

An Analysis of the Shipping Industry's Response to Climate Change-related Regulation: Present and Future

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기후변화 관련 규제에 대한 해운업계의 대응 분석: 현재와 미래

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Executive Summary (English)

In 2020, BlackRock's CEO Larry Fink emphasized that climate risk equates to investment risk, placing a spotlight on the significance of Environmental, Social, and Governance (ESG) factors. With over 120 countries committing to Net-Zero goals by 2050, shipping companies must adapt to new challenges posed by regulatory shifts and operational changes in pursuit of decarbonization.

One of the primary challenges facing the shipping industry is complying with increasingly stringent environmental regulations, particularly those set forth by the International Maritime Organization (IMO). The IMO's ambitious targets for reducing greenhouse gas emissions are placing pressure on shipping companies to invest in greener technologies and processes. Many companies are transitioning to alternative fuels such as LNG, biofuels, and green methanol, yet these solutions come with substantial costs, both in terms of implementation and ongoing operations.

Additionally, the high costs associated with sustainable technologies, such as retrofitting fleets to meet environmental standards, present significant financial challenges. These costs inevitably impact the entire supply chain, and companies must balance the immediate financial burden with the long-term benefits of maintaining a compliant and sustainable fleet.

Another major challenge is the lack of green infrastructure in many regions. The logistics of operating alternative fuel vessels are complex, with limited refueling infrastructure globally. As a result, shipping companies may be forced to limit their sustainability efforts to specific trade routes or regions where green infrastructure is available. Leading companies such as CMA-CGM are achieving decarbonization goals through a diversified fuel strategy, while also strengthening their ability to flexibly respond to regulatory changes. These cases highlight the need for the shipping industry to adopt sustainable strategies for long-term growth.

Furthermore, managing Scope 3 emissions presents a significant challenge. Accurate data collection, supplier engagement, and technological solutions are critical for effectively managing these emissions. Collaboration with stakeholders is necessary to ensure consistent and reliable emissions reporting, but many shipping companies struggle with data reliability and the complexity of the supply chain.

Despite these challenges, the shipping industry has numerous opportunities for fostering sustainable growth. One of the most promising opportunities lies in raising customer awareness about the industry's sustainability initiatives. Many customers are unaware of the efforts shipping companies are making to decarbonize their operations. By effectively communicating

these initiatives, shipping companies can enhance their reputation as sustainability leaders and create opportunities to share the costs of green technologies with their customers.

Educating customers about the environmental benefits of sustainable shipping practices can lead to more collaborative partnerships. Customers who understand the investments required for decarbonization may be more willing to pay a premium for eco-friendly shipping solutions, helping to offset the high costs of sustainable technologies. This approach can create a more balanced and financially viable pathway for shipping companies to achieve their decarbonization goals.

Another significant opportunity lies in the adoption of digital technologies such as AI for route optimization, blockchain for supply chain transparency, and IoT for monitoring fuel consumption. These innovations can significantly enhance operational efficiency while reducing emissions. Moreover, digital tools can provide real-time data that emphasizes the industry's commitment to sustainability, thereby improving customer engagement and transparency.

Green financing also presents a critical opportunity. As governments and financial institutions increasingly offer incentives for sustainable practices, shipping companies can access subsidies, grants, and low-interest loans to support their investments in green technologies. These financial tools help offset the high upfront costs of transitioning to alternative fuels and retrofitting fleets, making it easier for companies to pursue sustainability without compromising financial performance.

Lastly, the growing demand for sustainable logistics from consumers and businesses offers new business opportunities. Customers are increasingly making decisions based on the environmental impact of their supply chains. By positioning themselves as leaders in green shipping, companies can differentiate their services and attract environmentally conscious clients, thereby gaining a competitive advantage in the market.

In conclusion, while the shipping industry faces significant challenges in transitioning to sustainable practices, these challenges are surmountable. By effectively managing Scope 3 emissions, communicating sustainability initiatives, and leveraging financial and technological opportunities, the industry can navigate these challenges and secure long-term growth. The shipping industry plays a crucial role in the global transition to a greener economy, and by embracing sustainability, it can lead the way toward a more responsible and prosperous future.

Executive Summary (Korean)

2020년, BlackRock의 CEO Larry Fink는 기후 변화 위험이 투자 위험임을 강조하며 ESG(환경, 사회, 지배구조) 요인의 중요성을 널리 알렸다. 2050년까지 120개 이상의 국가가 탄소중립을 목표로 하고 있으며, 이에 따라 해운업계도 이러한 변화에 적응해야 하는 도전 과제에 직면하고 있다.

해운업계는 점차 강화되는 환경 규제, 특히 국제해사기구(IMO)의 온실가스 배출 감축 목표에 대응해야 한다. IMO의 목표는 해운업체들에게 대체 연료 및 친환경 기술에 대한 투자 압박을 가중시키고 있다. 많은 해운업체들이 LNG, 바이오 연료, 그린 메탄올과 같은 대체 연료로의 전환을 시도하고 있으나, 대체 연료의 도입 및 운영은 막대한 자본 투자를 요구하며, 이는 공급망 전반에 걸쳐 비용 부담을 가중시킨다.

또한, 지속 가능한 기술 인프라의 부족도 큰 문제로 지적된다. 특히, 대체 연료 주유소와 같은 친환경 인프라가 충분하지 않은 실정에서 해운업체들이 글로벌 차원에서 일관된 친환경 솔루션을 제공하기 어려운 상황이다. CMA-CGM과 같은 선도 기업들은 다각적인 연료 전략을 통해 탈탄소화 목표를 달성하고 있으며, 규제 변화에 유연하게 대응하는 능력을 강화하고 있다. 이러한 기업들의 사례는 해운업계가 장기적인 성장을 위해 지속 가능한 전략을 채택할 필요성을 보여준다.

더불어, Scope 3 배출 관리와 같은 복잡한 환경적 도전 과제도 존재한다. 이는 기업의 공급망 전체에서 발생하는 배출을 의미하며, 복잡한 공급망 구조와 데이터의 정확성 문제가 지속 가능한 성장의 걸림돌로 작용하고 있다. 이러한 문제를 해결하기 위해서는 공급업체와의 협력이 필수적이며, 정확한 데이터 수집 및 분석 시스템이 필요하다. 이렇듯 많은 도전 과제가 존재하지만, 해운업계는 지속 가능한 성장을 촉진할 수 있는 다양한 전략들을 고려할 수 있다.

첫째, 많은 고객들이 해운업체들이 수행하고 있는 탈탄소화 노력에 대한 이해가 부족한 상황에서, 적극적인 홍보를 통해 ESG 투자에 대한 비용 부담을 유도할 수 있다. 고객들이 친환경적인 해운 솔루션을 위해 추가 비용을 지불하거나, 공동의 지속 가능한 목표를 지원하는 파트너십을 형성하는 것은 해운업체들이 탈탄소화 비용을 상쇄하는 데 도움을 줄 수 있다.

둘째, AI를 이용한 경로 최적화, 블록체인을 통한 공급망 투명성 제고, IoT를 통한 연료 소비 모니터링 등은 운영 효율성을 높이는 동시에 배출을 줄일 수 있다. 이러한 기술들은 실시간 데이터를 제공하며, 고객들에게 해운업계의 지속 가능성에 대한 노력을 투명하게 보여줄 수 있는 중요한 도구가 될 수 있다.

셋째, 녹색 금융의 활용은 해운업계가 지속 가능한 성장을 위해 활용할 수 있는 또 다른 기회이다. 정부 및 금융기관들이 지속 가능한 운영을 위해 다양한 재정적 지원을 제공함에 따라, 해운업체들은 보조금, 저금리 대출 등의 혜택을 통해 친환경 기술 투자 비용을 절감할 수 있다. 이를 통해 해운업체들은 비용 부담 없이 지속 가능한 기술을 도입하고,

탈탄소화 목표를 달성할 수 있는 기회를 마련할 수 있다.

결론적으로, 해운업계는 지속 가능한 성장을 위해 비용과 환경적 영향을 균형 있게 관리해야 한다. Scope 3 배출을 줄이기 위해 고객과의 협력을 통해 비용을 분담하는 전략이 중요하며, 이를 통해 지속 가능한 성장을 촉진할 수 있다.

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I. Introduction

1. Research Background

In 2020, BlackRock's CEO, Larry Fink, issued an annual letter emphasizing that climate change risk represents investment risk. This letter garnered widespread attention for highlighting the significance of ESG (Environmental, Social, and Governance) factors in investment decision-making, particularly emphasizing the pivotal role of Environmental Sustainability. Over 120 countries have committed to achieving Net-Zero and Decarbonization by 2050, signifying a global movement toward climate action.

Heightened public awareness and activism surrounding climate change issues have further underscored the urgency of addressing these challenges. The establishment of a more stringent regulatory framework and a growing global consensus on climate-related matters have become unequivocal. For companies, adapting to these changes is not merely a choice but an imperative necessity.

The global shipping industry plays an undeniable role in facilitating international trade, essential to the operations of the majority of manufacturing companies. It is estimated that over 90% of world trade is transported by sea, with cargo ships carrying essential goods ranging from grain and coffee to manufactured products and essential medical supplies, the shipping industry serves as the invisible backbone of international trade, connecting producers and consumers across continents.¹

However, the significant benefits of maritime transport come at a substantial environmental cost. The shipping industry is a major contributor to greenhouse gas (GHG) emissions, accounting for an estimated 3% of global CO₂ emissions annually, a seemingly small amount, however, the rapid growth rate of these emissions is a cause for serious concern.² In 2023, carbon emissions from international shipping had increased by 20% compared to levels recorded a decade earlier.³ These emissions primarily consist of carbon dioxide (CO₂), sulfur oxides (SO_x), and nitrogen oxides (NO_x).

These pollutants have a significant impact on climate change and its associated environmental problems, such as rising sea levels, ocean acidification, and extreme weather events. The burning of heavy fuel oils by ships releases not only CO₂, a major heat-trapping gas,

¹ <https://www.oecd.org/ocean/topics/ocean-shipping/>

² Greenhouse gas emissions and reduction strategies for the world's largest greenhouse gas emitter, Science of The Total Environment, 2024, 944, 173895.

³ Review of Maritime Transport 2023, UNCTAD

but also SO_x and NO_x, which contribute to acid rain and respiratory problems.⁴ This environmental footprint casts a long shadow over the industry's crucial role.

The urgency of addressing the climate crisis has prompted increased international focus on reducing emissions from all sectors, including maritime transportation. International organizations, national governments, and environmental groups are increasingly focusing on holding industries accountable for their environmental impact. As a result, the shipping industry faces growing pressure to adopt sustainable practices and reduce its greenhouse gas emissions.

The International Maritime Organization (IMO), the UN agency responsible for regulating international shipping, has implemented stricter emission standards, and is exploring even more ambitious regulations for the future. Continuing with business-as-usual practices poses significant risks for the shipping industry itself.

Climate change is anticipated to have significant implications for the shipping industry, including rising insurance costs, disruptions to trade routes, and shifting consumer preferences. First, the increasing frequency and severity of extreme weather events are expected to drive up the cost of insuring ships and cargo against damage and loss. Second, rising sea levels, melting polar ice caps, and more frequent storms may disrupt traditional shipping routes, resulting in longer transit times, higher fuel consumption, and potential damage to port infrastructure.

Finally, consumer preferences are shifting as environmental concerns grow. Consumers are increasingly demanding sustainable products, and this pressure is extending to the shipping industry. Companies that fail to adopt sustainable practices face the risk of losing both customers and investors, as the demand for environmentally responsible partners intensifies.

These factors could impact the profitability of shipping companies and slow down the smooth flow of global trade. In this context, sustainable growth becomes a critical challenge and opportunity for the shipping industry. Sustainable growth refers to the ability of companies to achieve long-term economic success while minimizing their environmental impact. This requires striking a balance between profitability, operational efficiency, and environmental responsibility.

2. Research Objective

This research explores the challenges and opportunities facing shipping companies in response to climate change regulations. It examines various sustainable growth strategies that can enable shipping companies to comply with regulations, reduce their environmental impact, and achieve long-term economic viability.

To achieve these objectives, this paper investigates the primary climate change

⁴ NO_x emissions as an indicator for sustainability, Environmental and Sustainability, 2022, 15, 100188.

regulations impacting the shipping industry, focusing on existing and forthcoming regulations established by international organizations such as the IMO, along with potential stricter standards from regional and national authorities.

Additionally, it explores the sustainable technologies and practices that shipping companies can adopt. This includes an examination of alternative fuels, advancements in ship design, operational efficiency measures, and industry-wide initiatives aimed at promoting sustainability.

Furthermore, this paper analyzes how these strategies can contribute to the industry's growth while ensuring compliance with regulations. It evaluates the cost-benefit implications of various approaches and their potential to enhance competitiveness in a future characterized by increasingly stringent environmental regulations. By addressing these critical areas, this paper aims to provide valuable insights for shipping companies navigating a landscape marked by significant environmental and regulatory changes.

II. Current Status

1. Current Status of the Shipping Industry ⁵

The global shipping industry continues to demonstrate its remarkable resilience in the face of ongoing challenges. While 2022 witnessed a slight dip in global ocean trade volume, likely a lingering effect of the COVID-19 pandemic, the industry is projected to experience a rebound in 2024. This growth signifies the sector's ability to adapt and recover from unforeseen circumstances. However, growth is likely to moderate in the medium term, potentially influenced by ongoing geopolitical tensions and a more cautious global economic climate.

One of the most significant trends reshaping the shipping landscape is the shift in global trade patterns. The war in Ukraine has had a profound impact on shipping routes, particularly for essential commodities like oil and grain. A growing trend of "reshoring" and regionalization is emerging, where countries are increasingly sourcing goods closer to home. This shift in focus has led to the adoption of new shipping routes, with average transportation distances for key commodities increasing. Beyond the immediate impact of the war, broader changes in globalization patterns are likely to influence shipping routes in the long term. Understanding and adapting to these evolving dynamics will be critical for shipping companies to remain competitive.

Perhaps the most pressing challenge facing the maritime industry is achieving a delicate balance: decarbonization while maintaining economic viability. Meeting stricter environmental regulations established by bodies like the IMO is essential. However, companies must also navigate the need to balance environmental goals with economic considerations. Finding innovative solutions that promote sustainability without compromising profitability will be key. This may involve investments in cleaner technologies such as alternative fuels and energy-efficient ship designs. Additionally, operational efficiency improvements through route optimization and shore power usage can contribute to reducing the industry's environmental footprint.

The container shipping sector faces a unique challenge: overcapacity. In simpler terms, there are currently more container ships available than there is cargo to be transported. This oversupply puts pressure on freight rates, potentially leading to a race to the bottom for shipping companies. Carriers may need to employ strategies like "slippage" (delaying scheduled sailings) and "vessel idling" (temporarily taking ships out of service) to manage capacity and maintain profitability. However, such measures can have a ripple effect, potentially impacting

⁵ Review of Maritime Transport 2023, UNCTAD

supply chains and delivery schedules. Finding a long-term solution to the overcapacity issue will require collaboration between shipping companies, regulatory bodies, and logistics providers.

The impact of the pandemic has also been unevenly felt across the industry. While most regions have seen improvements in global container shipping connectivity compared to the height of the pandemic, Small Island Developing States (SIDS) are lagging behind. Island nations that serve as regional transshipment hubs have shown some signs of recovery, but others remain significantly impacted. This uneven recovery underscores the need for targeted support to ensure that all nations, regardless of size or location, can benefit from global maritime trade. Investing in infrastructure development and fostering regional cooperation in the shipping sector can help bridge the gap and ensure a more inclusive maritime future.

The state of the global shipping fleet also presents a challenge. While the fleet is expanding at a moderate pace, with growth concentrated in container and oil tanker capacity, a concerning trend emerges: the aging of the fleet. Over half of all vessels are now more than 15 years old. This aging fleet presents challenges in terms of operational efficiency and environmental impact. Modernization efforts, with a focus on energy-efficient technologies, are crucial to improve operational efficiency and reduce emissions. Investing in retrofitting existing vessels and building new, cleaner ships will be essential for the industry to meet its environmental goals.

Finally, container freight rates, which experienced a significant surge in early 2022 likely due to pandemic-induced supply chain disruptions, have stabilized in 2023, returning to pre-pandemic levels. While this stabilization is a positive sign, it also indicates a potentially more competitive landscape for container shipping companies. Margins may be tighter, and companies will need to find ways to differentiate themselves through service quality, reliability, and a commitment to sustainability to attract and retain customers.

2. The Greenhouse Gas Emissions Status of the Shipping Industry

Earth's climate has always changed, but lately, it's warming much faster than usual. Since the industrial revolution, global temperatures have risen by about 0.9 °C, primarily driven by human activities that release greenhouse gasses like CO₂, methane, and nitrous oxide.⁶ This greenhouse effect traps heat, causing the planet to warm at an alarming rate. Rising temperatures have triggered a cascade of effects, including warming oceans, melting ice sheets, rising sea levels, ocean acidification, and extreme weather events.

⁶ The pathway to green shipping 2021, KPMG

While the global shipping industry navigates the rough waters of fluctuating trade patterns and geopolitical tensions, a far more pressing storm brews on the horizon: its undeniable contribution to greenhouse gas emissions. Accounting for nearly 3% of global CO₂ emissions in 2022, the sector's heavy reliance on fossil fuels for propulsion has placed it squarely in the spotlight of environmental concerns. This reality presents a critical challenge – the imperative to transition towards sustainable practices and decarbonize operations.

Greenhouse gas emissions from the international shipping sector, encompassing maritime transport alongside road, rail, and air travel, have been on a worrying upward trajectory. Estimates suggest a 5% increase in emissions from 2020 to 2022, returning the sector to pre-pandemic levels. This concerning trend calls for immediate action to transition towards more sustainable practices. To mitigate climate change, a significant reduction in carbon intensity – the amount of CO₂ emitted per unit of cargo transported – is essential. This translates to a fundamental shift away from traditional fossil fuels and a focus on cleaner, more environmentally friendly alternatives.

However, the transition towards green shipping is not without its challenges. Issues like ship recycling, waste management, and achieving the necessary emission reductions remain hurdles to overcome. The global fleet currently boasts over 105,493 vessels of 100 gross tons (GT) and above, with oil tankers, bulk carriers, and container ships accounting for 85% of total capacity, with more than half exceeding 15 years of age.⁷ Ship recycling practices often raise concerns about environmental pollution and worker safety, while outdated technologies hinder energy efficiency and contribute to higher emissions.

Furthermore, ensuring transparency in governance and tax practices is crucial to build trust with stakeholders. Collaborative efforts are needed to address these challenges, and the industry must be prepared to invest in research and development, infrastructure upgrades, and crew training for a successful transition. The journey towards decarbonization will require significant investments, technological advancements, and unwavering commitment, but the rewards of a cleaner future for the industry and the planet are undeniable.

3. Maritime Sector Environmental regulations and GHG Reduction Strategies

1) The EU: A More Stringent Approach

The EU has emerged as a global leader in pushing for stricter environmental regulations in the maritime sector. The European Commission plays a pivotal role in shaping the agenda, often advocating for stricter measures than those proposed by the IMO.

⁷ Review of Maritime Transport 2023, UNCTAD

- **EU Emissions Trading System (EU ETS):** The EU ETS is a carbon pricing scheme that has been in operation since 2005. It is the largest of its kind in the world and covers a wide range of industries, including power generation, energy-intensive industries, and aviation.

The EU ETS operates on a cap-and-trade system, where a cap is set on the total amount of greenhouse gases that can be emitted by covered entities. Allowances to emit are then distributed to these entities through auctioning and free allocation. Entities that emit more than their allocated allowances must purchase additional allowances from those who emit less.

In July 2023, the EU provisionally agreed to extend its Emissions Trading System (ETS) to cover maritime transport. This decision will require shipping companies operating within the EU to purchase emissions permits for their CO₂ emissions, potentially significantly increasing the cost of polluting voyages.

The EU's proposal to include the shipping industry in the EU ETS has sparked debate within the maritime sector. While the EU argues that this would level the playing field with other industries and reduce carbon emissions, the industry itself raises concerns about potential trade conflicts, the effectiveness of the scheme in reducing emissions, and the undermining of existing IMO regulations. Additionally, the challenge of obtaining accurate emissions data from ships poses a significant hurdle.⁸

- **Fuel EU Maritime:** This new EU regulation, adopted in 2023, sets increasingly ambitious targets for reducing the greenhouse gas intensity of fuels used by ships calling at EU ports. These targets will incentivize a shift towards cleaner fuels like LNG or biofuels in the long run.⁹
- **Stricter Emission Control Areas (ECAs):** The EU has existing ECAs in the Baltic Sea and North Sea with stricter sulfur content limits for marine fuels. The EU might further tighten regulations in these areas and potentially designate additional ECAs in environmentally sensitive regions.¹⁰

2) The International Maritime Organization (IMO) and its Regulatory Framework¹¹

⁸ <https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets-en>

⁹ [http://europa.eu/parl/eu/thinktank/en/document/EPRS_ATA\(2022\)733689](http://europa.eu/parl/eu/thinktank/en/document/EPRS_ATA(2022)733689)

¹⁰ <http://www.sustainable-ships.org/rules-regulations/>

¹¹ <https://www.imo.org/en/about/pages/default.aspx/>

The International Maritime Organization (IMO) is the specialized agency of the United Nations responsible for regulating international shipping. As the global body overseeing maritime safety and environmental protection, the IMO plays a critical role in setting emission standards for the shipping industry. In this section, some of the key IMO regulations affecting the industry will be examined.

MARPOL Annex VI (Energy Efficiency for Existing Ships): Adopted in 2009, MARPOL Annex VI established the Energy Efficiency Design Index (EEDI) for new ships. The EEDI is a technical requirement applicable to large, energy-intensive ships, aiming to release ships 30% more efficient than those built in 2014 by 2025. The EEDI sets mandatory CO₂ emission reduction targets for new ship designs, progressively becoming stricter over time. By implementing the EEDI, the goal is to release 30% more energy-efficient ships by 2025 compared to those constructed in 2014. This phased approach encourages continuous improvement in ship design and fuel efficiency.

The regulation also introduced the Ship Energy Efficiency Management Plan (SEEMP), requiring existing ships to develop a plan to improve operational efficiency and reduce fuel consumption. SEEMP allows shipping companies to optimize ship operations, such as optimizing speed, course changes, and installing heat recovery methods. It enables ongoing monitoring and improvement of energy efficiency throughout the ship's lifecycle.

IMO 2030 and 2050 Greenhouse Gas (GHG) Strategy: In 2023, the IMO adopted a revised GHG strategy with more ambitious targets. It aims to reduce GHG emissions from international shipping by at least 20% (striving for 30%) by 2030 compared to 2008 levels. Furthermore, the strategy sets a long-term target of achieving net-zero emissions from. This significant increase in ambition compared to previous targets will necessitate substantial changes within the industry.

The IMO regulations, particularly the tightening of emission reduction targets, will have a significant impact on shipping companies, as described below.

- **Increased Investment Costs:** Compliance with stricter emission standards may require investments in new technologies, such as cleaner fuels, exhaust gas cleaning systems (scrubbers), or energy-efficient ship designs. These upfront investments can be substantial, placing a financial burden on some companies.
- **Operational Changes:** Companies may need to adapt operational practices to meet efficiency targets. This could involve optimizing voyage planning, reducing sailing speeds, and exploring alternative routing options. These changes could potentially impact journey times and delivery schedules.

- **Fuel Price Fluctuations:** The transition to cleaner fuels like LNG or alternative fuels still under development introduces new variables to fuel costs. Companies will need to factor in potential price fluctuations and infrastructure availability for these fuels in their planning.

3) Korea: Aligning with International Standards and Domestic Ambitions

South Korea's approach to maritime environmental regulations is as follows.

- **Compliance with International Maritime Organization (IMO) Regulations:** As a member of the IMO, South Korea adheres to international regulations, such as MARPOL Annex VI (Energy Efficiency for Existing Ships) and the IMO 2030 and 2050 GHG Strategy. The tightening of emission reduction targets set by the IMO will have a significant impact on the Korean shipping industry, necessitating investments in cleaner technologies and operational efficiency improvements.
- **Domestic Initiatives for Enhanced Sustainability:** Recognizing the urgency of climate change, South Korea has implemented additional domestic regulations and strategies:
- **Roadmap for Decarbonization of the Domestic Shipping and Fisheries Sector (2020):** This roadmap outlines ambitious targets for domestic shipping, aiming to reduce GHG emissions by 70% compared to 2018 levels by 2050.
- **Focus on Green Ships:** The Ministry of Oceans and Fisheries (MOF) prioritizes the development and adoption of green ships. This includes promoting the use of LNG as a cleaner alternative fuel in the short term, while exploring long-term solutions like biofuels, hydrogen, and ammonia.
- **Emission Trading System (ETS) under Consideration:** While not yet implemented, the Korean government is actively considering the introduction of an ETS for the maritime sector. This system, similar to the one adopted by the EU, would require shipping companies to purchase emissions permits, potentially incentivizing a shift towards cleaner fuels and operational practices.

4) Ports

Currently, there are various ways ports encourage ships to emit fewer greenhouse gases (GHGs). One common method is through different fees, like the "environmentally differentiated

port fee," which about 28 out of the top 100 biggest ports use.¹² This fee reduces costs for ships that are considered eco-friendly, based on their characteristics. Some US ports offer incentives for ships that slow down near the port. The Panama Canal Authority gives priority to cleaner ships. In Spain, environmental considerations are part of the criteria for towing services. Shanghai has a system where ports and local ships trade emission rights, and Norway has a tax on nitrogen oxides (NOx).

5) Carbon Tax Implementation¹³

Although the EU ETS has been in existence and successful since 2005, carbon tax has emerged as a tool to fight against climate change. Finland was the first country to implement a carbon tax in January 1990, followed later by Singapore, Argentina, Japan. While both ETS and carbon tax put a price on carbon and generate revenue, a carbon tax appears to be the more suitable choice for the maritime sector due to its simpler implementation. Carbon taxes leverage existing tax infrastructure, eliminating the need for complex cap-and-trade systems and associated challenges like price volatility and the potential for fraud as seen in the EU ETS case.

Furthermore, carbon taxes offer inherent flexibility in adjusting emissions allowances year-on-year, a feature that can be difficult to achieve within an ETS framework. This flexibility is crucial for the shipping industry, allowing for gradual adaptation and investment in clean technologies.

Therefore, while a hybrid system combining elements of both might be considered, a global carbon tax implemented by the IMO presents a more feasible and effective short-term solution for the shipping industry. This approach leverages existing infrastructure, offers inherent flexibility, and can generate revenue to support the development and adoption of clean technologies, ultimately paving the way for a more sustainable future.

6) Shipping Companies Current Efforts and Actions

6-1) Development of alternative fuels in international shipping

The global shipping industry, consuming over 400 million tons of marine fuel annually, with demand projected to rise, the industry struggles with stricter regulations on sulfur content,

¹² Reducing shipping greenhouse gasemissions 2018, ITF-OECD

¹³ <https://earth.org/explainer-what-is-a-carbon-tax-pros-and-cons-and-implementation-around-the-world/>

pushing for cleaner options.¹⁴ Fuel costs, constituting a significant portion of operational expenses, further incentivize the search for sustainable solutions.

Fortunately, a range of promising alternative fuels exists. LNG, a popular fossil-fuel-based option, boasts lower CO₂ emissions compared to traditional fuels, but methane emissions are a growing concern. Infrastructure for LNG bunkering is expanding rapidly, making it a readily available choice for many ships. However, hydrogen emerges as the cleanest contender, producing zero carbon emissions when derived from renewable energy. Despite its potential, its high cost, challenging transportation and storage requirements, and evolving regulations pose hurdles to widespread adoption.

Wind propulsion, a technology with historical roots, offers a different approach. Utilizing wind energy through wind sails and rotors, it can significantly reduce fuel consumption on specific routes with favorable conditions. While not a universal solution, it presents a viable option for certain segments of a ship's journey. Batteries, while not currently capable of powering large vessels on their own, hold promise for smaller ships thanks to advancements in lithium-ion technology. Their potential is further enhanced when combined with other renewable energy sources like solar, which, despite limitations in energy density, can contribute to a ship's partial electricity needs.

Choosing the right path forward is definitely not easy. Each alternative fuel presents its own set of advantages and limitations in terms of environmental impact, cost, availability, infrastructure, and technical feasibility. Careful evaluation of these factors is crucial to determine the best solutions for different types of ships and routes. Continued research and development are paramount to improve existing technologies, making them more cost-effective and accessible.

Ultimately, the transition to a greener shipping industry needs collaborative efforts between governments, shipping companies, and technology developers. Policy support and incentives are essential to encourage wider adoption of sustainable fuels and technologies. By diversifying its fuel mix and embracing innovation, the shipping industry can chart a course towards significant reductions in greenhouse gas emissions, paving the way for a cleaner and more sustainable future.

6-2) Efficient technologies by shipping lines and ports for ship operations

The shipping industry is undergoing a digital revolution, using the power of technology to enhance efficiency, safety, and environmental performance. One key area of focus is data-driven decision making. Implementing smart ship technologies, which upgrade core ship

¹⁴ Review of Maritime Transport 2023, UNCTAD

systems, generates vast amounts of data on weather, navigation, and sensor readings. This data is crucial for optimizing ship operations, reducing fuel consumption, and ultimately minimizing greenhouse gas emissions.

Maritime autonomy, though still in its trial stage, holds immense potential for the future. Onboard computers equipped with advanced algorithms can make critical decisions about routes, speeds, fuel consumption, maintenance schedules, and even harbor mooring, leading to significant improvements in navigation, productivity, and overall efficiency.

Smart ports are another exciting development, utilizing artificial intelligence, big data, the internet of things (IoT), and blockchain technology to optimize operations and enhance shipping performance. Extensive research and trials are underway for both newly built unmanned vessels and retrofitting existing ships with autonomous capabilities.

Recognizing the transformative potential of these technologies, the IMO is actively considering incorporating maritime autonomy into its regulatory framework. This ensures safe, secure, and environmentally sound trials and operations, paving the way for a more sustainable and autonomous future for the shipping industry.

6-3) Transparency

The success of any business is often based on the trust and loyalty of its customers. In the shipping industry, where some elements have traditionally been concealed in secrecy, a push for greater transparency and accountability is gaining momentum, particularly in the face of increasingly stringent climate change regulations.

Customers expect clear visibility into factors that impact their shipments, such as ship location, arrival times, and any potential delays. While some shipping lines offer such information on their websites, there's room for further improvement. Hidden surcharges within shipping costs often leave customers with a distorted picture of the true price, making informed decisions about carriers difficult.

Digitalization is a powerful tool for the shipping industry, but its full potential can only be realized when coupled with transparency. Blockchain technology, for example, offers opportunities for enhanced transparency, particularly when tracking emissions and fuel consumption. This data can be crucial for demonstrating compliance with climate regulations and building trust with environmentally conscious stakeholders.

Transparency is not merely an expense; it's a crucial step towards building strong partnerships, achieving cost-efficiency throughout the supply chain, and demonstrating a commitment to sustainable practices. Claims that customers lack the ability to handle data are

often unfounded, as evidenced by initiatives like Hapag-Lloyd's smart container program¹⁵, which provides customers with real-time tracking and temperature monitoring capabilities. Additionally, logistics companies like Kobo360 and Airspace have demonstrated the value of transparency in expediting critical shipments during times of disruption.

Customers are demanding transparency, and the shipping industry must respond. By embracing openness and data accuracy, the industry can proactively manage supply chain disruptions, empower customers with informed decision-making about environmentally responsible carriers, and build stronger, more trustworthy relationships within the entire ecosystem. This shift towards transparency will not only benefit individual businesses but also contribute to a more efficient, resilient, and sustainable shipping industry as a whole. As climate change regulations tighten, transparent practices will be essential for shipping lines to demonstrate their commitment to environmental responsibility and secure a sustainable future.

6-4) ESG (Environmental, Social and Governance)

The concept of ESG, including Environmental, Social, and Governance factors, emerged in the early 2000s, driven by the recognition that responsible business practices contribute to sustainable markets and better societal outcomes. This framework has become a critical tool for investors evaluating companies, with ESG ratings influencing investment decisions.

For the shipping industry, ESG holds particular significance in the face of tightening climate regulations. Key environmental concerns include greenhouse gas emissions, compliance with regulations, marine pollution, and responsible ship recycling practices. Socially, the industry grapples with issues like labor rights, diversity, and safety. Governance concerns include transparency, anti-corruption measures, and political accountability.

While ESG ratings vary across industries, the shipping sector faces specific challenges related to corruption, sanctions, human rights, recycling practices, waste management, and emissions. Integrating ESG into their business models is crucial for shipping companies, as investors increasingly prioritize sustainable practices. Studies show a rising trend in ESG-focused investments, with companies demonstrating strong ESG performance often attracting better talent, generating long-term value, and achieving superior financial results.

Transparency plays an important role in ESG integration. Reputational damage can be wide-spread in today's information age, making transparency a necessity for companies to maintain trust with stakeholders. Banks, for example, utilize ESG factors like emissions data

¹⁵ <https://www.hapag-lloyd.com/en/services-information/cargo-fleet/container-monitoring/overview.html>

potentially impacting lending decisions, high ESG-rated firms are more likely to receive a bank loan, and these loans come with lower interest rates.¹⁶

While the ultimate goal of achieving sustainability in the shipping industry remains a topic of discussion, integrating ESG principles offers a clear path forward. Implementing responsible ship recycling practices, investing in research and development of clean technologies, and exploring alternative fuels like wind power are all crucial steps. The question remains whether the industry will adopt these long-term solutions or prioritize short-term gains. Regardless, the increasing focus on ESG within the financial sector and growing public demand for environmentally conscious practices necessitate a significant shift towards a more sustainable future for the shipping industry.

6-5) Sustainability into long-term business plan of shipping lines

Shipping companies are actively taking steps towards reducing their environmental impact and achieving sustainability. These efforts demonstrate a growing commitment within the shipping industry to transition towards a greener future, even though further research and collaboration are necessary to fully achieve carbon neutrality.

Maersk, the world second largest shipping company, announced their ambitious goal to become carbon-neutral by 2050 by reducing emissions by 50% by 2030 and 90% by 2040, ultimately leading to complete carbon neutrality by 2050. This initiative reflects their commitment to sustainability and reducing their environmental impact. To achieve this target, Maersk is investing heavily in a range of sustainable technologies and practices designed to mitigate its environmental impact. This includes the development and deployment of energy-efficient vessels equipped with advanced propulsion systems, hull designs, and onboard technologies to optimize fuel consumption and minimize emissions. Additionally, Maersk is exploring alternative fuels such as biofuels, hydrogen, and ammonia as viable substitutes for traditional fossil fuels, with ongoing research and development efforts focused on enhancing the scalability and affordability of these solutions.

Operational efficiency is another cornerstone of Maersk's sustainability strategy, with a focus on optimizing logistics processes to reduce emissions throughout the supply chain. This involves initiatives such as route optimization, vessel speed management, and improved container utilization to maximize cargo capacity and minimize the environmental footprint per unit of goods transported. Furthermore, Maersk is leveraging digital technologies and data analytics to enhance visibility and transparency across its operations, enabling real-time monitoring and optimization of energy consumption and emissions.

¹⁶ Corporate ESG Profiles and Banking Relationships, The Review of Financial Studies, 2021, 35(7)

CMA-CGM, the world 3rd largest shipping company, is also committed to achieving carbon neutrality by 2050 and is implementing a multi-faceted strategy to meet this target. CMA-CGM has already started operating LNG-powered vessels, which significantly reduce emissions compared to traditional fossil fuels, and is investing in next-generation alternative fuels such as biofuels and green methanol. The company aims to reduce its overall emissions by 40% by 2030. To support these efforts, CMA-CGM is building new, sustainable vessels and upgrading its existing fleet with eco-friendly technologies.

CMA-CGM also places a strong emphasis on operational efficiency to accelerate decarbonization. By introducing smart ship technologies that monitor fuel consumption and optimize routes in real time, the company maximizes fuel efficiency while minimizing emissions. Additionally, digital innovation plays a crucial role in enhancing visibility and efficiency across the supply chain, allowing CMA-CGM to communicate its sustainability efforts transparently to its customers.

Operational efficiency is another cornerstone of both Maersk's and CMA-CGM's sustainability strategies, with a focus on optimizing logistics processes to reduce emissions throughout the supply chain. This involves initiatives such as route optimization, vessel speed management, and improved container utilization to maximize cargo capacity and minimize the environmental footprint per unit of goods transported. Furthermore, Maersk is leveraging digital technologies and data analytics to enhance visibility and transparency across its operations, enabling real-time monitoring and optimization of energy consumption and emissions.

Another shipping line, Hapag-Lloyd also recognizes the importance of operational efficiencies and sustainable practices in reducing greenhouse gas emissions in the maritime industry. One key aspect of their strategy involves retrofitting vessels with cleaner technologies such as LNG and biofuels. By retrofitting their vessels to use LNG as fuel, Hapag-Lloyd can significantly reduce their environmental footprint and comply with increasingly stringent emissions regulations. In addition to LNG, biofuels, derived from renewable sources such as plant oils or waste materials, offer the potential to diversify their energy sources and move towards a more sustainable and environmentally friendly shipping operation.

Besides, Hapag-Lloyd is also committed to responsible ship recycling practices. Ship recycling is a critical aspect of sustainability in the maritime industry, as it ensures the safe and environmentally sound disposal of end-of-life vessels. By responsibly recycling older vessels at the end of their operational life, Hapag-Lloyd minimizes the environmental impact of its fleet and promotes the circular economy in the maritime sector.

III. Research Methodology

This research methodology outlines a plan to investigate sustainable growth strategies for shipping companies in response to climate change regulations. It will employ a mixed-method approach, combining qualitative data from interviews with quantitative data collection methods. This approach aims to provide comprehensive insights into current ESG practices, challenges in Scope 3 emissions management, and effective data collection methodologies.

In this research, a small-scale purposive sampling method was employed to select participants in order to obtain diverse information relevant to the research topic. This method is suitable for selecting participants with rich experiences and diverse perspectives, considering the objectives of the research. Specifically, focusing on shipping companies and customers was crucial in investigating topics related to sustainability in the shipping industry. This approach facilitated the acquisition of various perspectives and specialized knowledge necessary for the research.

1. Target Audience

- 1) **Shipping Companies:** This includes executives, decision makers and sustainability managers within shipping companies of all sizes. They are directly impacted by climate change regulations and need actionable strategies to achieve sustainable growth.
- 2) **Customers, both beneficial cargo owners and freight forwarders:** This also includes executives, logistics managers, supply chain managers, procurement managers and sustainability managers

2. Data Collection Methods

This research employed a qualitative research approach, conducting in-depth face-to-face interviews as well as case studies for profound analysis. This combination facilitated a comprehensive investigation into the subject matter, allowing for rich insights and understanding. Despite limitations in sample size and data collection methods, this study is anticipated to provide valuable insights into sustainable growth strategies for the shipping industry in response to climate change.

Conduct multiple in-depth interviews (30 minutes) with 10 experts from both shipping companies and customers (Beneficial cargo owners and Freight Forwarders). Utilize a semi-

structured interview format with a predefined questionnaire to ensure consistency while allowing for probing follow-up questions.

As shown in Table 1, survey plan was established by comparing the position of the shipping companies and the customers, the factors of influence, and the necessary strategies.

Table 1. Summary of the key characteristics to select the target groups.

	Shipping Companies	Export and Import Customers (Beneficial Cargo Owners and Freight Forwarders)
Position	Executives, decisions makers, sustainability managers	Executives, logistics managers, supply chain managers, procurement managers, sustainability managers
Influence Factor	Directly impacted by climate change regulations	Sensitive to factors influencing the selection of a shipping company
Strategy	Required feasible strategies for sustainable growth	Acknowledging the importance of choosing a sustainable logistics partners

3. Scope 1, 2, and 3 Emission Explanation

In order to ensure the interviewees, understand the full scope of this research, it is critical to clarify the concepts of scope 1, 2, and 3 emissions, which are central to the research.

- 1) **Scope 1 Emissions:** These are direct emissions from owned or controlled sources. For shipping companies, this would typically include emissions from fuel combustion in ships, vehicles, and other operational machinery that is directly under the company's control.
- 2) **Scope 2 Emissions:** These are indirect emissions from the generation of purchased energy. In the shipping industry, this might refer to the electricity or other forms of energy consumed by offices, terminals, and warehouses.
- 3) **Scope 3 Emissions:** These are all other indirect emissions that occur in a company's value chain, both upstream and downstream. For shipping companies, this includes emissions from the production and transportation of fuels, emissions from the operation of vessels owned by subcontractors, and emissions from customers' use of the services, such as transporting goods.

Understanding these categories of emissions is essential for participants in the study, as Scope 3 emissions are the most challenging to manage, requiring extensive data collection,

collaboration, and verification methodologies and the most relevant with this research since ocean transportation is categorized as the scope 3 emission.

4. Questionnaire Design

The questionnaire was designed for the following purposes, and more specific insights could be obtained through in-depth analysis of the survey results.

- 1) **Analysis of shipping companies' Sustainable Growth Strategies:** Based on the results of the interviews and surveys, shipping companies' strategies to achieve sustainable growth in response to climate change regulations can be derived. These strategies can address a variety of aspects, including increasing energy efficiency, introducing green fuels, and reducing carbon emissions.
- 2) **Customer perception and needs research:** This may include the perception of climate change and the resulting needs from your customers' perspective. For example, the preference for environmentally friendly options, awareness of the company's environmental responsibility, and more.
- 3) **Understanding current sustainability-related policies and regulations:** This methodology can determine companies and customers' understanding of current climate change regulations and sustainability-related policies through interviews and surveys. This can address awareness of companies' response strategies to government policy changes and changes in customer demands.
- 4) **Analysis of key trends and development potential:** Based on the collected data, development potential of companies and customers can be analyzed. This can address a variety of aspects, including introducing new technologies, exploring collaboration possibilities.

The following Table 2 summarizes the possible outcomes for each survey item, and Appendix shows the questionnaire for the interviews with shipping companies and customers

Table 2. Summary of the possible outcomes for each survey item

I. Background Information	
Question	Possible Outcomes
Current roles and organizations	Consider the different roles in their industries
Career years	Consider the career-level of interviewee

ESG Department/Activities	Understand the status of ESG activities
Scope 1,2 and 3 awareness and progress	Evaluate the awareness and progress regarding Scope 1,2 and 3
II. Current Sustainability Practices	
Question	Possible Outcomes
Whether and what sustainability initiatives are in place	Identify sustainability initiatives such as fuel efficiency, alternative fuels, operational optimization, and more
Key driving factors	Identify key motivations such as regulatory pressures, cost reductions, and environmental concerns
Main challenges	Identify main challenges such as technological limitations, financial constraints, regulatory uncertainty, operational disruptions and lack of expertise
Current practice for Scope 1,2 and 3	Assess current methods and practice in place for Scope 1,2, and 3
Identification and categorization for Scope 3 emissions	Categorize different sources of Scope 3 emissions
Methodologies to verify for Scope 3 emissions	Evaluate methodologies for verifying Scope 3 emissions
Data collection process for Scope 3 emissions measurement	Analyze the data collection process for measuring Scope 3 emissions
Tools and technologies of data collection for Scope 3 emissions	Identify tools and technologies used in data collection for Scope 3 emissions
Verification methodologies of data accuracy and consistency for Scope 3 emissions	Ensure data accuracy and consistency in Scope 3 emissions reporting
Scope 3 emission calculations by category from upstream and downstream flows	Provide detailed calculation of Scope 3 emissions by category
Visibility of CO ₂ emissions and platform	Enhance the visibility of CO ₂ emission through specific platforms
Indication of ESG in the process of procurement or weight on ESG	Understand the importance and utilization of ESG
Whether the customer has ESG requirements	Understand customer needs
III. Impact of Climate Change Regulations	
Question	Possible Outcomes
Most significant climate change regulations	Evaluate impact of regulations such as EU ETS, IMO, US and Korean government policies

Impact of climate change regulations on the shipping industry	Predict the influence of these regulations on future competitiveness
Strategies to achieve long-term sustainability goals	Understand strategies for regulatory compliance and achieving sustainability
Countries with major impact	Assess which countries have the most significant regulatory influence
IV. Future Outlook and Strategies	
Question	Possible Outcomes
Scope 3 emissions management and reduction challenges	Identify key challenges in managing and reducing Scope 3 emissions
Areas of potential for improvement	Propose ways to improve emissions measurement and verification processes.
How to improve regulation	Suggest regulatory improvements that encourage sustainable practices.
Long-term sustainability goals	Identify and benchmark long-term sustainable goals
Environmental footprint reduction strategies	Highlight strategies such as adopting new technologies, improving operational efficiency, and using alternative fuels.
Importance of collaboration among shipping companies, policymakers, and other stakeholders for sustainability practices	Assess the importance of collaboration among stakeholders for sustainable practices
Specific actions to incentivize from policymakers	Propose policy measures that could incentivize sustainability.
V. Additional Comments	
Question	Possible Outcomes
Additional comments	Provide further sustainability insights

5. Data Analysis Methods

The data analysis for this research will involve both qualitative and quantitative techniques, allowing for a comprehensive examination of the shipping industry's response to climate change regulations. The qualitative data, derived from in-depth interviews with industry

experts and stakeholders, will be analyzed using thematic analysis. This method will identify recurring patterns and themes related to sustainability challenges, technological adoption, and regulatory compliance. Thematic coding will be applied to the interview transcripts to categorize the data into key areas, such as Scope 3 emissions management, the impact of alternative fuel adoption, and stakeholder collaboration.

Also, a comparative analysis will be conducted to assess the differences between shipping companies that have fully embraced sustainable practices and those that are lagging. This will be done by comparing their operational efficiency, cost structures, and compliance with environmental regulations. The findings will provide a comprehensive overview of the strategic choices available to shipping companies and their potential for long-term growth in a heavily regulated environment.

6. Expected Outcomes

The expected outcomes of this research will contribute significantly to the understanding of how the shipping industry can adapt to and thrive under increasingly stringent climate change regulations. Firstly, the research is anticipated to identify the most impactful climate regulations affecting the industry, with a particular focus on how international and regional policies are shaping corporate strategies. Insights into the specific challenges posed by these regulations, including compliance costs and operational disruptions, will be highlighted.

The research is also expected to provide a detailed examination of the sustainable technologies and practices currently being adopted by leading shipping companies. This will include an assessment of alternative fuels such as LNG and biofuels, along with innovations in ship design and route optimization technologies. The outcomes will emphasize the cost-effectiveness of these solutions and their potential to reduce the industry's carbon footprint, while also addressing practical barriers to widespread adoption, such as infrastructure availability and technological limitations.

Moreover, the findings will highlight the critical importance of managing Scope 3 emissions, revealing how advanced data collection and verification methodologies can enhance sustainability reporting. The research is expected to underscore the role of stakeholder collaboration (especially between shipping companies, suppliers, and customers) in achieving sustainability goals. It will also reveal the knowledge gaps among customers regarding the shipping industry's environmental efforts, suggesting opportunities for better communication and shared responsibility in implementing green logistics solutions.

Finally, the outcomes of this research will provide shipping companies with actionable insights on how to balance compliance with growth, offering a roadmap for integrating

sustainability into their core operations while maintaining competitiveness in the face of regulatory and market pressures. The findings will not only inform corporate strategy but also contribute to the broader discourse on sustainable development in the maritime industry.

IV. Data Analysis and Strategic Suggestions

1. Background of the Survey Participants and their Respective Companies

The interview involved a total of 10 participants, categorized into the following roles: 3 Procurement Managers, 3 Logistics Managers, 2 Sustainability Managers, 1 CEO, and 1 Sales Manager. Notably, 80% of the interviewees have more than 10 years of work experience in the shipping industry. This long-term experience is critical because the topic of ESG is inherently complex and requires insights from various departments across different sectors.

The companies represented in the interviews include:

- 2 Technology Companies
- 2 Chemical Companies
- 3 Freight Forwarders
- 3 Ocean Carriers

Most of these companies are global players in their respective industries. Importantly, 7 out of the 10 companies have established ESG departments or designated ESG focal points. Companies with dedicated ESG teams are significantly more proactive in engaging with ESG initiatives, both internally and externally. Regarding the awareness of Scope 1, 2, and 3 emissions, most interviewees demonstrated a conceptual understanding but reported minimal progress in actual implementation. Although they are aware of the differences and requirements for Scope 1, 2, and 3, many acknowledged that there is a lack of recognition or clear action within their companies or among their customers.

- Roles & Organizations: Various roles contributed diverse insights from different industries, enhancing the understanding of how different sectors are engaging with ESG.
- Career Experience: The extensive experience of the participants allowed for deep discussions on the intricacies of ESG, particularly in relation to the shipping industry.
- ESG Activities: 70% of the companies have a formal ESG department or function, and these companies tend to be more proactive in addressing ESG concerns.
- Scope 1, 2, and 3 Awareness: Despite a clear understanding of ESG concepts, implementation lags behind, especially in the areas of Scope 3 emissions.

Most participants indicated that their companies are in the early stages of addressing

Scope 3 emissions. For companies in the Tech and Chemical sectors, supplier collaboration and data collection were highlighted as major barriers. Companies expressed difficulty in obtaining accurate and reliable data from suppliers, and there is no standardized approach for collecting Scope 3 emissions data.

2. Analysis Results for the Current Sustainability Practices

1) Current Practices for Shipping Companies

It has become evident that all three shipping companies interviewed are actively implementing various sustainability initiatives. These include placing orders for green vessels and exploring alternative fuels such as LNG, biofuels, green methanol, and ammonia, with plans for future fuel orders as well. This trend is not limited to the companies interviewed but is also being embraced by leading players across the shipping industry. Analysis for the current sustainability practices of Maersk, CMA-CGM, and MSC suggests that CMA-CGM's strategy, which balances short-term adaptability with long-term sustainability planning, offers the most robust framework for achieving decarbonization goals while effectively managing risks and securing future growth in a dynamic regulatory environment.

Strategies

- **Maersk:** Focuses on green methanol and has positioned itself as a leader in ship decarbonization, driving the concept of the green fleet. However, the actual number of methanol ships in operation or planned is relatively limited (24 ships, 384,000 TEU by 2028). The company tends to emphasize promotion and marketing over substantial large-scale investments. The following Fig.1 shows the comparison of sustainable fleet and capacities for shipping companies by 2028.
- **CMA-CGM:** As shown in Fig. 1, CMA-CGM prepares various fuel options, including methanol, LNG, and retrofitted methanol, and has a balanced decarbonization strategy for the medium and long term. This approach helps mitigate risks and allows flexibility in responding to future regulatory changes. The company focuses on large-scale investments rather than promotion, which strengthens its long-term preparation for decarbonization. CMA-CGM's emphasis on large-scale investments in decarbonization, rather than focusing on promotional activities, strengthens its ability to execute its sustainability goals. The company's proactive investments ensure it is prepared for future changes in the industry. Also, CMA-CGM fosters strong collaboration with customers to share the costs and responsibilities of ESG investments, enhancing long-

term partnerships and aligning with sustainability objectives.

- **MSC:** Primarily focuses on LNG, taking a different approach compared to Maersk. While LNG has a well-established infrastructure, providing stable supply, its CO₂ reduction potential is lower than that of Green Methanol. MSC is focused on medium-term regulatory compliance with LNG and adopts a relatively conservative approach compared to methanol.

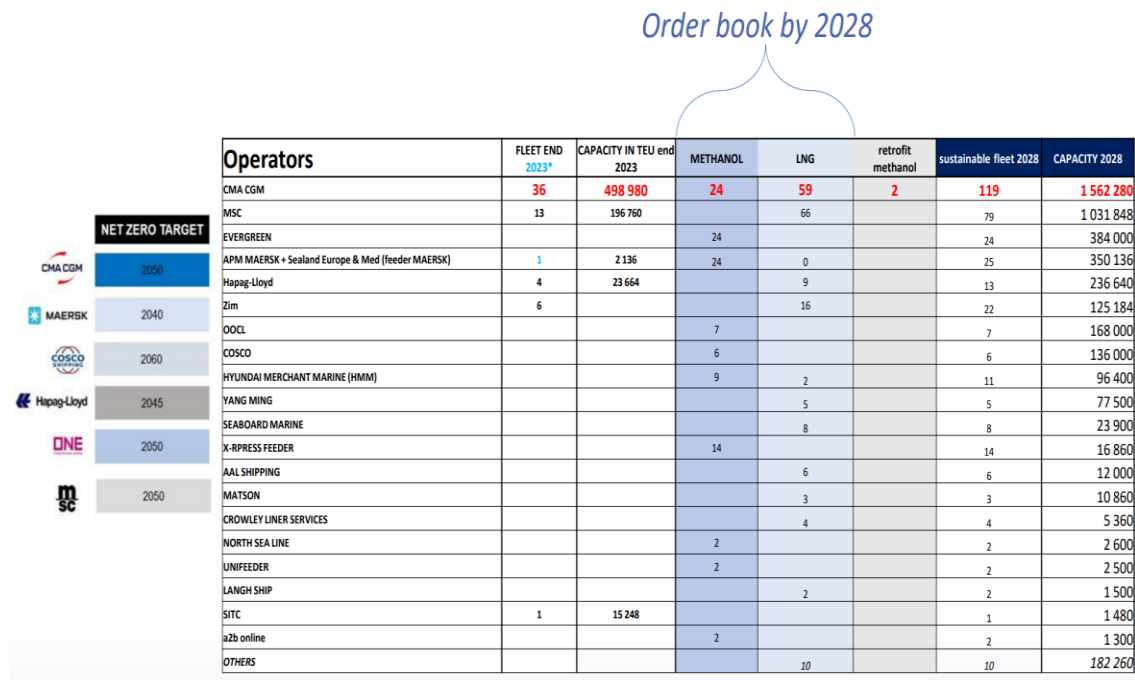


Fig. 1. Comparison of sustainable fleet and capacities for shipping companies by 2028

(Source: Order Book by 2028, Alphaliner, December 2023)

Fuel Choices

- **Maersk:** By focusing on Green Methanol, Maersk aims to reduce CO₂ emissions by 80~100%. However, there is a high risk due to uncertainties surrounding the supply and infrastructure for Green Methanol. Although this strategy holds long-term promise, the current lack of a robust supply chain may limit its immediate feasibility.
- **CMA-CGM:** The company has a diversified fuel strategy, adopting both methanol and LNG, which could reduce CO₂ emissions by 20~30% and potentially by 80~100% with Green Methanol. The combination of methanol and LNG allows for flexibility in adapting to different regulatory scenarios.
- **MSC:** With its primary focus on LNG, MSC has the potential to reduce CO₂ emissions by 20~30%. Although LNG is a well-established and stable technology, it offers lower long-term decarbonization potential compared to methanol.

Risk Management

- **Maersk:** The focus on Green Methanol presents risks related to supply and infrastructure uncertainties. As demand for methanol fuel grows, there could be supply chain disruptions and rising costs. Maersk appears to be focusing more on promotion rather than presenting clear solutions to these challenges.
- **CMA-CGM:** By adopting a diversified fuel strategy, CMA-CGM effectively mitigates risks. The flexibility of using both methanol and LNG allows the company to switch to alternative fuels if one supply chain becomes unstable. This balanced approach is the most robust in terms of risk management.
- **MSC:** While focusing on LNG offers stable supply due to well-established infrastructure, the lower CO₂ reduction potential compared to methanol could limit its ability to meet long-term decarbonization goals.

Investments and Execution Capacity

- **Maersk:** The company places significant emphasis on promotion, highlighting the potential of Green Methanol, but lacks substantial large-scale investments. This approach may be effective in the short term but could be criticized for its lack of execution power.
- **CMA-CGM:** The company is actively making investments and implementing decarbonization plans, which goes beyond mere promotion. From a long-term perspective, CMA-CGM's investment strategy appears to be the most ideal.
- **MSC:** Focusing on LNG seems to be suitable for achieving medium-term decarbonization goals. However, compared to methanol, the long-term investment efficiency may be lower.

Long-term Sustainability

- **Maersk:** The strategy focusing on Green Methanol holds the most potential for meeting long-term decarbonization goals. However, concerns about the supply chain and infrastructure raise questions about long-term feasibility.
- **CMA-CGM:** The strategy of using both methanol and LNG ensures long-term sustainability in various scenarios. CMA-CGM is preparing the most options and is well-positioned to respond flexibly to future regulations.
- **MSC:** While LNG is currently stable and a proven fuel, it may have limitations in achieving long-term decarbonization goals compared to Green Methanol.

Customer Relationships and ESG Strategies

- **Maersk:** Maersk's focus is more on promotion than on collaborating with customers, which could result in a lack of mutual understanding with clients regarding ESG initiatives.
- **CMA-CGM:** By actively collaborating with customers, CMA-CGM is likely to establish a long-term partnership for sharing costs and responsibilities related to ESG investments. This is a crucial strategic element in ensuring sustainability through ESG investments.
- **MSC:** While the LNG-based strategy aligns with current ESG goals, it may not achieve the same long-term decarbonization results as fuels like methanol.

2) Current Practices for Manufacturing Companies

While shipping companies are focusing on Green Vessel and alternative fuels related initiatives, the other manufacturing companies interviewed in Tech and Chemical sectors are also actively promoting various sustainability initiatives.

Strategies for Tech Companies

- Focus on energy savings through energy-efficient production processes and the adoption of renewable energy sources. Both companies have committed to reducing carbon emissions across their global operations, with a focus on enhancing the energy efficiency of their manufacturing plants and products
- For instance, one of them has integrated solar panels into its facilities and aims to transition to 100% renewable energy in certain regions by 2050 and also another one has similar goals, with its "Zero Carbon 2030" initiative that focuses on reducing carbon emissions and adopting renewable energy solutions.
- Both companies have invested heavily in the development of eco-friendly products, such as energy-efficient LED lighting, smart appliances, and electronics with reduced environmental footprints.
- Energy savings are achieved by implementing energy-efficient technologies, upgrading production lines, and installing LED lighting in manufacturing facilities.
- Both companies have also focused on reducing energy consumption through AI-based solutions for smart energy management in their products.

Strategies for Chemical Companies

- Chemical companies focus on emissions control and energy savings in their production

processes.

- The company has made significant investments in energy-efficient technologies, including cogeneration plants and process optimization. They have focused on minimizing environmental impacts from chemical production. Energy-saving measures, waste management initiatives, and low-carbon production technologies have been key elements of their sustainability strategy.
- Both chemical companies focus on energy-efficient production techniques. One company, for example, uses advanced processes for heat recovery, reducing the overall energy footprint of their manufacturing operations.
- The other one has also implemented energy-saving measures by using energy-efficient machinery and focusing on reducing the carbon footprint of its operations through innovation in low-energy chemical production.

This analysis highlights the key sustainability strategies and initiatives that both tech and chemical companies are employing, much like the shipping liners, to drive decarbonization, energy savings, and compliance with future regulations. The focus is on energy-efficient production, the adoption of alternative fuels, and risk management, with long-term goals aligning towards more sustainable business models.

3) Key Drivers for Sustainability Initiatives

From the interviews conducted, it has become clear that regulatory pressure is the primary driver behind the sustainability initiatives being implemented by tech and chemical companies, as well as shipping liners. Of the respondents, 40% identified regulatory pressure as the key motivator, indicating that businesses are preparing for stricter environmental regulations expected in the near future. Customer demand was the second most cited driver at 20%, showing that customers are increasingly prioritizing sustainability in their purchasing decisions. Finally, brand reputation accounted for 10%, demonstrating that companies are aware of the growing importance of ESG performance for their brand image.

- **Regulatory Pressure:** 40% of the interviewees emphasized regulatory pressure as the main driver. This suggests that many companies are recognizing the importance of future-proofing their operations by proactively aligning with upcoming environmental regulations. Industries, especially in tech and chemicals, anticipate stricter requirements, and companies are starting to invest in sustainable technologies and processes to comply with these.

- **Customer Demand:** 20% of respondents mentioned that customer demand is pushing them toward sustainable practices. Customers, particularly B2B clients, are increasingly seeking out suppliers and partners that have a strong commitment to sustainability. This is especially true in global supply chains, where sustainability credentials are becoming a differentiator.
- **Brand Reputation:** 10% of respondents, sustainability initiatives are driven by brand reputation. In industries where public perception matters, companies are adopting environmentally responsible practices not just to comply with regulations but to enhance their market position and consumer trust.

4) Key Challenges for Sustainability Practices

The survey also revealed the significant challenges that companies face in scaling up their sustainability practices. These are:

- **Financial Constraints (50%):** The top challenge, identified by 50% of interviewees, is financial constraints. Many companies do not yet have the necessary budget allocation to fully implement sustainability initiatives, which are often capital-intensive. Retrofitting facilities, upgrading technology, or switching to renewable energy sources can require significant upfront investment, which can be difficult for companies to justify without clearer financial returns.
- **Regulatory Constraints (30%):** Another 30% of respondents highlighted regulatory constraints as a major challenge. This indicates that many companies are struggling with a lack of clarity or visibility on future regulatory changes. This uncertainty makes it difficult for businesses to plan and allocate resources effectively, as they are unsure of the specific requirements they will need to meet. It also suggests that some companies are hesitant to invest heavily in sustainability without clear guidelines from regulatory bodies.
- **Key Takeaways:**
 - **Proactive Investment in Sustainability:** While regulatory pressure is a primary driver, the lack of clear regulations has left many companies reluctant to fully commit. For tech and chemical companies, a proactive investment strategy, even in the face of uncertainty, can help ensure they are not caught off-guard when new regulations are enforced.
 - **Financial Planning and Support:** Companies will need to address the financial challenges posed by sustainable initiatives. Governments and regulatory bodies could help ease this burden by offering subsidies, tax breaks, or green financing

options, making it easier for businesses to invest in sustainability.

- **Customer and Market Trends:** Although regulatory compliance is key, growing customer demand for sustainable products indicates that companies could benefit from expanding their sustainability programs. Aligning their strategies with customer expectations will likely lead to stronger market positioning and long-term competitiveness.

This analysis highlights that regulatory pressure and financial challenges are critical factors that must be addressed to ensure companies can effectively scale up their sustainability initiatives.

5) Current Practices for Scope 1 Emissions

To prioritize key actions and strategies for managing Scope 1 emissions in the interviewed companies, the following order of priorities is summarized, based on typical industry practices and the potential impact of each activity on emissions reduction and regulatory compliance:

- A. Direct Emission Measurement-Fuel Consumption Tracking:** Direct tracking of fuel consumption is critical for any company aiming to monitor and reduce Scope 1 emissions. It is the most immediate and actionable source of emissions data and allows for direct control over emissions from on-site fuel use.
- B. Emission Reduction Strategies- Energy Efficiency Initiatives:** Energy efficiency initiatives are one of the most cost-effective ways to reduce emissions. These initiatives can significantly lower fuel consumption and emissions without major capital investment compared to renewable energy integration.
- C. Emission Reduction Strategies- Renewable Energy Integration:** Integrating renewable energy sources reduces dependency on fossil fuels, directly reducing Scope 1 emissions. It is typically more capital-intensive but highly impactful in the long term.
- D. Direct Emission Measurement-On-Site Emissions Monitoring:** Monitoring emissions directly on-site, whether from manufacturing plants or operations, helps provide accurate data for compliance and reporting. It's essential to validate emissions tracking and ensure reductions are being achieved.
- E. Reporting and Compliance- Regulatory Compliance:** Ensuring compliance with local and international regulations is critical to avoiding penalties and keeping operations in line with future legislative changes. Many industries are facing increasing regulatory pressures, making this a high priority.

By focusing first on fuel consumption tracking and energy efficiency initiatives, companies can achieve immediate reductions in Scope 1 emissions, while compliance, reporting, and employee engagement ensure long-term success and sustainability.

6) Current Practices for Scope 2 Emissions

For Scope 2 emissions, which typically relate to indirect emissions from purchased electricity and energy use, prioritization should focus on reducing energy consumption and transitioning to cleaner energy sources. Based on the interviews, the results of prioritizing Scope 2 emissions management can be summarized as follows.

- A. **Energy Efficiency Measures- Energy Efficiency Programs:** Energy efficiency programs are the most immediate and cost-effective way to reduce Scope 2 emissions. Implementing these programs can directly reduce the amount of electricity consumed, lowering overall emissions without needing major infrastructure changes.
- B. **Energy Consumption Tracking- Electricity Usage Monitoring:** Monitoring electricity usage is crucial for understanding the company's energy consumption patterns and identifying areas for improvement. Precise tracking allows companies to manage energy use efficiently and supports the optimization of energy efficiency programs.
- C. **Renewable Energy Procurement- Direct Renewable Energy Sourcing:** Directly sourcing renewable energy (such as wind or solar) is one of the most effective ways to reduce Scope 2 emissions. While it often requires upfront investments and changes in supplier relationships, it offers significant long-term emissions reductions and supports energy security.
- D. **Energy Efficiency Measures-Energy Audits and Assessments:** Conducting energy audits helps identify inefficiencies and areas for improvement within existing operations. These audits are essential for planning effective energy-saving measures and ensuring the company's energy use is optimized for minimal emissions.
- E. **Renewable Energy Procurement-Renewable Energy Certificates:** Procuring RECs allows companies to support renewable energy projects indirectly. While it may not reduce energy consumption on-site, it helps offset emissions from purchased electricity and supports the growth of renewable energy globally.

This prioritization reflects a focus on reducing energy consumption and sourcing cleaner energy, while ensuring compliance and reporting standards are maintained. By prioritizing energy efficiency programs, direct renewable sourcing, and thorough energy consumption

tracking, companies can achieve significant reductions in their Scope 2 emissions

7) Current Practices for Scope 3 Emissions

For Scope 3 emissions, which encompass indirect emissions throughout the value chain (both upstream and downstream), prioritization should focus on improving data collection, engaging suppliers, and implementing reduction strategies. The following is the proposed priority list based on the potential impact and feasibility of each action, as derived from the interview.

- A. **Data Collection and Supplier Engagement-Supplier Surveys and Collaboration:** Collaboration with suppliers is the foundation of Scope 3 emissions management. Supplier surveys help gather data on emissions throughout the value chain, which is crucial for identifying areas for improvement and enabling emissions reduction initiatives. Without accurate data from suppliers, it is difficult to manage Scope 3 emissions effectively.
- B. **Emission Reduction Strategies-Sustainable Procurement Policies:** Sustainable procurement policies directly influence the carbon footprint of the value chain by prioritizing low-carbon materials and services. These policies enable companies to select suppliers who are committed to reducing emissions, thereby driving significant long-term reductions in Scope 3 emissions.
- C. **Emission Reduction Strategies-Supplier Improvement Programs:** Helping suppliers improve their sustainability practices can lead to significant reductions in upstream emissions. Supplier improvement programs encourage best practices, such as adopting energy-efficient technologies or transitioning to renewable energy and are a direct way to reduce emissions across the value chain.
- D. **Lifecycle Assessment-Lifecycle Assessment (LCA):** LCAs provide a comprehensive view of the environmental impact of products throughout their life cycle, from raw materials to disposal. By conducting LCAs, companies can identify emissions hotspots and opportunities for improvement, making this a critical tool for Scope 3 management.
- E. **Technology and Innovation- Advanced Analytics and Tools:** Advanced analytics and tools can significantly enhance data collection, monitoring, and emissions tracking. These technologies streamline the process of gathering and analyzing Scope 3 data, making it easier to identify trends, predict future emissions, and take targeted actions for reduction.

This prioritization reflects a balance between data collection, supplier engagement, and

emission reduction strategies to manage Scope 3 emissions effectively. Engaging suppliers and implementing sustainable procurement policies are prioritized because they have the most direct impact on reducing emissions across the value chain.

8) Ocean Transportation as a Key Aspect of Scope 3 Emissions

In the context of Scope 3 emissions for companies interviewed, most of the companies 50% of interviewed answered that ocean transportation may not be considered a foundational element of their Scope 3 emissions with several reasons.

- A. Proportion of Emissions:** For many manufacturing and production companies, the majority of Scope 3 emissions are generated upstream in the supply chain (e.g., raw material extraction, production processes, energy consumption) and downstream during the use and disposal of products. While ocean transportation is a component of logistics, its share of total Scope 3 emissions may be relatively smaller compared to other activities like material sourcing, product usage, or waste management.
- B. Indirect Impact:** Ocean transportation is typically managed by third-party logistics providers or shipping companies, making it an indirect contributor to Scope 3 emissions. These emissions are more difficult to directly influence compared to upstream processes, like selecting low-carbon materials or improving energy efficiency within manufacturing plants.
- C. Focus on Key Leverage Points:** When companies prioritize emission reduction efforts, they tend to focus on areas where they have the greatest control or where the potential impact is highest. For many production companies, this means focusing on supplier engagement, sustainable procurement, and improving product design or lifecycle assessments. Ocean transportation, while significant, may be seen as less impactful compared to addressing emissions at the source (raw materials, energy consumption, etc.).
- D. Regulatory and Market Pressure:** Many companies face regulatory and market pressures to reduce emissions in areas closely tied to their operations and products, such as energy usage, production processes, and product end-of-life management. Ocean transportation, being part of the broader logistics sector, may not be directly regulated or as closely scrutinized under typical environmental standards for manufacturing firms.
- E. Focus on Emission Reduction at the Source:** Companies often prioritize decarbonizing their core operations—such as manufacturing, product design, and energy usage—over reducing emissions in areas they don't directly manage, like third-party shipping. The idea is that reducing emissions at the source may lead to more

significant long-term reductions.

- F. Availability of Low-Carbon Alternatives:** In many industries, reducing emissions in areas like procurement or manufacturing processes may offer more immediate and viable solutions compared to tackling ocean transportation, which depends on the wider adoption of green shipping technologies

While ocean transportation does contribute to Scope 3 emissions, companies may view it as a secondary or less controllable aspect of their emissions profile compared to upstream and downstream processes that they can directly manage or influence.

9) ESG Weight in Bidding & Procurement

The purpose of this question was to understand how companies are integrating Net Zero and decarbonization goals into their supply chain management, particularly in procurement decision. The majority of the interviewees acknowledged that ESG criteria are now becoming a standard part of their procurement and bidding processes. Companies are increasingly setting specific ESG requirements for suppliers, such as reduced carbon footprints or adherence to sustainability certifications. From the interviews, it is clear that ESG is gaining importance in procurement and bidding processes as companies increasingly recognize their role in promoting Net Zero and decarbonization.

Despite the positive trends, some interviewees highlighted challenges in fully integrating ESG into procurement decisions. Financial constraints and the lack of clear regulations on how to measure and verify suppliers' ESG performance were mentioned as obstacles. Some companies are also concerned that focusing too much on ESG might lead to higher costs or longer lead times in their supply chain.

10) Requirement from Customers about ESG

Many interviewees indicated that their customers are now explicitly requiring ESG standards to be integrated into contracts. Particularly, large customers have started to demand that suppliers include carbon reduction goals in contractual agreements. If these goals are not met, it may limit the potential for contract renewal or result in penalties. This has become a primary way in which customers are pressuring suppliers to implement more proactive ESG strategies in support of Net Zero objectives. The interview results revealed that customers are placing significant pressure on suppliers to integrate ESG into contracts, provide performance

reports, and ensure supply chain transparency.

Customers are increasingly requesting suppliers to provide regular ESG performance reports. This includes detailed metrics such as carbon emissions, energy usage, and renewable energy adoption. Regular reporting ensures transparency in the supply chain and enables customers to monitor the progress of decarbonization efforts

Several respondents shared that customers are requiring suppliers to obtain specific ESG certifications or meet certain sustainability standards before contracts can be signed. Certifications such as ISO 14001 and SBTi (Science-Based Targets initiative) were mentioned as examples of global ESG certifications that have become mandatory. These certifications act as guarantees that suppliers are meeting a certain level of environmental responsibility.

3. Impact of Climate Change Regulations

This chapter presents the results from interviews regarding the impact of climate change regulations on companies, particularly in terms of operational and cost implications for ocean delivery. The analysis of interview results regarding regulations and their expected significance for their companies is summarized as follows.

1) EU Emissions Trading System (EU ETS) - Most Significant Impact

The EU ETS was identified as the regulation with the most significant impact on companies involved in ocean delivery. Under the EU ETS, shipping companies are required to buy emissions allowances for each ton of CO₂ they emit while delivering goods to and from EU ports. As this directly increases operational costs, many companies foresee the need for substantial investments in energy-efficient technologies and alternative fuels, such as green methanol or biofuels.

2) International Maritime Organization (IMO) Regulations - Significant Impact

The IMO has introduced various global regulations to reduce carbon emissions from the shipping industry, such as the IMO 2023 Carbon Intensity Indicator (CII) and Energy Efficiency Existing Ship Index (EEXI). While global in nature, these regulations will impact all shipping companies and force compliance with stringent carbon efficiency standards. Respondents pointed out that these regulations will likely lead to increased operational costs due to retrofits, slower steaming, and the need for fuel efficiency improvements.

3) US Governmental Measures - Moderate Impact

The United States has not yet introduced comprehensive regulations that target ocean delivery as stringently as the EU or IMO, but measures such as the Clean Air Act and various state regulations, especially in California (California Air Resources Board, CARB), are beginning to take shape.

4) Korean Governmental Restrictions - Less Significant Impact

Korean governmental restrictions have been less extensive in comparison to EU ETS and IMO regulations. However, Korea is beginning to develop its own emissions reduction frameworks, particularly for energy-intensive sectors like shipping. These regulations are more likely to influence domestic ocean delivery and logistics companies rather than global shipping liners. Interviewees noted that while there are increasing discussions in Korea about decarbonization, the actual regulatory frameworks are not yet as advanced or stringent as those

in the EU or under the IMO.

The majority of respondents agreed that stricter climate change regulations will have a significant or very significant impact on the competitiveness of the shipping industry. EU ETS and IMO Regulations emerged as the most impactful, with US and Korean regulations seen as less significant in the immediate future.

To comply with these evolving regulations and achieve long-term sustainability, companies are adapting their business models by investing in alternative fuels and modern fleets, collaborating with customers and suppliers to share the cost of decarbonization, and leveraging technology and innovation to improve operational efficiency and regulatory compliance. These actions will not only assist shipping companies in achieving their decarbonization objectives but also position them for long-term competitive success in an environment where climate regulations are becoming increasingly stringent.

4. Future Outlook and Strategies

This section derives strategies from interviews conducted with various shipping and production companies, focusing on their approaches to managing Scope 3 emissions, regulatory challenges, and long-term sustainability goals. Based on seven key questions, the companies' perspectives on sustainability and the action identified as essential for the successful transition to decarbonization are examined.

1) Biggest Challenges in Managing and Reducing Scope 3 Emissions

Scope 3 emissions, which encompass indirect emissions throughout the value chain, pose significant challenges for companies, with the interviews revealing three key areas of focus:

- **Data Complexity:** Many companies struggle with tracking emissions data from multiple suppliers, especially when those suppliers are located in different regions with varying capabilities for emissions reporting.
- **Supplier Engagement:** Convincing suppliers to commit to emission reduction targets requires substantial effort and resources, particularly for companies operating in regions with limited infrastructure.
- **Standardization Issues:** The lack of standardized methods for calculating Scope 3 emissions makes benchmarking progress difficult. This inconsistency is a major hurdle for companies aiming to reduce emissions and set meaningful targets.

The companies highlighted that overcoming these challenges requires improved collaboration with suppliers and the implementation of advanced technologies to streamline data collection and reporting

2) Potential for Improvement in Scope 3 Emissions Measurement and Verification

The interviews revealed several opportunities for improving Scope 3 emissions measurement and verification processes:

- **Enhanced Data Collection Methodologies:** Companies identified the need for better data collection techniques, such as using IoT sensors and blockchain to automate the process and improve data accuracy.
- **Supplier Engagement Programs:** Companies expressed the need to support their suppliers with tools and resources to improve their emissions tracking and reporting capabilities. This involves not only incentivizing suppliers but also providing them with training and technical support.
- **Standardized Reporting Frameworks:** There is a clear demand for universally accepted frameworks to ensure that emissions data are comparable across companies

and industries. Standardization would also make it easier to track progress and identify areas for improvement.

3) Improving Existing Regulations to Incentivize Sustainable Practices

Regulatory improvements are essential for advancing sustainability in the shipping industry, with interviewees proposing the following actions:

- **Tightening Emission Standards:** Stricter regulations targeting CO₂, NO_x, and SO_x emissions from ships were frequently mentioned as an essential step. These regulations would push the industry to adopt cleaner technologies and alternative fuels more rapidly.
- **Financial Incentives for Green Technologies:** Many interviewees advocated for the introduction of subsidies, tax breaks, or grants for companies investing in sustainable technologies. This financial support could ease the transition to low-emission vessels and infrastructure.
- **Standardized Reporting Requirements:** Mandatory reporting on environmental performance and emissions across the supply chain would encourage greater transparency and help companies align with sustainability goals.

4) Long-Term Aspirations for Sustainable Growth in the Shipping Industry

Most companies interviewed demonstrated a strong commitment to achieving long-term sustainability through decarbonization, with aspirations included:

- **Reduction of Carbon Emissions:** Many companies have set targets for achieving net-zero emissions by 2030 or 2050, depending on their current technological capabilities and infrastructure investments.
- **Adoption of Alternative Fuels:** A key strategy for companies is transitioning to alternative fuels, such as LNG, biofuels, and green methanol, to reduce their carbon footprint in both the short and long term.
- **Supply Chain Sustainability:** Companies aim to create sustainable supply chains by working closely with their suppliers to reduce upstream and downstream emissions. This approach focuses on a holistic view of sustainability across the value chain.

5) Benchmarking Sustainability in the Shipping Industry

The analysis of the interviews regarding companies to benchmark for sustainability is as follows:

- **CMA-CGM:** Known for its diversified fuel strategy and significant investments in decarbonization technologies, CMA-CGM's proactive approach to ESG goals has made it a leader in the shipping industry.

- **Maersk:** Recognized for its pioneering efforts in green methanol adoption, Maersk is leading the push towards decarbonization. However, some noted that Maersk focuses more on promotion and less on large-scale execution compared to its peers.
- **MSC:** MSC's commitment to LNG as a transitional fuel has been praised for its stability and regulatory compliance, although it was seen as less ambitious in terms of long-term decarbonization compared to methanol.

6) Importance of Collaboration Among Shipping Companies, Policymakers, and Stakeholders

Collaboration was unanimously viewed as critical to driving decarbonization efforts in the maritime sector:

- **Shared Responsibility:** The responsibility for decarbonization cannot rest solely on shipping companies. Collaboration with policymakers, fuel suppliers, and technology providers is essential to create the necessary regulatory and financial frameworks.
- **Innovation Through Partnerships:** Collaborating with other industry players and suppliers is crucial for developing innovative solutions, such as new fuel technologies and emissions tracking systems.
- **Global Standards:** Coordinated efforts among international regulatory bodies, such as the IMO, are necessary to establish consistent global standards for emissions reductions and sustainability.

7) Specific Actions Policymakers and Regulatory Bodies Can Take

Interviewees suggested several actions that policymakers can take to support sustainable practices in the shipping industry:

- **Stricter Emission Regulations:** Governments should implement tighter emissions limits on CO₂, SO_x, and NO_x to encourage the shipping industry to adopt cleaner technologies and alternative fuels.
- **Financial Incentives for Green Investments:** Subsidies, grants, and other financial incentives should be made available for companies investing in green vessels, alternative fuels, and decarbonization technologies.
- **Development of Green Infrastructure:** Governments must invest in the infrastructure needed to support alternative fuels, such as methanol and LNG, particularly at key ports around the world.

The shipping industry is at a pivotal point in its sustainability journey. Managing Scope 3 emissions and complying with evolving regulations will require concerted efforts in data

collection, supplier engagement, and technological innovation. By focusing on collaboration with stakeholders and making significant investments in alternative fuels and emissions reduction technologies, companies can achieve their long-term sustainability goals. However, success in this endeavor will also depend on supportive regulatory frameworks and the development of green infrastructure, as well as a shared commitment to global decarbonization efforts.

V. Conclusions

The shipping industry is at a critical juncture, facing immense pressure to transition to more sustainable practices in response to climate change. With the global push for decarbonization gaining momentum, shipping companies must tackle a series of challenges stemming from regulatory changes and operational shifts. However, these challenges also present significant opportunities for growth and innovation, particularly for early adopters within the industry who embrace sustainable solutions.

Previous studies have highlighted the critical role of technological advancements, regulatory frameworks, and stakeholder collaboration in reducing environmental footprints. However, challenges such as high implementation costs, regulatory uncertainties, and technological limitations persist.

The purpose of this paper is to identify the sustainable growth strategies adopted by shipping companies in response to climate change regulations. By analyzing data from a comprehensive survey of industry stakeholders, this paper explores current sustainability practices, challenges, and future outlooks. The findings highlight the importance of ESG initiatives, especially in managing Scope 3 emissions.

1. Challenges in Achieving Sustainable Growth

One of the key challenges identified through the survey is the need for the industry to comply with increasingly stringent environmental regulations, particularly those aimed at reducing carbon emissions. The IMO has set ambitious targets to cut greenhouse gas emissions, and shipping companies must now align with these goals or risk non-compliance. This puts immense pressure on shipping companies to invest in greener technologies and processes. Many shipping lines are transitioning to alternative fuels such as LNG, biofuels, and green methanol, but these solutions come with high costs, both for implementation and ongoing operation.

Another challenge is the rising cost of sustainable technologies. Retrofitting fleets to meet environmental standards, investing in new fuel technologies, and upgrading port operations for sustainability all require significant financial outlays. These costs inevitably get passed along the supply chain, impacting all stakeholders. In an industry already operating on thin margins, balancing these sustainability investments with cost-efficiency poses a critical dilemma. Companies must weigh the short-term financial burden against the long-term benefits of maintaining a green and compliant fleet.

A notable challenge is the availability of green infrastructure. While many leading shipping

companies, such as CMA-CGM and Maersk have committed to reducing their environmental footprint, the infrastructure to support these initiatives (such as fueling stations for alternative energy sources) is still underdeveloped in many regions. This creates logistical barriers, making it difficult for shipping companies to offer consistent green solutions globally. The result is that sustainability efforts may be limited to specific trade routes or regions where green infrastructure is more readily available, thereby restricting the industry's ability to scale sustainable solutions across all operations.

CMA-CGM stands out for its well-balanced and diversified approach to decarbonization, making it a leader in sustainability within the shipping industry. CMA-CGM has adopted multiple fuel options, including methanol and LNG, which provides greater flexibility in meeting both current and future regulatory requirements. This multi-fuel strategy allows the company to mitigate risks associated with fuel supply disruptions and regulatory changes, positioning it for long-term success.

Also, CMA-CGM's emphasis on large-scale investments in decarbonization, rather than focusing on promotional activities, strengthens its ability to execute its sustainability goals. The company's proactive investments ensure it is prepared for future changes in the industry. Furthermore, CMA-CGM fosters strong collaboration with customers to share the costs and responsibilities of ESG investments, enhancing long-term partnerships and aligning with sustainability objectives.

By balancing short-term adaptability with long-term sustainability planning, CMA-CGM's strategy provides the most robust framework for achieving its decarbonization goals while effectively managing risks and securing future growth in a dynamic regulatory environment.

And industry's adoption of sustainable practices is causing supply chain disruptions. As ships undergo retrofitting or maintenance to meet new environmental standards, fleet availability can be reduced, leading to capacity shortages and delays. This is particularly problematic for global supply chains that rely on just-in-time logistics. Shipping companies must develop contingency plans to avoid such disruptions, but doing so adds complexity and cost to their operations.

In addition to operational challenges, the survey revealed that many stakeholders, particularly customers, are not fully aware of the sustainability efforts being undertaken by the shipping industry. While the industry is making significant strides in reducing its Scope 3 emissions (emissions that occur in a company's value chain, including logistics), there remains a gap in customer awareness. This lack of understanding means that many customers are not aware of the additional costs involved in adopting sustainable shipping practices, nor do they recognize the benefits these practices bring to the environment. As a result, shipping companies are often left shouldering the financial burden of these initiatives without sufficient support

from their customers or supply chain partners.

The biggest challenges in managing Scope 3 emissions included supply chain complexity and data reliability. Potential areas for improvement were identified as data accuracy, supplier engagement, and technological solutions. Collaboration among stakeholders was deemed crucial for driving sustainable practices.

The findings highlight the importance of a comprehensive approach to sustainability in the shipping industry. Effective management of Scope 3 emissions requires robust data collection and verification methodologies, supported by advanced technologies and stakeholder collaboration. Regulatory frameworks should be designed to incentivize sustainable practices while addressing the financial and technological challenges faced by companies.

Regulatory pressure and cost savings emerged as the primary drivers of sustainability initiatives. However, technological limitations and financial constraints posed significant challenges. This highlights the need for supportive policies and financial incentives to facilitate the adoption of green technologies.

Best practices identified include comprehensive data collection, supplier engagement, and third-party verification. Companies that successfully manage Scope 3 emissions tend to have robust data management systems and strong collaboration with suppliers and stakeholders. Also, addressing the challenges in managing Scope 3 emissions requires a multi-faceted approach involving improved data collection, enhanced supplier engagement, and the adoption of advanced technologies. Continuous improvement and standardization are key to achieving accurate and reliable emissions reporting.

2. Opportunities for Sustainable Growth

Despite these challenges, there are considerable opportunities for the shipping industry to foster sustainable growth. One of the most promising opportunities lies in raising customer awareness about the industry's sustainability initiatives. Based on our survey findings, there is a significant information gap between what shipping companies are doing to reduce emissions and what their customers understand about these efforts. By promoting their actions more effectively, shipping companies can not only enhance their reputation as leaders in sustainability but also create opportunities to share or balance the costs of these green technologies with their customers.

Educating customers on the environmental benefits of decarbonizing ocean services and the investments required for such efforts can help create a more collaborative environment. Customers who are aware of the sustainable practices in shipping may be more willing to pay a premium for eco-friendly shipping solutions or engage in partnerships that support shared

sustainability goals. This increased willingness to support green logistics can enable shipping companies to offset the costs of sustainable technologies, thus creating a more balanced and financially viable approach to decarbonization.

Moreover, the adoption of digital innovations such as AI for route optimization, blockchain for supply chain transparency, and IoT for monitoring fuel consumption presents an opportunity to enhance both operational efficiency and environmental performance. These technologies can significantly reduce emissions by optimizing routes and improving fuel efficiency, all while providing real-time data that can be shared with customers to further emphasize the industry's commitment to sustainability. Additionally, digital tools can help shipping companies track and report on their environmental impact more effectively, offering transparent insights into how green initiatives are being implemented across the supply chain.

Green financing is another area of opportunity. As governments and financial institutions increasingly offer incentives for businesses adopting sustainable practices, shipping companies can access subsidies, grants, and lower-interest loans to support their investments in green technologies. These financial tools can help offset the high upfront costs associated with alternative fuels and retrofitting, making it more feasible for shipping companies to continue pursuing their decarbonization goals without compromising financial performance.

Lastly, the growing demand from consumers and businesses for sustainable logistics is driving new business opportunities for shipping companies that prioritize sustainability. Customers are increasingly making decisions based on the environmental impact of their supply chain choices. By positioning themselves as leaders in green shipping, companies can differentiate their services and attract environmentally conscious clients. The shift towards sustainability is not just a regulatory requirement but also a competitive advantage in a market where corporate responsibility is becoming a key factor in business relationships.

In conclusion, the shipping industry is at a crossroads where it must balance the cost of adopting sustainable practices with the pressing need to reduce environmental impact. Challenges such as rising costs, regulatory compliance, and supply chain disruptions are significant but surmountable. The key lies in not only making these necessary changes but also in raising awareness among customers about the industry's efforts in reducing Scope 3 emissions.

Shipping companies need to proactively communicate their sustainability initiatives and collaborate with customers to share the financial responsibilities of implementing green technologies. By doing so, the industry can navigate these challenges while seizing the opportunities to promote sustainability, enhance customer relationships, and secure long-term growth. The shipping industry has a critical role to play in the global transition to a greener economy, and by leveraging its sustainability efforts, it can lead the way toward a more

responsible and prosperous future.

3. Recommendations for Sustainable Growth

Sustainable growth strategies for shipping companies in response to climate change-related regulations can be recommended as follows. Enhancing data collection and verification involves standardizing methodologies to ensure the accuracy and consistency of Scope 3 emissions data. Additionally, leveraging advanced technologies such as IoT devices and machine learning can improve data management and analysis, enhancing decision-making processes.

Increasing supplier engagement is critical for promoting accurate emissions reporting and encouraging efforts toward emissions reduction. Providing resources and incentives to suppliers, along with establishing clear guidelines and support systems, helps align their practices with sustainability goals and fosters a cohesive approach throughout the supply chain.

Strengthening collaboration and transparency among shipping companies, policymakers, and stakeholders is essential for developing unified standards and practices aimed at reducing emissions. Utilizing platforms dedicated to supply chain transparency enables effective tracking and management of emissions, fostering accountability and progress toward sustainability objectives.

Policy enhancements by governments and regulatory bodies are crucial for supporting initiatives focused on sustainable technologies. This includes offering financial incentives, subsidies, and implementing supportive policies to accelerate the adoption of alternative fuels and green technologies in maritime transport infrastructure, thereby advancing sustainable practices in the industry.

By addressing these areas, the shipping industry can significantly reduce its environmental footprint, enhance operational efficiency, and contribute to global sustainability goals.

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Appendix

Questionnaire for the interviews with shipping companies and customers

Questionnaire
Thank you for participating in this research on sustainable growth strategies for shipping companies in response to climate change regulations. Your insights are valuable in understanding the challenges and opportunities associated with achieving a more sustainable maritime industry.
I. Background Information
1. What is your current role and organization within the shipping industry?
A. CEO/CFO/COO B. Sustainability Manager C. Logistics Manager D. Other (_____)
2. How many years of experience do you have in the shipping industry?
A. Less than 1 year B. 1-5 years C. 6-10 years D. More than 10 years
3. Does your company have ESG department or functions or focal points?
A. Yes B. No
4. Does your company have any ESG campaign related to environmental performance?
A. Yes B. No
5. Do you have clear ideas of Scope 1, 2 and 3 and recognize any progress of your company or your customers about Scope 1, 2 and 3?
A. Yes, we have clear ideas and recognize significant progress B. Yes, we have clear ideas but minimal progress C. No, we do not have clear ideas D. Not sure

II. Current Sustainability Practices

1.Has your company or your customers implemented any specific sustainability initiatives in recent years? Please select any initiative if your company and your customers are taking (Select all that apply)

- A. **[Fuel efficiency measures]** e.g., slow steaming, hull modifications
- B. **[Alternative fuels]** e.g., LNG, biofuels, hydrogen
- C. **[Operational optimization]** e.g., route optimization, port call optimization
- D. **[Energy-efficient technologies]** e.g., LED lighting, energy-saving devices
- E. **Others** (_____)
- F. None or Not sure

2.If yes, what are the key drivers behind these initiatives? (Select all that apply)

- A. Regulatory pressure
- B. Cost savings
- C. Environmental concerns
- D. Customer demand
- E. Brand reputation
- F. Others (_____)

3.What are the main challenges your company or your customers face in implementing and scaling up sustainable practices? (Select all that apply)

- A. **[Technological limitations]** e.g., lack of mature technology
- B. **[Financial constraints]** e.g., high upfront costs
- C. **[Regulatory uncertainty]** e.g., changing regulations
- D. **[Operational disruptions]** e.g., integration with existing systems
- E. **[Lack of expertise]** e.g., knowledge gap in sustainable practices
- F. **Others** (_____)
- G. None or Not sure

4.What is current practice of your company or your customers for Scope 1, 2 or 3?

**4-1. [Scope 1] What is current practice of your company or your customers for Scope 1?
(Select all that apply)**

- A. [Direct Emission Measurement] **Fuel Consumption Tracking**
- B. [Direct Emission Measurement] **On-Site Emissions Monitoring**
- C. [Emission Factors and Calculations] **Standard Emission Factors**
- D. [Emission Factors and Calculations] **Inventory Management Systems**
- E. [Reporting and Compliance] **Regular Reporting**
- F. [Reporting and Compliance] **Regulatory Compliance**
- G. [Emission Reduction Strategies] **Energy Efficiency Initiatives**
- H. [Emission Reduction Strategies] **Renewable Energy Integration**
- I. [Emission Reduction Strategies] **Employee Training and Engagement**
- J. **Others:** _____

**4-2. [Scope 2] What is current practice of your company or your customers for Scope 2?
(Select all that apply)**

- A. [Energy Consumption Tracking] **Electricity Usage Monitoring**
- B. [Emission Factors and Calculations] **Standard Emission Factors**
- C. [Renewable Energy Procurement] **Renewable Energy Certificates (RECs)**
- D. [Renewable Energy Procurement] **Direct Renewable Energy Sourcing**
- E. [Energy Efficiency Measures] **Energy Efficiency Programs**
- F. [Energy Efficiency Measures] **Energy Audits and Assessments**
- G. [Reporting and Compliance] **Regular Reporting**
- H. [Reporting and Compliance] **Regulatory Compliance**
- I. [Employee Engagement and Training] **Employee Awareness Programs**
- J. **Others:** _____

4-3. [Scope 3] What is current practice of your company or your customers for Scope 3? (Select all that apply)
A. [Data Collection and Supplier Engagement] Supplier Surveys and Collaboration B. [Data Collection and Supplier Engagement] Supplier Training and Support C. [Emission Factors and Calculations] Standard Emission Factors D. [Emission Factors and Calculations] Spend-Based and Activity-Based Methods E. [Lifecycle Assessment] Lifecycle Assessment (LCA) F. [Reporting and Transparency] Comprehensive Reporting G. [Reporting and Transparency] Third-Party Verification H. [Emission Reduction Strategies] Supplier Improvement Programs I. [Emission Reduction Strategies] Sustainable Procurement Policies J. [Technology and Innovation] Advanced Analytics and Tools K. [Customer Engagement] Collaboration with Customers L. Others: _____ _____
5.How does your company currently identify and categorize Scope 3 emissions? (Select all that apply)
A. [Data Collection] Data from various sources, including suppliers, transportation providers, and waste management companies B. [Emission Factors] GHG Protocol and industry-specific guidelines C. [Categorization] Categorize the emissions into the 15 recognized categories outlined by the GHG Protocol's Scope 3 Standard D. [Verification and Validation] Audits and engage third-party verifiers E. [Continuous Improvement] Review and update the methodologies and data sources F. Others: _____ _____
6.What methodologies do you use to verify the amount of Scope 3 emissions generated by your activities? (Select all that apply)
A. Third-party verification B. Internal audits C. Peer benchmarking D. Others (_____) E. None or Not sure

7.Can you elaborate on the data collection process for Scope 3 emissions measurement?
STEP 1. Setting Data Collection Priorities
[TIPS] Determine criteria and assign priorities to selected items, collecting more precise data for items with higher priority ☞ Criteria to select priorities: ①Emission Volume Criteria, ②Expenditure Amount Criteria, ③Criteria Tailored to Company Goals
[YOUR ANSWER]
STEP 2. Data Selection
[TIPS] Consider the specific characteristics of the selected items and the company's circumstances to choose the data to be collected and their target quantities ☞ Primary Data: Directly collected from a company's value chain (e.g., The cradle-to-gate carbon emissions of supplied products calculated from supply chain companies (Category 1)) ☞ Secondary Data: Not collected from a company's value chain (e.g., Cradle-to-gate carbon emissions of supplied products obtained from the LCI DB (Category 1))
[YOUR ANSWER]
STEP 3. Data Collection and Preservation
[TIPS] Collect the necessary data and supplement any missing data ☞ Primary Data: If there are emission data for product/service units related to the company, collect the relevant values ☞ Secondary Data: Verify the metadata such as the original source, the boundaries included in the data, and the manner in which the data was collected
[YOUR ANSWER]
STEP 4. Data Quality Improvement
[TIPS] Identify the uncertainties inherent in the data and find weak points in the collected data to enhance overall accuracy ☞ Data Quality Requirement: Technical representativeness, Temporal representativeness, Geographical representativeness, Completeness, Reliability
[YOUR ANSWER]

8.What tools and technologies do you utilize for collecting data relevant to Scope 3 emissions? (Select all that apply)
A. [Carbon accounting software] e.g., Sphera, Simapro, or CarbonTrust B. [Supplier engagement platforms] e.g., EcoVadis or CDP Supply Chain C. [Enterprise resource planning (ERP) systems] e.g., SAP or Oracle D. [Spreadsheets and manual data entry] e.g., Microsoft Excel or Google Sheets E. [Internet of Things (IoT) devices] e.g., IoT sensors and devices F. [Life cycle assessment (LCA) tools] e.g., GaBi or OpenLCA G. Others (_____) H. Not sure
9.How do you ensure the accuracy and consistency of the collected Scope 3 emissions data? (Select all that apply)
A. Implement data validation protocols B. Conduct regular audits C. Standardize data collection methods D. Train employees and stakeholders E. Third-party verification services F. Implement the centralized data management system G. Others (_____) H. Not sure
10. Can you describe the methodologies used for measuring Scope 3 emissions categorized by upstream and downstream flows?
[Upstream Flows]
A. Supplier Surveys and Data Collection: _____ _____ B. Lifecycle Assessment (LCA): _____

C. Emission Factors:

D. Spend-Based Methodology:

[Downstream Flows]

A. Customer Surveys and Data Collection:

B. Usage Patterns Analysis:

C. Product End-of-Life Assessment:

D. Emission Factors for Downstream Activities:

E. Integration with Customer Reporting:

11. Does your company or your customer secure the visibility of CO₂ emission or any challenges for securing the visibility? If yes, please share any existing platform. (Select all that apply)

- A. **[Carbon Accounting Software]** Platforms provide data integration, emissions calculation, scenario modeling, and reporting capabilities
- B. **[Supply Chain Transparency Platforms]** Platforms leverage technologies such as blockchain and IoT to gather real-time data and provide stakeholders with visibility into emissions hotspots and trends
- C. **[Collaborative Initiatives]** Participation in collaborative initiatives such as industry alliances, sustainability consortia, and multi-stakeholder platforms
- D. **Others:** _____

12. Does your company or your customers clearly indicate ESG in the process of procurement or bidding? Please share in details if there is any weight on ESG? (Select all that apply)

- A. Supplier Evaluation Criteria
- B. ESG Standards and Certifications
- C. ESG Performance Metrics
- D. Risk Management
- E. Stakeholder Engagement
- F. ESG Reporting and Transparency
- G. **Others:** _____

13. Have you got any push or requirements regarding ESG from your customers? If yes. Please share in details. (Select all that apply)

- A. ESG Integration in Contracts
- B. ESG Performance Reporting
- C. Supply Chain Transparency
- D. ESG Certification and Standards
- E. Stakeholder Engagement
- F. **Others:** _____

III. Impact of Climate Change Regulations
1. Which climate change regulations will be most significantly impacting on your company or your customers in terms of the operation and cost? Please list the following examples in order of significance.
Priority: _____ > _____ > _____ > _____ <i>☞ Priority example: (A) EU > (B) IMO > (C) US > (D) Korean</i> A. EU ETS B. IMO regulations C. US governmental measures D. Korean governmental restrictions E. Others (_____)
2. Do you anticipate that stricter climate change regulations will have a significant impact on the future competitiveness of the shipping industry? Please choose the weight from A (No impact) to E (Maximum impact).
A. No impact B. Low impact C. Moderate impact D. High impact E. Maximum impact
3. How do you see your company adapting its business model to comply with evolving regulations and achieve long-term sustainability goals? Please choose the weight from A (Not adapting) to E (Fully adapting).
A. Not adapting at all B. Some adaptation C. Moderate adaptation D. Significant adaptation E. Fully adapting
4. Which country will be the most significantly impacting on your company or your customers or focusing countries? Please list the country in order of significance.
Priority: _____ > _____ > _____ > _____

☞ Priority example: US > UK > Korea > Others

IV. Future Outlook and Strategies

1. What are the biggest challenges your company faces in managing and reducing Scope 3 emissions? (Select all that apply)

- A. The complexity of the supply chain and tracking emissions data from numerous suppliers across various regions
- B. Obtaining reliable data from third-party vendors who may lack the necessary infrastructure or commitment to sustainability practices.
- C. The lack of standardized methodologies for calculating Scope 3 emissions, leading to inconsistencies and difficulties in benchmarking progress
- D. Engaging suppliers and stakeholders to commit to emission reduction targets, which requires substantial effort and resources
- E. Others: _____

2. What areas do you see potential for improvement in your Scope 3 emissions measurement and verification processes? (Select all that apply)

- A. **[Data Accuracy and Completeness]** Improving data collection methodologies, ensuring data consistency across different sources
- B. **[Supplier Engagement]** Providing guidance, resources, and incentives to encourage suppliers to measure and report their emissions accurately
- C. **[Scope 3 Categories]** Identifying additional emission sources, disaggregating data to capture emissions from different activities more accurately
- D. **[Emission Factors and Assumptions]** Continuously updating emission factors and assumptions
- E. **[Verification and Validation]** Conducting audits, engaging third-party verifiers
- F. **[Technology Solutions]** Using the machine learning, data analytics, and blockchain to automate data collection
- G. **[Benchmarking and Comparison]** Benchmarking the Scope 3 emissions performance against industry peers and best practices
- H. Others: _____

3.How can existing regulations be improved to incentivize sustainable practices within the shipping industry? (Select all that apply)
A. [Tightening Emission Standards] Implementing stricter emission standards for ships, particularly focusing on reducing greenhouse gas emissions such as CO₂, SO_x, and NO_x B. [Carbon Pricing Mechanisms] Introducing carbon pricing mechanisms, such as carbon taxes or emissions trading schemes C. [Incentives for Green Technologies] Providing financial incentives, tax breaks, or subsidies for shipowners who invest in and adopt green technologies and practices D. [Port Infrastructure and Services] Investing in port infrastructure and services to support sustainable shipping practices E. [Transparency and Reporting Requirements] Strengthening transparency and reporting requirements for ship emissions and environmental performance F. [International Cooperation and Collaboration] Enhancing international cooperation and collaboration among governments, industry stakeholders, and international organizations G. Others: _____ _____ _____ _____ _____
4-1. What are your company or your customers 's long-term aspirations for achieving sustainable growth in the maritime industry? (Select all that apply)

- A. Reduction of carbon emissions
- B. Adoption of clean technologies
- C. Enhancing energy efficiency
- D. Circular economy practices
- E. Strengthening regulations and compliance
- F. Promoting digitalization and smart shipping
- G. Stakeholder collaboration
- H. Others (_____)

4-2. If you choose any benchmarking company for sustainability in the maritime industry, which company and Why?

- A. Maersk
- B. CMA CGM
- C. MSC (Mediterranean shipping company)
- D. COSCO
- E. Evergreen Marine Corp.
- F. Others (_____)

Feel free to provide additional details on your choice:

5.Which specific strategies do you believe hold the most potential for reducing the environmental footprint of the shipping industry?

A. [Technological advancements] e.g., new propulsion systems B. [Operational efficiency improvements] e.g., better logistics planning C. [Alternative fuel adoption] e.g., green hydrogen, biofuels D. [Policy changes and incentives] E. [Collaboration with stakeholders] F. Others (_____)
6. How important do you consider collaboration among shipping companies, policymakers, and other stakeholders in driving the transition towards a sustainable maritime future?
A. Not important B. Slightly important C. Moderately important D. Very important
7. What specific actions could policymakers and regulatory bodies take to further incentivize and support the adoption of sustainable practices within the shipping industry? (Select all that apply)

- A. Implement stricter emissions regulations for ships, including limits on SOx, NOx, and CO₂ emissions
- B. Provide financial incentives such as subsidies or grants for shipping companies to invest in sustainable technologies.
- C. Develop green port infrastructure to support the use of alternative fuels and reduce emissions from ships at berth.
- D. Encourage international cooperation through organizations like the IMO to establish consistent global standards for sustainable shipping.
- E. Support research and development initiatives focused on advancing sustainable shipping technologies.
- F. Increase public awareness of the importance of sustainable shipping and the role of policymakers in promoting it.
- G. Explore market-based measures like emissions trading schemes to incentivize emissions reductions in the shipping industry.

Feel free to provide additional opinion:

V. Additional Comments

1. Do you have any additional thoughts or insights on the challenges and opportunities related to sustainable growth in the shipping industry?

is [example] a major challenge in sustainable growth for the shipping industry is finding cost-effective ways to adopt environmentally friendly practices. Nevertheless, this presents opportunities for companies to differentiate themselves and attract eco-conscious customers

Feel free to provide additional opinion:
