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Incorporating Environmental Costs to Shipping Companies in the Maritime Industry: A Way to Make Financial Decisions that Last

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Abstract: The shipping industry, which transfers more than 80% of the world's goods by volume, is under more and more pressure to think about how it affects the environment. This article examines the integration of environmental costing methodologies inside the financial management systems of shipping businesses. The study employs institutional theory, stakeholder theory, and environmental management accounting (EMA) frameworks to analyze the systematic identification, quantification, and incorporation of environmental costs—such as carbon emissions, air pollution, ballast water management, and regulatory compliance—into managerial decision-making. The analysis investigates the implications of the European Union Emissions Trading System (EU ETS) expansion to maritime transport commencing January 2024, the International Maritime Organization's (IMO) revised GHG Strategy, and the FuelEU Maritime regulation. This study introduces a comprehensive environmental costing model for shipping businesses that integrates conventional cost accounting with comprehensive environmental cost accounting. It accomplishes this by establishing a systematic literature review and a conceptual framework. The results show that actively using environmental costing makes things more clear, helps businesses follow the rules, makes stakeholders more accountable, and in the end, gives them a long-term competitive edge. The report concludes with recommendations for practitioners, policymakers, and further research.

Keywords: Environmental costing, marine shipping, environmental management accounting, EU ETS, decarbonization, sustainability reporting, and green shipping are all important terms.

I. Introduction

The principal way that products are traded around the world is by sea. It carries nearly 80% of the world's products by volume and more than 70% by value (UNCTAD, 2024). The transportation business is the best way to carry goods since it uses the least amount of energy, but it has generated a lot of environmental problems because it is so enormous. In 2023, international shipping emitted roughly 850 million tons of CO2, which is about 2.6% of total greenhouse gas (GHG) emissions on Earth (IMO, 2023). Shipping activities also release a lot of air pollutants, like sulfur oxides (SOx), nitrogen oxides (NOx), and particulate matter, in addition to carbon emissions. These contaminants are harmful to human health and the environment (Corbett et al., 2007).

Environmental costing is now a key accounting tool for figuring out, measuring, and assigning costs that have to do with how a business affects the environment. Environmental management accounting (EMA) improves traditional cost accounting by including environmental costs in decision-making processes for managers. This lets businesses figure out how their environmental strategies will affect their bottom line (Jasch, 2003; Schaltegger & Burritt, 2000). Environmental costing is no longer an option in the marine business; it is becoming increasingly essential due to a confluence of legal, market, and societal factors.

The EU Emissions Trading System (EU ETS) will start to cover maritime transport in January 2024. Shipping businesses will have to disclose their carbon emissions in a very different way now (European Commission, 2023). Shipping businesses who have ships with a gross tonnage of 5,000 or more that dock at EU ports must acquire and give up emission allowances that match the emissions they have certified. The IMO's new GHG Strategy, which was adopted in July 2023 and targets for net-zero GHG emissions from international shipping by or around 2050, combined with this legal reform, has made it highly vital for shipping businesses to set up solid environmental costing systems (IMO, 2023).

Even though environmental costing is becoming more significant in the shipping industry, there is still a big gap in the academic literature regarding how to put it into effect in shipping companies' financial management systems. Previous studies have examined carbon accounting in isolation (Di Vaio et al., 2025) and sustainability reporting within the shipping industry (Lister et al., 2015); nevertheless, there is a lack of comprehensive environmental costing frameworks that address all environmental costs incurred by maritime businesses. This study aims to rectify this shortcoming by introducing a thorough environmental costing framework tailored to the unique characteristics and problems of the maritime transportation industry.

This is how the rest of the paper is set up. Part 2 talks about the relevant literature and the theoretical basis. Part 3 deals about the rules and laws that govern how shipping businesses charge for the expenses of pollution. Section 4 goes into more detail on the proposed framework for environmental costing. In Section 5, we speak about what happens in the actual world and the challenges that come up when the plan is put into reality. The concluding portion of Section 6 gives a short review of the results and ideas for more research.

II. Theoretical Framework and Literature Review

2.1. Theoretical Foundations of Environmental Management Accounting

Environmental management accounting is a specific sort of management accounting that deals with the collecting, analysis, and use of both financial and non-financial data about an organization's environmental operations (Burritt et al., 2002). In 2001, the United Nations Division for Sustainable Development (UNDSD) defined EMA as the process of locating, acquiring, analyzing, and applying both physical and monetary information to make decisions in an organization. At its foundation, EMA attempts to make the hidden environmental costs that traditional accounting systems sometimes hide by putting them in overhead accounts or ignoring them altogether (Jasch, 2003).

The theoretical underpinnings of environmental costing in organizational settings are sourced from multiple established paradigms. Institutional theory explains how firms respond to regulatory, moral, and mimetic forces when they put environmental accounting methods into place (DiMaggio & Powell, 1983). In the maritime sector, the implementation of environmental costing systems is driven by coercive pressures from international regulations such as MARPOL Annex VI and the EU ETS, normative pressures from industry organizations and classification societies, and mimetic pressures from leading shipping companies (Wang et al., 2023). Stakeholder theory clarifies the imperative for shipping businesses to harmonize the expectations of several stakeholders, such as regulators, investors, cargo owners, port authorities, and civil society, in their environmental accounting processes (Freeman, 1984; Di Vaio et al., 2025).

2.2. Costs to the environment in the shipping industry

There are various ways that shipping corporations have to pay for damage to the environment. Stavroulakis and Papadimitriou (2022) proposed a total cost of ownership framework for shipping that considers all expenses associated with shipping methods. This framework divides the costs of shipping that the corporation has to pay for itself from the expenses that society has to pay for shipping. Their approach identifies numerous kinds of environmental costs that are not directly related to the economy, like expenses for noise, climate change, and harm to habitats.

Shipping businesses have to pay for things like installing scrubbers and using low-sulfur fuels to fulfill environmental standards. They also have to pay for things like pollution prevention and waste management. They also have to spend money on green technology investments like systems for cleaning exhaust gas, treating ballast water, and making energy

use more efficient (Ramalho & Santos, 2021). Some of the possible environmental costs that could happen are oil spills, fines for not meeting emission rules, and expenditures for cleaning up. The EU ETS's extension to shipping has also created a new sort of direct environmental cost: the cost of buying carbon emission allowances (Chen et al., 2024).

External environmental costs, which are not directly borne by the shipping firm but rather placed on third parties and the environment, are also significant. Kalli et al. (2013) evaluated the external costs of shipping emissions in European waters, while Essen et al. (2020) and Vierth and Merkel (2022) quantified the external costs of transport across modes, demonstrating considerable variation in the level of internalization contingent upon the valuation methodology employed. Internalization, which is when taxes, levies, or emission trading schemes change external costs into internal expenses, is a highly essential principle for environmental costing in shipping (Ramalho & Santos, 2021; Cariou & Cheaitou, 2012).

2.3. Reporting and making shipping sustainability known

The link between environmental costing and sustainability reporting is getting more and more significant in the shipping business. Di Vaio and colleagues have significantly enhanced the understanding of how carbon management accounting incorporates partnership collaborations into emissions measurement within shipping companies, examining this through stakeholder theory, legitimacy theory, and resource-dependence theory (Di Vaio et al., 2025). Their research shows that shipping businesses use different cooperation techniques to get resources to support ecologically friendly development goals while still following IMO rules.

The marine industry has quickly started using Environmental, Social, and Governance (ESG) reporting systems. The Poseidon Principles, which were made in 2019 for banks that invest in shipping, set rules for how to evaluate and share information so that shipping portfolios are in line with a lower emission trajectory (Alexandridis et al., 2018). These improvements illustrate that more and more individuals are aware that environmental costing is not only a technique to fulfill the rules; it's also a strategic necessity that influences access to money, insurance conditions, and trust from stakeholders.

III. The restrictions that change how much shipping costs for the environment

3.1. The EU Emissions Trading System now includes shipping.

Starting in January 2024, the EU ETS will encompass shipping. This is the biggest shift to the laws that shipping companies have to follow when it comes to environmental costs. The European Commission (2023) says that all ships with a gross tonnage of at least 5,000 that enter EU ports must pay a carbon price for their CO_2 emissions, no matter what flag they fly. The system includes all emissions from journeys within the EU and half of emissions from trips that start or end outside the EU. Shipping companies will have to give up allowances for 40% of their emissions in 2024 (in 2025), 70% of their emissions in 2025 (in 2026), and 100% of their emissions from 2027 on.

Shipping companies will have to deal with a lot of money because of the EU ETS. Chen et al. (2024) made a model for carbon and cost accounting for liner shipping under the EU ETS. They found that the sailing stage is responsible for 94.70% of CO_2 emissions from liner shipping and that the EU Allowance (EUA) cost is a big new part of the total cost of shipping operations. The rates for EU ETS allowances are between 54 and 81 euros per tone of GHG in the first half of 2024. This makes it exceedingly expensive for maritime firms. Because of this, shipping businesses really need to employ environmental costing systems (Christodoulou & Cullinane, 2023). Kotzampasakis (2025) conducted a systematic literature review of 51 peer-reviewed publications assessing the maritime EU ETS, concluding that it can achieve significant emissions reductions at lower overall costs compared to regulatory alternatives; however, uncertainties remain regarding carbon leakage risks and varying economic impacts.

3.2. IMO's rules and GHG strategy

The International Maritime Organization's new GHG Strategy, which was approved in July 2023, sets lofty goals for lowering GHG emissions from international shipping. By 2030, emissions should be decreased by 20% to 30%, by 2040, they should be cut by 70% to 80% (relative to 2008 levels), and by 2050, they should be net-zero (IMO, 2023). The IMO is also working on a way to charge for greenhouse gas emissions from ships. People think this system will be approved in 2025 and start working in 2027 (Flodén et al., 2024). These changes in the rules have a huge effect on how shipping businesses figure out how much their activities cost the environment. This is because they show that emissions limitations are getting harsher and that operations that utilize a lot of carbon will cost more.

The IMO's regulatory framework includes a lot of environmental laws that shipping companies have to comply and pay for, in addition to GHG rules. The Energy Efficiency Design Index (EEDI), the Energy Efficiency Existing Ship Index (EEXI), and the Carbon Intensity Indicator (CII) all have costs that must be included in environmental costing systems (Wang et al., 2023). These laws have a big effect on costs, and it takes specialized accounting methods to figure them out.

3.3. The FuelEU Maritime Regulation

The FuelEU Maritime rule builds on the EU ETS by making it mandatory for ships that dock at EU ports to use cleaner fuels that slowly lessen the amount of greenhouse gases that the energy they use releases. The aims are 2% lower than the 2020 value (European Commission, 2023) and grow up to 6% lower by 2030 and 80% lower by 2050. Shipping businesses will have to consider more about the environmental implications of this law since they will have to buy alternative fuels and propulsion systems to reach the goals. Fines for not following the standards immediately effect the company's costs, which makes it even more vital to complete a full environmental costing.

IV. An All-Inclusive Environmental Costing System for Shipping Companies

This part suggests a complete environmental costing system for shipping businesses, based on the theoretical and regulatory study that came before it. The framework contains four pieces that function together: (a) locating and sorting costs, (b) measuring and quantifying them, (c) reporting on them and helping people make decisions, and (d) merging and distributing them.

4.1. Finding costs and putting them together

The first step in the framework is to locate and group all the charges that the shipping firm has to pay for that are related to the environment. Shipping businesses can categorize their environmental costs into the following areas based on the EMA classification system that the International Federation of Accountants (IFAC, 2005) came up with and changed for the maritime industry:

Category 1: Costs of Treating Waste and Emissions: These are costs for things like treating sewage, ballast water, bilge water, solid waste, and exhaust gas (scrubbers). Shipping businesses have had to pay a lot more after the IMO 2020 sulphur cap went into effect. Ships had to either use low-sulphur fuels that satisfied the standards or build exhaust gas cleaning equipment (Stavroulakis & Papadimitriou, 2022).

Category 2: Costs of Environmental Management and Prevention: This area comprises the costs of environmental management systems (ISO 14001 certification), environmental monitoring and auditing, environmental training for crew and shore staff, and costs of environmental impact assessments. More and more shipping companies that use green shipping methods are spending money on these safety measures (Lai et al., 2011).

Category 3: Material and Energy Costs of Non-Product Output: In shipping, this category covers the cost of fuel used above optimal efficiency levels, the energy cost of bad voyage planning, and material losses from processes that aren't efficient. Even simple changes that make a ship use less fuel can save a lot of money and cut down on emissions (Psaraftis & Kontovas, 2013). This is because fuel expenditures normally make up 40–60% of the entire cost of running a ship.

Category 4: Carbon Emission Costs: The EU ETS for shipping has turned this category into a clear and measurable expense. The cost of buying EUA allowances, the cost of monitoring, reporting, and verification (MRV) under the EU MRV Maritime Regulation, and probable future expenses under the planned IMO GHG pricing scheme are also included. Chen et al. (2024) demonstrated that one may accurately calculate these costs by utilizing emission data from particular trips and the prevailing carbon pricing.

Category 5: Expenses of Following the Rules: These are the expenses of following MARPOL rules, EEDI/EEXI rules, CII improvement measures, ballast water management convention rules, and anti-fouling system rules. Christodoulou et al. (2021) assessed the direct expenses incurred by the maritime sector due to EU ETS inclusion, employing MRV data and highlighting the significant financial burden of compliance.

Category 6: Contingent and Intangible Environmental Costs: This category includes prospective future costs like cleaning up an oil spill, paying fines for breaking the rules, legal expenditures, and damage to a company's brand after an environmental disaster. It's hard to put a precise number on these expenses, but they are substantial financial hazards that need to be thought about when building systems for environmental costing (Gray, 1992).

4.2. Measuring and Counting

The framework's measuring section talks about how to figure out how much environmental costs that have been established are worth. Standard accounting systems work for things like buying equipment, paying for fuel, and paying for carbon credits. But you need more advanced tools to figure out how much external costs and contingent liabilities are.

If a maritime company is considering about investing in green technologies and alternative fuels, Life Cycle Cost Analysis (LCCA) is a highly helpful tool. Zhang et al. (2022) employed a process-based hybrid life-cycle inventory modeling methodology to evaluate the cradle-to-propeller footprint of cargo ships, demonstrating that the intrinsic environmental costs of ship production should be considered alongside operational expenses. Chen et al. (2024) propose a formula for calculating the carbon cost under the EU ETS. This formula uses data on fuel consumption for each voyage, emission factors for different types of fuel, the coverage percentage that applies (40%, 70%, or 100% during the phase-in period), and the current price of EUAs to find the total carbon cost for each voyage.

The Handbook on External Costs of Transport (Essen et al., 2020) gives standard unit values for pollution, climate change, noise, and other environmental costs for each type of transportation. This is how you figure out external environmental costs. The level of internalization of external costs is quite low for maritime transport. Only about 4% of external costs are currently internalized through existing regulatory systems. This is far lower than the 33% for road transport and 62% for diesel rail (Ramalho & Santos, 2021). This large difference underscores how crucial it is for shipping businesses to undertake environmental costing ahead of time.

4.3. Distribution and Integration

Businesses need to include environmental expenses in their management accounting systems and link them to the proper cost items, like specific ships, voyages, trade routes, or business units. Activity-based costing (ABC) is an excellent technique to break down expenses since it shows you how much environmental costs are tied to the things that generate them (Wang & Tang, 2017). The EU ETS, for example, can charge carbon charges for certain trips based on how much fuel is used and how much pollution is created. You can charge ships for the upkeep of scrubbers according on how many hours they are used.

To add environmental costs to present financial management systems, the chart of accounts needs to be updated, environmental cost centers need to be set up, and environmental key performance indicators (KPIs) need to be made. Azizah et al. (2024) shown that the adoption of EMA in the shipping industry is facilitated by both environmentally friendly shipping practices and regulatory pressure. They also demonstrated that EMA is a crucial instrument for assessing the financial impacts of environmental initiatives and enhancing overall environmental performance.

4.4. Reporting and Helping People Make Choices

The last element of the framework talks about how to use and report environmental cost information to assist people make choices. Management should acquire regular, thorough information on the environmental costs of each ship, voyage, and fleet. This will help them choose the right mix of vehicles, the best routes, the right speed, the right fuel, and the right technology to invest in. Di Vaio et al. (2025) say that external reporting should follow recognized frameworks as the Global Reporting Initiative (GRI), the Sustainability Accounting Standards Board (SASB), and the Task Force on Climate-related Financial Disclosures (TCFD).

Shipping businesses utilize information on the costs of pollution for a number of reasons to assist them make decisions. It helps make judgments about renewing the fleet and buying new technology at the strategic level. For example, it looks at different kinds of fuel propulsion systems. At the operational level, it assists with planning trips and choosing the best speeds that balance corporate goals and environmental costs. It lets you correctly guess how much it will cost to follow the rules and how many carbon credits you will need. The development of Environmental Ship Indexing (ESI) and analogous rating systems underscores the necessity for the shipping sector to disclose environmental expenses (Lai et al., 2011).

V. Discussion: Issues with putting things into action and what they signify in real life

5.1. Putting It into Action: Problems

Shipping businesses who seek to adopt full environmental costing systems have a lot of huge issues. The biggest challenge is collecting the appropriate information. To get a true picture of the cost of the environment, you need specific, ship-level information on things like fuel use, emissions, trash output, and spending on environmental management. The EU MRV Maritime Regulation has made it easier to get information from ships that dock in EU ports. However, there are still gaps in the data for ships that don't go to the EU and for smaller ships that don't have to disclose their data.

It's also harder to figure out how to split costs in the marine world. Shipping corporations sometimes operate within complex organizational structures that encompass ship management firms, charterers, and beneficial owners, which may obscure accountability for environmental costs and complicate their allocation. Also, there is still a lot of disagreement about how to assess external environmental costs, and the unit values can be extremely different depending on the approach employed and where they are (Essen et al., 2020).

The lack of defined environmental accounting principles specific to the maritime sector hinders adoption. The GHG Protocol and the ISO 14051 standard on Material Flow Cost Accounting are examples of frameworks that give general advice. However, they don't take into account the unique aspects of shipping operations, such as how voyages are international, how many flag states there are, and how environmental costs vary between vessels and companies.

5.2. What this means for shipping businesses in the real world

Despite these issues, environmental costing has several real-world benefits. Shipping businesses who set up their own environmental costing systems can get a lot of strategic benefits. First, knowing the real costs of environmental compliance makes it easier to prepare for it. This is especially true in the EU ETS, where being able to guess carbon costs can have a large effect on revenues. Second, environmental costing helps customers decide whether or not to invest by giving them a clearer picture of the total cost of ownership for different types of ships, fuel options, and technological investments (Stavroulakis & Papadimitriou, 2022).

Third, being upfront about the environmental costs of transportation helps the company's reputation and its relationships with stakeholders. More and more, cargo owners pick carriers based on how well they safeguard the environment. For instance, the Clean Cargo Working Group gives the container shipping industry standard ways to report on how well they are doing for the environment (Lister et al., 2015). Companies who can prove they are appropriately costing the environment and making regular progress in lowering their environmental expenses are more likely to secure good financing conditions under frameworks like the Poseidon Principles and attract customers who care about the environment.

Fourth, environmental costing can help operations run more smoothly, which lowers expenses and the impact on the environment at the same time. Finding and analyzing the environmental costs of inefficient routing, fuel waste, and speeding might help you find methods to save money that you would not have seen before. Psaraftis and Kontovas (2013) found that simply slowing down can save a lot of money and cut down on CO_2 emissions by a lot.

5.3. What this means for people who make policy

This paper's analysis has several consequences for policymakers. The fact that only roughly 4% of the external environmental costs of maritime transport are currently internalized (Ramalho & Santos, 2021) illustrates that current rules and regulations are not enough to make private costs meet social costs. The EU ETS's extension to shipping is a huge start toward eliminating this gap in internalization, but more measures may be needed to properly cover all the environmental costs that shipping causes.

Policymakers should also look about how rules and laws might make shipping businesses more likely to utilize technologies that take the environment into account. If the current MRV standards were used with mandatory environmental cost disclosure requirements, the industry may be more open and easier to compare. Also, making environmental accounting rules for shipping that are only for that industry will aid companies who want to set up entire environmental costing systems.

VI. Final Thoughts

This article has examined the incorporation of environmental expenses within maritime shipping firms. It proposes a comprehensive framework encompassing all categories of environmental costs, ranging from direct compliance expenses to costs transferred to third parties. The study reveals that the EU ETS's expansion to maritime transport and the IMO's updated GHG Strategy have made shipping businesses feel the need to build more complex methods for calculating environmental costs. This is both a need and a chance.

The suggested framework has steps for finding and classifying costs, measuring and counting them, allocating and integrating them, and reporting on them and helping with decisions. It gives shipping businesses a mechanism to add environmental factors in their financial management systems that is organized. The framework uses well-known EMA methods, but it also takes into account the maritime sector's unique features. For example, shipping operations are international, it is hard to figure out how to split costs between ships and voyages, and both direct and indirect environmental costs must be taken into account.

This study has significant implications in the real world. Shipping businesses that employ environmental costing can make their operations more effective, handle compliance better, make better investment decisions, and develop stronger connections with stakeholders. As the marine industry works to reduce its carbon footprint, environmental costing will become an important tool for keeping track of the complicated relationships between government rules, new technologies, and market pressures.

Subsequent research should focus on empirical validation of the proposed framework through case studies of shipping businesses at different stages of environmental costing implementation. Longitudinal research examining the relationship between environmental costing approaches and financial performance in the shipping industry would provide valuable insights for practitioners and policymakers. Moreover, the formulation of sector-specific environmental accounting standards, based on the framework outlined in this study, would signify a significant progression in both academic comprehension and practical implementation within the industry.

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