Target 7.2, to increase the share of renewable energy in final energy consumption, and the role of carbon accounting in supporting companies to describe these practices in their NFR. The analysis demonstrates a clear commitment of shipping companies towards decarbonization, as evidenced by the implementation of new technologies and renewable resources which, even though are still at an experimental phase, might produce a long-term positive impact on the decarbonization of the sector if continuously supported by shipping companies' investments and valorise within their strategies. This commitment is duly described within the selected reports through the implementation of different carbon accounting frameworks, as recognized added value to the description of these practices. However, the authors highlight that the description of the impact of decarbonization strategies on SDG7-Target 7.2, and more in general on SDGs, within the selected reports, do not include carbon emissions' data. The implementation of carbon accounting frameworks for the description of SDGs achievement strategies might enhance their transparency and accountability to stakeholders and society, as well as their CSR, increasing their legitimacy. The authors also highlight that the shipping companies selected are not implementing IR frameworks. The implementation of this reporting framework might result in benefits and advantages for shipping companies in terms of enhancement of legitimacy and comprehensiveness of information. Also, the lack of standardize measurement systems might enhance the fragmented reality of reporting frameworks and incentivize companies to disclose exclusively information of their interest, without producing actual positive impacts. In this context, the expected interoperability and collaboration among different reporting standards boards, i.e. ISSB and ESRS, might improve consistently the quality of information disclose as well as their transparency.

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Acknowledgements

The authors would like to thank the Editor-in-Chief and the two reviewers for their thoughtful handling of this article, as well as for providing helpful comments and constructive suggestions that contributed to its improvement. This work is an outcome of the "BlueShipping&Cruise Lab" (BSCLab), Department of Law, University of Naples Parthenope, Italy.

Funding

his work was funded by University Parthenope, Naples, Italy, (No. DM737/2021) - Research Financial Resources, "Ministero dell'Università e della Ricerca con Decreto Ministeriale del 25. 06.2021 n. 737 for research project entitled Transizione digitale per Modelli di Business Sostenibili e Resilienti nell'intero nave-porto verso l'Agenda 2030 – P.I. Prof. Dr. Assunta Di Vaio". This work was also supported by ForMare – Polo Nazionale per lo Shipping s.r.l.

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