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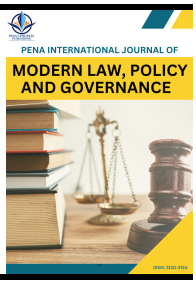

Environmental Tariffs for Sustainable Maritime Shipping in Malaysia: A PRISMA-Based Systematic Literature Review of Policy Readiness and Stakeholder Perspectives

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ABSTRACT

Maritime shipping plays a vital role in global trade, but it is also a significant source of greenhouse gas (GHG) emissions. In Malaysia, environmental tariffs as market-based policy tools remain underutilized despite international evidence of their potential for reducing emissions. This paper presents a PRISMA-based Systematic Literature Review (SLR) to evaluate policy readiness, stakeholder acceptance, and operational feasibility for implementing environmental tariffs in Malaysia's maritime sector, with a focus on Port Klang (Westport). Searches were conducted in Scopus, Web of Science, ScienceDirect, and Google Scholar from 2013 to 2024 using targeted Boolean search strategies. Of 90 initially identified studies, 15 met the inclusion criteria after a rigorous screening process. Thematic analysis revealed four core areas: institutional readiness, stakeholder perspectives, policy integration, and technological measures. Comparative insights from Europe, China, and ASEAN show that phased implementation, pilot programmes, and targeted incentives enhance success. The findings inform a conceptual policy model aimed at building regulatory capacity, engaging stakeholders, and fostering cross-sector collaboration to support Malaysia's maritime decarbonisation goals.

1. Introduction

Maritime shipping serves as the foundation of global trade, transporting nearly eighty percent of the world's goods and connecting industries and markets across continents [1]. However, this vital sector also represents a major source of greenhouse gas (GHG) emissions, contributing about three percent of the global total according to the International Maritime Organization (IMO). Without decisive intervention, emissions from shipping are expected to rise significantly in the coming years. In response, many countries and port authorities are pursuing sustainable measures such as cleaner fuels, energy-efficient vessel designs, and digital route optimisation. One promising yet underused

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strategy, especially in Southeast Asia, is the implementation of environmental tariffs, financial charges imposed on ships based on their pollution levels, to promote cleaner operations [2].

In Malaysia, particularly at Port Klang, environmental tariffs are still a new concept, as most sustainability initiatives remain focused on compliance and voluntary programs rather than economic incentives. Lessons from ports in Europe and China demonstrate that when environmental tariffs are paired with infrastructure improvements like shore power and LNG bunkering, emissions can be reduced without harming competitiveness [3]. Therefore, this study applies the PRISMA framework to assess global practices and develop practical recommendations for Malaysia's transition toward sustainable and low-carbon maritime operations.

1.1 Literature Review

1.1.1 Concept of environmental tariffs in maritime shipping

Environmental tariffs in the maritime industry establish a financial link between a ship's environmental performance and its operating costs, charging vessels based on their emissions of carbon dioxide, nitrogen dioxide, sulphur oxides, and other pollutants [4]. This system ensures that cleaner ships pay less, promoting accountability and encouraging sustainable practices. By internalising the cost of pollution, environmental tariffs make shipowners financially responsible for their environmental impact while motivating investment in cleaner technologies [5]. Rooted in the Environmental Economics Theory, this approach enhances market efficiency by reflecting the true cost of environmental harm [6,7]. Additionally, revenue generated from these tariffs can be reinvested in green port initiatives such as renewable energy, electrified cargo equipment, and emission monitoring systems, creating a sustainable feedback loop that supports continuous environmental improvement within the maritime sector.

1.1.2 Insights from international practice

The European Union demonstrates the effectiveness of environmental tariffs through differentiated port fees based on vessel performance under the Environmental Ship Index (ESI), where cleaner ships are rewarded and polluters pay more, leading to lower emissions without reducing port competitiveness [6]. Similarly, major Chinese ports applying emission-based charges have improved air quality, though small and medium-sized enterprises (SMEs) initially resisted due to cost concerns, prompting recommendations for gradual implementation and financial support [8]. In contrast, ASEAN countries like Malaysia, Singapore, and Indonesia have advanced in port electrification and alternative fuels but lack coordinated tariff policies, resulting in a "port shopping" risk as vessels may prefer ports with lower or no environmental fees, potentially disadvantaging early adopters in the region.

1.1.3 The Malaysian context

Malaysia's maritime environmental efforts have mainly centred on complying with international regulations such as MARPOL Annex VI, focusing on technological measures like renewable energy integration, port equipment efficiency, and shore power feasibility [9]. MARPOL is an international convention developed by the International Maritime Organization (IMO) to prevent pollution from ships and protect the marine environment. However, these initiatives alone do not influence shipping companies' economic behaviour as effectively as environmental tariffs do. Without financial incentives or penalties, there is little motivation for operators to utilise cleaner infrastructure, which

is why many global ports combine technological investments with market-based mechanisms like environmental tariffs to drive faster and more consistent adoption of sustainable practices.

1.1.4 Theoretical frameworks supporting tariffs

The Environmental Economics Theory supports environmental tariffs by assigning measurable costs to pollution, thereby motivating companies to adopt cleaner technologies and view sustainability as a competitive business strategy rather than a moral duty [5]. However, the Stakeholder Theory highlights that the effectiveness of such policies relies on the acceptance of diverse industry players, from large shipping lines to small port-based SMEs, whose financial capacities differ significantly [10]. To ensure fairness and broad compliance, policymakers must engage stakeholders early in designing tariff structures, offering incentives such as reduced rates for green technology adopters, subsidies for SMEs, and phased implementation to ease the transition toward sustainable maritime practices. Similar sustainability transitions have been reported across Malaysia's manufacturing and defence supply sectors, where automation, digitalisation, and localised supply frameworks enhanced both resilience and environmental outcomes [11,12].

1.1.5 Gaps identified in literature

The PRISMA-based review found major barriers to adopting environmental tariffs in Malaysia, including limited local research, weak emissions monitoring, poor institutional coordination, and resistance from SMEs [10,13]. Most existing studies are based on foreign contexts, making local adaptation difficult, while the absence of reliable data systems hinders fair implementation. SMEs also fear financial strain without incentives or phased support [14]. Additionally, a lack of regional policy alignment could lead to "port shopping," where ships avoid ports with higher fees. Addressing these issues requires stronger institutions, better monitoring technology, stakeholder engagement, and coordinated ASEAN-level policies for fair and effective tariff adoption.

2. Methodology

2.1 Research Design

The review adopted a balanced approach, combining comprehensive coverage of global studies on environmental tariffs, maritime sustainability, and port policy with a focused selection of research relevant to Malaysia's context. Using both structured database searches and manual screening, the process ensured that key international insights were captured while maintaining relevance to Malaysia's institutional, economic, and operational realities, thus achieving a strong balance between global perspective and local applicability.

2.2 Data Sources and Search Strategy

Four academic and research databases were selected: Scopus, Web of Science, ScienceDirect, and Google Scholar. Together, these platforms cover peer-reviewed journals, high-quality conference proceedings, and reputable policy papers.

The search strategy was built using Boolean operators to link key terms related to environmental tariffs, maritime emissions, and policy readiness. This ensured that the search captured both direct studies on tariffs and related works that offered transferable lessons on market-based mechanisms in maritime settings. The final search string was:

("environmental tariff*" OR "carbon tax*" OR "green levy*" OR "market-based instrument*" OR "maritime emission*" OR "port emission*")
AND ("shipping" OR "maritime transport" OR "Port Klang" OR "seaport*")
AND ("policy" OR "stakeholder" OR "readiness" OR "feasibility")

This approach was refined through several trial searches. Early searches were intentionally broad, but after reviewing initial results, the keywords were narrowed to improve relevance and avoid being flooded with unrelated material, such as environmental taxes in non-maritime sectors.

2.3 Criteria for Inclusion and Exclusion

Table 1
Screened studies based on inclusion and exclusion criteria

No.	Inclusion Criteria Met	Exclusion Criteria Triggered	Justification	Final Decision
[1]	C, D	–	Maritime emissions policy relevance	✓ Included
[2]	B, C, D	–	Focus on emission control areas	✓ Included
[3]	B, C, D	–	Marine fuel alternatives support policy context	✓ Included
[4]	B, C, D	–	Indirect market/policy relevance	✓ Included
[5]	A, C, D	–	Investment link to decarbonization economics	✓ Included
[6]	A, B, C, D	–	Regulatory solutions to shipping emissions	✓ Included
[7]	B, C, D	–	Supports global emission frameworks	✓ Included
[8]	A, C, D	–	Directly examines carbon tariffs	✓ Included
[9]	B, C, D	–	Port decarbonization strategy	✓ Included
[10]	A, B, C, D	–	Stakeholder readiness insights	✓ Included
[11]	C, D	–	Technology-sustainability parallel support	✓ Included
[12]	B, C, D	–	Stakeholder coordination lessons	✓ Included
[13]	B, C, D	–	Emission indicators directly relevant	✓ Included
[14]	B, C, D	–	Port green performance indicator relevance	✓ Included
[15]	B, C, D	–	Onshore renewable integration into ports	✓ Included
[16]	B, C, D	–	Sulfur emission reduction technologies	✓ Included

Source: Authors' synthesis (2025)

3. Results and Discussion

3.1 PRISMA Flow Summary

Table 2
PRISMA stages of article selection (2013–2024)

PRISMA Stage	Description	Number of Studies	Decision/Criteria Applied
Identification	Total records identified from Scopus, Web of Science, ScienceDirect, Google Scholar	90	Initial dataset collected
Duplicate Removal	Removal of duplicate records from the database overlap	14 removed	Prevents duplication bias
Screening (Titles & Abstracts)	Quick screening based on title relevance, sector focus, and publication year	76 screened	Non-maritime, outdated, or unrelated studies removed

Table 2 (Continued)

Records Excluded at Screening	Studies focusing on the wrong sector, pre-2013, lacking policy relevance	44 excluded	Failed inclusion criteria, triggered exclusion rules
Eligibility (Full-Text Assessment)	Detailed review for methodological rigor and policy transferability	32 assessed	Relevance to Malaysian context evaluated
Full-Text Exclusions	Too technical, lacking stakeholder/policy linkage	17 excluded	Triggered exclusion criteria
Final Studies Included	Studies meeting all inclusion criteria	✅ 15	Used for thematic synthesis

Source: Authors' PRISMA Screening (2025)

The eligibility stage involved a more detailed review of 32 full-text articles. Each study was assessed for methodological rigor, policy relevance, and transferability of insights to the Malaysian context. A further 17 studies were excluded, mainly because they focused narrowly on technical engineering without linking their findings to policy application or stakeholder impact. Ultimately, 15 studies were included in the final synthesis (Table 3).

Table 3
Key studies on environmental tariffs and maritime emissions (2013–2025)

No.	Focus Area	Methodological Type	Key Insight Contribution
[1]	Environmental & societal impact of ship emissions	Conceptual review	Highlights the health impact urgency supporting tariff adoption
[2]	Emission control areas & operational recovery	Empirical modelling	Shows route decisions affected by emission regulations
[3]	LNG & alternative fuels for emission reduction	Review	Demonstrates technological pathways complementing tariffs
[4]	Biofuels feasibility and GHG savings	Meta-analysis	Supports green fuel incentives within tariff schemes
[5]	Port investment & sustainability adaptation	Conceptual modelling	Indicates policy incentives drive emission-focused upgrades
[6]	Regulatory measures towards net-zero	Policy analysis	Provides evidence on tariff-linked decarbonization
[7]	Green technology adoption in Malaysia	Empirical	Supports policy readiness indicators for ports
[8]	Carbon tariff competition models	Quantitative economic modelling	Shows tariff balancing required to avoid competitiveness loss
[9]	Port decarbonization strategies	Systematic review	Reveals global port tariff policy trends
[10]	Net-zero transition readiness	Policy benchmarking	Highlights stakeholder acceptance gaps like Malaysia
[11]	Sustainability & automation parallels	Comparative cross-sector review	Demonstrates tech adoption relevance for port energy
[12]	Stakeholder coordination modelling	Case-based	Illustrates multi-stakeholder frameworks useful for tariffs
[13]	Carbon intensity indicator implementation	Applied policy evaluation	Supports digital emission monitoring requirements
[14]	Green port KPIs	Case study	Supplies measurable indicators to evaluate tariff outcomes
[15]	Shore power impact on emissions	Technical feasibility study	Reinforces tariff-linked port electrification benefits
[16]	Sulfur reduction technology selection	Decision modelling	Aligns technology readiness with tariff incentives

Source: Authors' synthesis (2025)

3.2 Thematic Findings

3.2.1 Institutional readiness

Institutional readiness plays a critical role in the effective implementation of environmental tariffs, as evidenced by studies from European contexts, particularly in Scandinavian ports, where success depends on clear legal mandates, strong administrative structures, and transparent emissions monitoring systems [13]. In contrast, Malaysia faces several institutional hurdles, including fragmented agency responsibilities, lack of a centralized authority to oversee environmental tariffs, and limited familiarity with market-based environmental mechanisms. These shortcomings hinder enforcement and compliance, underscoring that institutional readiness extends beyond regulatory authority to include skilled human resources, inter-agency coordination, and technical capacity for emissions tracking, as demonstrated by the examples of Gothenburg and Rotterdam ports [9].

3.2.2 Stakeholder acceptance

Stakeholder acceptance is a vital determinant of successful environmental tariff implementation, as studies emphasize the importance of engaging shipping companies, logistics providers, and SMEs early in the process to build trust and compliance [17]. International experiences, such as China's phased emission-based port charges with financial support and the EU's incentive schemes for cleaner vessels, show that transparent communication and fair incentives reduce resistance and encourage investment in green technologies [6]. For Malaysia, designing tariffs that consider the financial constraints of SMEs and offering transitional aid or incentives is crucial to ensuring cooperation and preventing industry pushback that could undermine policy effectiveness.

3.2.3 Policy integration and international lessons

The third theme highlights that environmental tariffs are most effective when integrated into broader sustainability frameworks rather than implemented in isolation [5]. In the EU, such tariffs are complemented by initiatives like port electrification, green shipping corridors, and alternative fuel subsidies, creating a cohesive approach that supports compliance and long-term decarbonisation [15]. For Malaysia, while its National Transport Policy and port master plans include sustainability objectives, they have yet to incorporate market-based tools such as environmental tariffs. Integrating these tariffs into a phased green port strategy could enhance policy coherence, align with regional climate goals, and prevent overlap or conflict among existing environmental measures.

3.2.4 Technological measures

The fourth theme emphasizes that technology is crucial for the success of environmental tariffs, as effective implementation depends on supporting infrastructure like shore power systems, emission monitoring, and alternative fuel facilities. European ports demonstrate that combining tariffs with such technologies as shore power, enabling ships to cut emissions while docked, creates strong incentives for cleaner operations [6]. In Malaysia, however, technological capacity remains limited despite growing interest in renewable integration. Introducing tariffs without adequate infrastructure could burden operators unable to reduce emissions, highlighting the need for technological readiness to progress alongside policy formulation [16].

3.3 Interconnections between themes

Although the four themes, institutional readiness, stakeholder acceptance, policy integration, and technological support, are discussed individually, they are closely interlinked, with weaknesses in any area potentially undermining the success of environmental tariffs. For Malaysia, this means that implementing such tariffs requires a holistic, coordinated strategy combining governance reform, infrastructure investment, industry collaboration, and regional partnerships. The accompanying SWOT analysis reinforces this perspective, identifying strengths such as alignment with global decarbonisation goals, weaknesses like institutional fragmentation and SME vulnerability, opportunities through pilot initiatives and green financing, and threats related to port competitiveness and "port shopping" risks.

Table 4
SWOT analysis of environmental tariffs in Malaysia's maritime sector

Strengths (S)	Weaknesses (W)
• Aligns with global decarbonization goals	• Fragmented institutional responsibilities
• Can reduce port-related emissions	• Limited emission monitoring infrastructure
• Incentivizes cleaner vessel operations	• SME financial resistance
• Generates revenue for green port upgrades	• Lack of experience with market-based tools

Opportunities (O)	Threats (T)
• Pilot programs and phased rollout	• Port competitiveness risk ("port shopping")
• Access to green financing incentives	• Industry resistance may delay adoption
• ASEAN policy harmonization potential	• High infrastructure upgrade costs
• Growth of port electrification	• Slow regulatory processes

Source: Authors' synthesis (2025)

3.4 Conceptual Policy Model for Environmental Tariffs in Malaysia

Based on the thematic analysis, the study presents a conceptual policy model for implementing environmental tariffs in Malaysia's maritime sector, integrating four key dimensions: institutional readiness, stakeholder acceptance, policy integration, and technological support. The model adopts a phased approach where institutional and technological readiness form the foundation, stakeholder acceptance ensures legitimacy, and policy integration aligns the initiative with long-term national and regional decarbonisation goals. As illustrated in Figure 1, these interconnected dimensions collectively guide the development of a sustainable and effective environmental tariff framework for the maritime industry.

Table 5
Conceptual policy model for environmental tariffs in Malaysia

Core Dimension	Strategic Focus	Key Enablers/Actions	Expected Outcomes
Institutional Readiness	Strengthen governance capacity for tariff implementation	• Establish centralized authority • Improve inter-agency coordination • Develop clear regulatory guidelines • Allocate trained personnel	• Enhanced enforcement • Transparent compliance • Reduced administrative fragmentation

Table 5 *(Continued)*

Stakeholder Acceptance	Foster industry trust and cooperation	• Early stakeholder engagement • Dialogue with SMEs and shipping lines • Transitional financial support • Awareness campaigns	• Reduced resistance • Higher compliance rates • Fair cost distribution
Policy Integration	Align tariffs with national and regional sustainability goals	• Embed tariffs in port master plans • Link with decarbonization policies • Integrate with ASEAN climate initiatives • Incentivize green shipping corridors	• Policy coherence • Regional competitiveness • Minimal policy conflict
Technological Support	Enable operational capability for emission reduction	• Deploy shore power (cold ironing) • Install emission monitoring systems • Facilitate LNG/alternative fuel access • Adopt digital tracking systems	• Accurate emission data • Operational efficiency • Lower onshore pollution

Source: Authors' conceptual framework (2025)

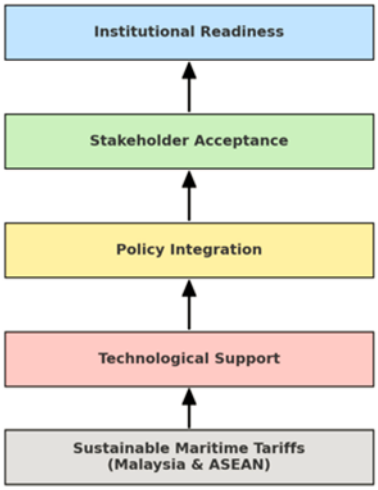

Fig 1: Conceptual policy model for environmental tariffs in Malaysia (Authors, 2025)

4. Conclusions

This study explored the feasibility of introducing environmental tariffs in Malaysia's maritime sector, with a particular focus on Port Klang, through a PRISMA-based Systematic Literature Review of 15 high-quality studies. By integrating global best practices, regional experiences, and local insights, the review found that while environmental tariffs have strong potential to reduce greenhouse gas emissions from shipping, their success depends on more than the tariff itself. Effective implementation requires a comprehensive framework that balances economic, institutional, and technological considerations.

Four key factors emerged as essential for successful implementation: institutional readiness, stakeholder acceptance, policy integration, and technological support. Strong governance is necessary to ensure fair enforcement and compliance, while active stakeholder engagement, especially among SMEs, is vital to build trust and financial feasibility. Embedding tariffs within broader sustainability policies and complementing them with technologies such as shore power and emission monitoring systems further enhances transparency and operational effectiveness.

For Malaysia, several challenges remain, including limited institutional capacity, weak monitoring mechanisms, and insufficient alignment with ASEAN environmental policies. To overcome these, a phased introduction of environmental tariffs, coupled with targeted infrastructure investment and inclusive stakeholder consultation, is recommended. If properly executed, Malaysia can position Port Klang as a regional pioneer in sustainable maritime development while advancing its commitment to global decarbonisation goals. Insights from other Malaysian industrial sectors, such as sustainable military ration supply chains and food manufacturing automation, further underscore that technology adoption and stakeholder coordination are vital enablers for sustainable transformation [11,12].

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References

[1] Roy, Atanu, and Manashi Chakraborty. "A review of ship emissions impacts on environmental, health, societal impacts and IMO's mitigation policies." *Regional Studies in Marine Science* (2024): 103964. doi: 10.1016/j.rsma.2024.103964.

[2] Z. Elmi et al., "Ship schedule recovery with voluntary speed reduction zones and emission control areas," Transp Res D Transp Environ, vol. 125, Dec. 2023. doi: 10.1016/j.trd.2023.103957.

[3] Zhang, Wanying, Jing Wang, Geng Qin, Satpathi Kuntal, Fuzhong Gong, and Ran Yan. "Review of the state-of-the-art of alternative marine fuels: A viable approach to zero-carbon shipping." *Cleaner Logistics and Supply Chain* (2025): 100232. doi: 10.1016/j.clscn.2025.100232.

[4] Silva, Jean Felipe Leal, Luiz Augusto Horta Nogueira, Heitor Cantarella, Raffaella Rossetto, Rubens Maciel Filho, and Glaucia Mendes Souza. "Meta-data analysis of biofuels in emerging markets of Africa and Asia: Greenhouse gas savings and economic feasibility." *Renewable and Sustainable Energy Reviews* 213 (2025): 115465. doi: 10.1016/j.rser.2025.115465.

[5] Chen, Dongxu, Yujie Gu, and Zhongzhen Yang. "Multi-period port cluster investment along the maritime silk road considering the matching of relocated industries and recipient countries." *Ocean & Coastal Management* 266 (2025): 107665. doi: 10.1016/j.ocecoaman.2025.107665.

[6] Liu, Pengfei, Yiyi Xu, Xiang Xie, Serkan Turkmen, Shanshan Fan, Hassan Ghassemi, and Guanghua He. "Achieving the global net-zero maritime shipping goal: The urgencies, challenges, regulatory measures and strategic solutions." *Ocean & Coastal Management* 256 (2024): 107301. doi: 10.1016/j.ocecoaman.2024.107301.

[7] Majekodunmi, Temitayo B., Mohd Shahidan Shaari, Noorazeela Zainol Abidin, and Abdul Rahim Ridzuan. "Green technology, exports, and CO2 emissions in Malaysia." *Heliyon* 9, no. 8 (2023). doi: 10.1016/j.heliyon.2023.e18625.

[8] Hua, Jiawen, Jun Lin, Kai Wang, and Yanjun Qian. "Levying carbon tariffs considering foreign competition and technology choice." *Omega* 135 (2025): 103321. doi: 10.1016/j.omega.2025.103321.

[9] Yildiz, Ramazan Ozkan, Elif Koc, Oguzhan Der, and Murat Aymelek. "Unveiling the contemporary research direction and current business management strategies for port decarbonization through a systematic review." *Sustainability* 16, no. 24 (2024): 10959. doi: 10.3390/su162410959.

[10] Mohd Zaideen, Izyan Munirah, Dan van der Horst, and Mohd Faizal Ramli. "Gearing up for a net zero GHG emission in Malaysia shipping sector: A reference from the United Kingdom." *Journal of International Maritime Safety, Environmental Affairs, and Shipping* 8, no. 3 (2024): 2370684.doi: 10.1080/25725084.2024.2370684.

[11] N. Fyadzillah and M. Taha, "AUTOMATED TECHNOLOGIES AND SUSTAINABILITY-BASED FOOD MANUFACTURING: SELECTED MALAYSIAN AND BRITISH MANUFACTURERS," 2016. [Online]. Available: https://www.researchgate.net/publication/385353024

[12] Hashim, Hani Kalsom, Muhammad Izzat Sallehudin, Nor Fyadzillah Mohd Taha, Roshamida Abd Jamil, and Mohd Norsyarizad Razali. "Sustainable Military Fresh Ration Supply: Exploring Key Factors and Camp Farming Potential." *Akademika* 95, no. 2 (2025): 135-153. doi: 10.17576/akad-2025-9502-08.

[13] Chuah, Lai Fatt, Kasypi Mokhtar, Siti Marsila Mhd Ruslan, Anuar Abu Bakar, Mohd Azhafiz Abdullah, Nor Hasni Osman, Awais Bokhari, Muhammad Mubashir, and Pau Loke Show. "Implementation of the energy efficiency existing ship index and carbon intensity indicator on domestic ship for marine environmental protection." *Environmental Research* 222 (2023): 115348. doi: 10.1016/j.envres.2023.115348.

[14] Alfian, Hikmah Affirin Shahrul, Amayrol Zakaria, and Aminuddin Md Arof. "Green Port Performance Indicators for Dry Bulk Terminal: A Case Study of Port Klang." *Journal of Ship and Marine Structures* 8, no. 1 (2025): 19-28. doi: 10.37934/jsms.8.1.1928.

[15] Makram, Merna, Ameen M. Bassam, Adel A. Tawfik, and Waleed Yehia. "Assessment of onshore renewable energy power supply for ship's emissions reduction in port said west port." *Journal of Marine Science and Application* 23, no. 2 (2024): 506-524. doi: 10.1007/s11804-024-00423-4.

[16] Zhou, Yan, and Chuanxu Wang. "Distributionally robust selection for sulfur emission reduction technologies in a shipping route with risk-averse criterion." *Computers & Industrial Engineering* 193 (2024): 110339. doi: 10.1016/j.cie.2024.110339.