e-ISSN: 3109-6425
p-ISSN: 3109-6433

Proceeding Jakarta Geopolitical Forum
Lembaga Ketahanan Nasional Republik Indonesia (LEMHANNAS RI)
Volume 8 | 2024
WEB : https://proceeding.lemhannas.com/index.php/jgf
DOI : https://doi.org/10.55960/jgf.v8i1.275

Conference Paper

SUSTAINABLE PRACTICES ADOPTION IN THE MARITIME INDUSTRY

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Abstract.

Maritime logistics plays a critical role in global trade while contributing significantly to greenhouse gas emissions, with shipping accounting for approximately 2.5 per cent of global emissions and the entire logistics chain contributing close to 11 per cent. The study analyses the structural and operational challenges of achieving net-zero emissions by 2040, emphasising the decarbonisation of vessels, ports, warehousing, and inland transport. Using a qualitative content analysis approach, the research systematically reviews corporate reports, academic literature, and industry data to assess the viability of alternative fuels, particularly green methanol and green ammonia. Although the adoption of green-fuel-powered vessels has commenced, major barriers persist in relation to fuel availability, cost, scalability, and safety. The findings indicate that decarbonisation requires more than technological readiness, necessitating long-term investment, regulatory support, and regional fuel production strategies, particularly in Southeast Asia. The study highlights the urgency of integrated, system-wide innovation to meet global climate targets in maritime logistics.

Keywords: green ammonia, green methanol, maritime decarbonisation, maritime logistics, supply chain sustainability.

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Article History:
Received : 22-04-2024
Revised : 14-05-2024
Accepted : 28-06-2024

Introduction

The maritime industry stands at a critical juncture, balancing the industries' role in global trade with increasing pressure to mitigate environmental concerns, as the sector responsible for approximately 2.5% of global greenhouse gas emissions (1,2). Achieving net-zero emissions by 2040 has become the central objective, encompassing not just maritime activities but also associate port terminals and inland logistics operations. This ambitious target poses a structural challenge, particularly given the 25-year operational lifespan of vessels (3). Every procurement decision made today must align with the long-term climate goals, ensuring that assets remain compliant with future environmental standards. The scale and complexity of modern logistics underscore the need for urgent, coordinated efforts in sustainable innovation (2,4). Without the kind of efforts, the sector risks undermining global climate commitments, even as the sector facilitates the movement of goods across continents.

Literature Review

Theoretical Studies

Achieving net-zero emissions in the maritime industry by 2040 requires a holistic approach that integrates shipping, port terminals, warehousing, and land transport (1,3). The complexity of this transition lies in the structural characteristics of the sector, particularly the long lifespan of maritime assets (5). This condition aligns with the theory of carbon lock-in, which suggests that infrastructure and capital-intensive systems create path dependencies that hinder transitions to low-carbon alternatives (6). Transitioning out of this lock-in requires a deliberate shift in investment strategies, guided by transition management theory, which emphasizes long-term planning, systemic change, and multi-level governance in steering complex socio-technical systems toward sustainability.

Empirical Studies

Shipping contributes approximately 2.5% of global greenhouse gas emissions, but empirical evidence shows that the broader supply chain generates a significantly higher environmental impact, reaching nearly 11% of total emissions (1,2,7). This discrepancy arises from the cumulative effect of interconnected logistics activities, comprising of inland transportation, warehousing, and cargo handling. Studies tracking product life cycles and carbon footprints across global value chains reveal that emissions intensify as goods move through multiple stages and modes of transport before reaching end consumers. The empirical data support a systemic view of emissions generation, where supply chain complexity, not just shipping activity, determines total environmental impact, that are reinforces

the need to assess and manage emissions across all nodes of the logistics network, not in isolation.

Methods

The study adopts a qualitative content analysis approach, defined as a research method for deriving replicable and valid inferences from textual data (8,9). The method enables a systematic exploration of industry reports, corporate disclosures, public statements, and peer-reviewed literature related to decarbonisation strategies in the maritime logistics sector. Data sources consist of corporate sustainability reports, conference proceedings, and empirical studies published over the past decade, with a focus on emissions reduction, alternative fuels, and supply chain sustainability. The selection criteria prioritize content relevant to net-zero targets, fuel innovation, and infrastructure readiness in global shipping and logistics, particularly in relation to Asia–Europe trade routes and Southeast Asian fuel production potential. The unit of analysis centres on decarbonisation initiatives and their alignment with long-term climate goals. The study was conducted over a one-year period, and data reliability was ensured through triangulation of sources and cross-referencing with industry-verified information and expert commentary.

Results and Discussion

To manage the systemic footprint, a net-zero emissions target by 2040 has been set, covering not only shipping but also port terminals, warehouses, and land transport (10). This ambitious goal must account for the structural constraints of asset longevity, particularly vessel lifespans of up to 25 years (5). Any ship purchased today must align with long-term decarbonisation objectives, as the ship will remain operational well into the 2040s(3).

Initial efforts toward decarbonisation, for example the deployment of the world's first container vessel powered by green methanol (3). Although this vessel carries a modest capacity of 3,000 TEUs, subsequent deliveries like larger ships capable of transporting 16,000 TEUs along Asia–Europe routes. These advancements represent a meaningful step forward but also expose limitations. Challenges like oversized fuel tanks, high operational costs, and, most critically, the limited availability of green methanol hinder full-scale adoption. The issue reflects a classic “chicken and egg” dilemma, where demand for green fuels exists, but production capacity remains underdeveloped.

To overcome these barriers, alternative fuels like green ammonia are under investigation (3). Testing of the first green ammonia-powered ship engine is expected within six to twelve months in Denmark. While ammonia offers the advantage of zero carbon emissions, the toxicity presents serious operational and

safety concerns. Balancing innovation and risk become essential as these new technologies transition from experimentation to commercial application.

Opportunities also exist beyond technical development. Resource-rich regions, for example Indonesia, possess untapped potential to become significant producers of green fuels. With abundant land, biomass, wind energy, and solar power (11,12). The country could emerge as a major supplier of green methanol and ammonia. Leveraging this potential requires investment, regulatory support, and international collaboration.

Ultimately, the findings confirm that technological readiness alone does not guarantee progress toward decarbonisation (3). Fuel availability, production scalability, and system-wide integration must advance in parallel. While the path forward involves uncertainty, the commitment to test, adopt, and refine emerging technologies remains essential to achieving a sustainable maritime and logistics future.

Conclusion

Reducing greenhouse gas emissions in the maritime and logistics sectors requires a comprehensive, system-wide approach. While shipping contributes about 2.5% of global emissions, the entire supply chain accounts for nearly 11%, highlighting the need to decarbonise beyond vessels to also covers inland transport, terminals, and warehousing. Achieving net-zero emissions by 2040 presents significant challenges due to the long lifespan of assets and limited availability of alternative fuels like green methanol and green ammonia. Although technological advancements have begun, for example the deployment of green-fuel-powered vessels, scaling up fuel production and overcoming cost, infrastructure, and safety issues remain critical obstacles. Resource-rich countries like Indonesia offer strategic opportunities for green fuel development, but realizing this potential requires coordinated investment, regulation, and innovation. The transition cannot rely on technology alone. The transition must be supported by long-term planning and collective commitment across the logistics ecosystem to achieve a truly sustainable and low-carbon future.

Acknowledgments
The author extends sincere gratitude to A.P. Moller Singapore Pte Ltd and Lembaga Ketahanan Republik Indonesia for their invaluable support throughout the various stages of developing this article

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