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Nur Syafiqah Mohammad Rafikhi and Nik Nurhalida Nik Hariry

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THE READINESS OF IMPLEMENTING A ZERO-EMISSION SHIPPING POLICY IN MALAYSIA

Nur Syafiqah Mohammad Rafikhi and Nik Nurhalida Nik Hariry

Faculty of Maritime Studies, Universiti Malaysia Terengganu, 21300 Kuala Nerus, Terengganu, Malaysia.

ABSTRACT

The shipping industry's growth in Malaysia has led to a significant increase in ship emissions, impacting air and marine quality and posing risks to human health, climate, and ecosystems. To address these environmental challenges, this research paper examines the implementation of a zero-emission shipping policy in Malaysia. The objectives of this study are to identify the impact of such a policy on the country's shipping industry for the successful implementation of the zero-emission policy. Qualitative methodology was employed, and interviews were conducted with the Marine Department Malaysia (MDM) to gather insights and data. Content analysis was applied to analyse the interview results. This research contributes to addressing the shipping industry's sustainability challenges in Malaysia by providing insights into the implementation of a zero-emission policy.

Keywords: Zero-emission, shipping policy, maritime industry, carbon emissions reduction, content analysis.

Introduction

International shipping is critical to the global economic system, transporting more than 80% of the total volume of products traded internationally (UNCTAD, 2021). Despite the efficiency of shipping as a mode of transportation, the overall number of ships and relatively large emissions from ships' engines influence the environment and human health (Alföldy *et al.*, 2013). With the growth of the global economy and the increasing significance of international trade, it is anticipated that emissions from the shipping sector will continue to increase rapidly. There is currently no systematic investigation of the effects of zero-emission shipping rules in Malaysia on CO₂ emissions (Solaymani, 2022).

According to Gössling, Meyer-Habighorst, and Humpe (2021), ship emissions are a significant source of total

air pollution and impact the sea, territorial waters, and coastal air quality. Emissions from the shipping industry include CO₂, nitrous oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), unburned hydrocarbons (HC), and particulate matter (PM_{2.5}, PM₁₀). This is concerning because the figure is anticipated to increase with the growth of global trade activity. Furthermore, another source emphasizes that shipping accounts for 2.8% of global greenhouse gas emissions, owing primarily to its rapid growth, emphasizing the expected increase in emissions with the expansion of global trade activities (Morante, 2022). The International Maritime Organization (IMO), by implementing the legal provisions outlined in the International Convention on the Prevention of Pollution from Ships (MARPOL 73/78) and its annexes, is tasked with regulating greenhouse gas emissions from international shipping. There are two indices that measure ship-generated gas pollution. Firstly, the IMO-implemented Energy Efficiency Existing Ship Index (EEXI) to reduce ships' greenhouse gas emissions. EEXI is a measurement of a ship's technical design and ships must obtain EEXI approval once in their lifespan, no later than the first periodic survey in 2023 (EEXI | Energy

Efficiency Existing Ship Index - DNV, 2023). Secondly, the Carbon Intensity Indicator (CII) addresses ship CO₂ emissions. IMO adopted it in June 2021. It measures ship carbon dioxide emissions per transport operation, such as cargo carried or distance traveled. Ships with high carbon intensity must reduce their emissions. It promotes GHG emission reduction and worldwide shipping fleet carbon efficiency.

According to MIDA (2021), Malaysia's maritime industry contributes to approximately 40% of the country's GDP. Malaysia exports more than 90% of its goods by sea. MIDA also explains that global temperatures are rising and sea lanes are becoming congested. Mechanical engines continue to emit harmful pollutants, and half of the world lacks access to clean fuels and technology. As a result, the Malaysian maritime industry needs to emphasise lowering carbon dioxide emissions and encouraging sustainable development. According to Green (2021), if no action is taken to reduce international shipping carbon emissions, they are expected to increase 90-130% over 2008 levels by 2050. Currently, the shipping industry accounts for approximately 3% of total emissions. Based on the World Economic Forum, the shipping industry was responsible for 90% of world trade by volume (Yusof, 2022).

Nonetheless, switching to alternate fuels is challenging, as many of the available alternatives are either technologically or practically incomplete. Solakivi *et al.* (2022) pointed out that there are limited studies on how rules and regulations affect the shift towards alternative fuels; they also emphasised the need for studies addressing the challenges to the adoption of alternative fuels from the standpoint of a shipowner. This indicates that the Malaysian government has yet to establish a policy on regulations for replacing ship fuel to reduce emissions. The shipping industry poses one of the most significant challenges for

implementing a zero-emissions strategy due to its long asset lifespans, substantial energy dependence, and limited feasible transportation options. Consequently, this study is crucial for assessing Malaysia's shipping industry's readiness to implement a zero-emission policy and the impact of such a policy.

Literature Review

CO₂ is a non-toxic, odourless, and tasteless gas that is produced as a byproduct of the burning of carbon and the respiration of living beings (Directorate, n.d.). CO₂ emissions are those that are produced as a result of the combustion of fossil fuels and the production of cement. According to Schwartz, Gustafsson, and Spohr (2020), it is thought that about 3% of all carbon emissions are caused by shipping and it is expected that the shipping industry's CO₂ emissions will rise by 50 - 250% between 2015 and 2050. Because of the large size and quantity of ships, as well as the extensive distances that they sail, the shipping industry is a substantial contributor to CO₂ emissions. Additionally, ships typically use high-sulfur fuels, which are known to produce a greater amount of CO₂ per unit of energy than other types of fossil fuels. However, reducing CO₂ emissions caused by the shipping industry is a difficult and time-consuming effort that requires international collaboration and investment in new technology. Nitrous oxides are a group of highly reactive gasses that are made when fuel burns, especially at high temperatures. At the same time, many vessels with internal combustion engines also release nitrous oxides at different levels (Yuksel, 2021). Nitrous oxide (NOx) is a type of air pollutant that comes from ship engines and boilers. Shipping's NOx emissions contribute to bad air quality and human health, especially in port cities where ships release a lot of pollutants. According to Eyring, Corbett, Lee, and Winebrake (2007), most marine engines operate at

high temperatures and pressures without the use of efficient reduction methods, which contributes to the relatively high levels of NO_x emissions. This gas can make it hard to breathe, make it hard to see, and have other negative effects on the environment.

Sulfur oxides (SO_x) are a type of air pollution produced when fossil fuels, including diesel and coal, used in the shipping industry are burned. The high average sulfur content (2.4 - 2.7%) of marine fuels primarily contributes to the high levels of SO₂ emissions by most vessels that sail the ocean (Eyring *et al.*, 2007). According to Klimont, Smith, and Cofala (2013), because of the significant negative effects that sulfur dioxide emissions have on human health, as well as land and aquatic ecosystems, governments all over the world are taking steps to regulate them more strictly. Thus, the shipping industry is looking into regulations to limit the amount of sulfur that can be found in marine fuels and to encourage the research and development of technologies that are less harmful to the environment to cut down on the amount of SO₂ that is emitted.

Challenges of Implementing Zero-Emission Policy

The shipping sector is a major contributor to greenhouse gas emissions. The ship owners and national governments will need to take significant action to slow the progression of climate change and lower greenhouse gas emissions. Governments need to invest in capacity building within the shipping industry. The effectiveness of regulations is reduced when there are criteria that are difficult or impossible to satisfy due to a lack of knowledge, skills, or funds on the side of the players or mismanagement on the part of policymakers. Presently, Malaysia has no specific policies about zero-emissions shipping. However, the country has taken some steps to improve the environment and reduce pollution from the shipping industry.

According to Majid Zain and Nubli (2022), Malaysia has signed the International Convention for the Prevention of Pollution from Ships (MARPOL). By signing MARPOL, Malaysia may gain access to international incentives and collaborations aimed at promoting sustainable practices and technologies in the shipping industry, thereby reducing carbon emissions (George *et al.*, 2017). MARPOL also contains provisions for reducing various pollutants, such as sulfur oxides and nitrogen oxides.

Malaysia reduces emissions that impact air quality and contribute to climate change by implementing these measures, but Malaysia has no specific policies for zero-emission shipping. However, the country has taken steps to deal with marine pollution and improve the environment, it has promised to help green technologies grow in Malaysia. According to Wan *et al.* (2016), there are three steps to dealing with marine pollution: First, clean up ship scrapping; second, control emissions; and third, improve port management. The shipping industry will have a hard time reducing emissions because ship owners will continue to put a high priority on keeping a low-cost transportation model (Hoang *et al.*, 2022). According to Yusof (2022), bunker oils like methanol, ammonia, and hydrogen are not yet available in quantity to power all the world's 60,000 ocean-going ships, and they are several times more expensive (Yusof, 2022). Furthermore, resistance to change is a management challenge. Because the shipping industry has relied on fossil fuels for decades, some businesses and individuals may be resistant to change. The shipping industry is under increased pressure to reduce CO₂ emissions and comply with regulations, such as the International Maritime Organization's (IMO) goal of reducing shipping's carbon intensity.

The shift to zero-emission shipping practices is a challenge that involves major investment in new technology and

infrastructure (Hoang *et al.*, 2022). The cost of adopting technologies that produce zero emissions is one of the primary obstacles that the shipping industry must overcome to successfully navigate this shift (Hoang *et al.*, 2022). Developing and implementing new propulsion systems, purchasing and installing new fuel storage and distribution systems, and retrofitting existing ships to make them compatible with zero-emission technologies are some of the higher costs associated with environmentally friendly shipping. These costs, which include the cost of fuel and maintenance are often greater for zero-emission technologies as compared to traditional systems-based on fossil fuels. Furthermore, the lack of infrastructure and support systems for zero-emission technology, such as hydrogen fueling stations and electric charging networks is another obstacle that the shipping sector must overcome to be successful (Singh *et al.*, 2022). The establishment of this infrastructure is one of the potential roadblocks to the broad adoption of zero-emission shipping because it is both costly and calls for a considerable investment.

Among the currently applicable policy instruments for reducing gas emissions generated by Malaysia's shipping industry are the National Bio-fuel Policy of 2006, Environmental Quality Act (Amendment) 2012 - Act A1441, and IMO Strategy on Reduction of GHG Emissions from Ships. The National Bio-fuel Policy of 2006 has played a pivotal role in shaping Malaysia's approach to reducing gas emissions in the shipping industry. By promoting the use of biofuels, this policy has contributed to a measurable decrease in the carbon footprint of maritime activities, fostering sustainable and environmentally friendly practices (Shahid *et al.*, 2014). The Environmental Quality Act (Amendment) 2012 (Act A1441) has had a considerable impact on Malaysia's shipping industry's regulation of gas emissions (Mustafa &

Fauzi, 2022; Atheefa Sufeena Suaree *et al.*, 2023). This amendment has reinforced enforcement mechanisms through strengthened legislative frameworks and updated standards, resulting in increased compliance and a good trajectory toward a cleaner and more environmentally sustainable maritime sector. Malaysia's endorsement of the IMO Strategy on Reducing GHG Emissions from Ships demonstrates the country's commitment to address global climate concerns within the shipping industry. The impact of this worldwide partnership can be seen in increased industry awareness, enhanced technology uptake, and continuous efforts to meet emission reduction targets, connecting Malaysia with global aspirations for a greener marine future (Joung *et al.*, 2020).

Theory

The diffusion innovations theory describes the process by which new technologies and other advancements spread within societies and cultures, starting from their initial adoption and progressing toward more widespread use. By employing this theory, we can gain insight into how technological progress and innovation impact the adoption and implementation of policies intended to achieve zero emissions (Halton, 2021). Taking measures to decrease greenhouse gas output or implementing strategies to lower pollutant discharges requires the application of technology, which in turn require the backing of technical innovation. Controlling, lowering, removing, and absorbing greenhouse gasses is the goals of these technological advancements. For example, the technological innovations that are in development to reduce emissions from the shipping industry are battery-powered and hybrid vessels. The actions that a nation's government, corporation, or any other public or private organization takes to mitigate the effects of pollution on the natural environment

are referred to as environmental policy theory. To be more specific, environmental policy refers to efforts intended to stop or lessen the negative impact that human activities have on ecosystems (Bueren, 2023). The regulation sets environmental standards. Interventions encourage or discourage specific behaviours and their impacts, including emissions. The theory of environmental policy investigates the processes by which environmental policies are formulated and put into practice to address environmental problems. It can be used to gain an understanding of how policies to achieve zero emissions are developed, implemented, and enforced.

In the context of Malaysia, the Environmental Quality Act of 1974 (EQA 1974) is the principal legislation in the country that governs the protection and preservation of the environment. Sections 21 and 51 of the EQA 1974 confer upon the Minister responsible for environmental protection the power to promulgate regulations that establish the permissible standards for the release of hazardous substances and pollutants into the environment and prohibit the emission of gaseous substances into the environment (Majid Zain & Nubli, 2022). Through the development of a road map, Malaysia may be able to realize its objective of becoming carbon neutral by the year 2050. The Carbon-Free Energy Roadmap for Malaysia (2015-2050) was the first roadmap to address CO₂ emissions from the energy sector and statistically quantify mitigating impacts (Chan & Sopian, 2022).

Methodology

This study utilised the qualitative method, where primary data and secondary data were used. The primary method will be interviews, conducted with the sample's respondents to survey the progress of the zero-emission shipping policy in Malaysia.

Then, secondary data, usually from past studies or research, will help the researcher understand better about the topic in this study. This research will collect data from existing data sources on the internet, books, articles, journals, libraries, and research reports. The instrument that will be used in this research is the open-ended interview. Open-ended questions do not give participants a set of answers but instead let them respond in their own words (Allen, 2017). The researcher used open-ended questions to encourage discussion of the interviewees' thoughts and experiences, instead of simply statistical responses. This is because open-ended responses allow respondents to give more options and opinions.

In this study, the chosen sampling method is purposive sampling, which involves selecting individuals or groups of individuals who have extensive knowledge or experience about the subject of interest. According to Palinkas, Horwitz, Green, Wisdom, Duan, and Hoagwood (2015), purposive sampling is commonly used in qualitative research to optimise limited resources by identifying and selecting cases that provide rich and informative data. Participants are selected based on specific characteristics, such as their expertise or experience. Hence, this study conducted surveys of the progress of the zero-emission shipping policy in Malaysia. The sample's respondents are employees of the Marine Department Malaysia (MDM) is a government agency responsible for the administration, regulation, and development of Malaysia's maritime sector, including the enforcement of environmental regulations for shipping activities. Officials from this department can provide insights into the environmental impacts of shipping emissions and the benefits of implementing a zero-emission shipping policy. The range of the sample's respondents among 2-3 persons.

Content Analysis

In this research, the method of content analysis will be used to investigate the challenges of implementing a zero-emission shipping policy. According to Elo *et al.* (2014), content analysis is a method of qualitative data analysis by thoroughly analysing text, audio, or visual data to discover patterns, themes, and meanings. Typically, the content analysis process consists of three phases: Preparation, organisation, and reporting. Also, it involves transcribing the interviews and creating a classification scheme to identify policy implementation themes, problems, and perspectives. The coding scheme should address impediments, successful practices, stakeholder viewpoints, and other pertinent elements.

By methodically reviewing a wide range of relevant documents, reports, articles, and policy papers, content analysis can study the problems of adopting a zero-emission shipping strategy. This method dissects and categorises textual material by using predefined coding categories aligned with crucial criteria such as technological limitations, economic limits, regulatory difficulties, or public perception. It reveals the prevalence and complexities of these issues through quantitative and qualitative analyses, providing a complete knowledge of the barriers to adopting and implementing such policies. Content analysis contextualizes findings within the shipping industry and policy landscapes, allowing for informed policymaking and targeted interventions to overcome barriers to reaching zero-emission shipping goals.

Data Analysis

RO1: To determine the readiness of Malaysia's shipping industry in implementing a zero-emission policy.

The Malaysian government's proactive pursuit of a zero-emission shipping policy unexpectedly aligns with both international decarbonization initiatives and industry-specific preparedness. According to the Paris Agreement, Malaysia is ready and committed to reducing 45% of greenhouse gas emissions by 2030 (Zain, 2022). The United Nations Conference on Trade and Development's (UNCTAD) recent report, underlining the shipping sector's readiness for a low-carbon future, repeat the direction charted by Malaysian policymakers. This confluence generates propitious conditions for oil and gas companies to leverage their established technical expertise in developing net-zero solutions tailored specifically for the shipping industry's imminent transformation (Wong *et al.*, 2022). By synergistically harnessing policy ambitions, global momentum, and industry know-how, Malaysia can propel its shipping sector toward a clean and sustainable future.

Table 1 shows the data analysis of the first research objective, which is to determine the readiness of Malaysia's shipping industry to implement a zero-emission policy that can be categorized into four topics: Policy, technology, cost, and alternative fuel.

Table 1: Open coding process for objective 1

Government/ Expert	Topic	Code	Interview Statement
Marine Department Malaysia	Policy	RO1MDPC	...the most important thing regarding adopting the zero-emission policy is the legislation, that is the legislation, where matters related to zero-emission are closely related to the MARPOL Convention. RO1MDPC01
			...policy means a guideline to implement things related to zero-emission policy and the challenge Malaysia will go towards zero-emission. RO1MDPC02
	Technology	RO1MDTG	...there is technology to adapt it and replace the diesel itself for example ammonia, methanol... RO1MDTG01
			...the technology, for these two ships things are engines and also fuel... RO1MDTG02
	Cost	RO1MDCS	...these facilities will be affected and technology has to be capable of it suitability for ship operations... RO1MDTG02
			... for example, cost... where do we want to get the source...maybe There is no more source of fuel and this is costly ... RO1MDCS01
Alternative fuel			...cost will be fully borne by the shipowner... RO1MDCS02
		RO1MDAF	...there is the technology that can replace diesel itself, for example, ammonia, methanol... these do not produce CO ₂ ... RO1MDAF01
			... adopted MFO and then change to Hydrogen to Ammonia, needs to put in a new engine... RO1MDAF02
			...these ships want to use less oil carbon, they want to use ammonia, then the need to identify whether the hydrogen is available and also the availability of facilities at the port... RO1MDAF02

As a result of the responses, it is possible to conclude that the Malaysian shipping industry is ready to implement a zero-emission policy in terms of the policy itself, technology, cost, and alternative fuel.

RO2: To identify the impact of a zero-emission policy on Malaysia's shipping industry.

Despite short-term policy interventions within the Malaysian shipping industry to curb emissions, the substantial economic burdens associated with zero-emission vessel procurement and the current supply chain constraints hindering their accessibility, present formidable barriers to achieving total decarbonization (Yusof, 2021). A synergistic nexus manifests when environmental benefits, enhanced competitiveness, innovation, job creation,

and public health improvements converge. As evidenced by this study, the embrace of sustainable practices in the maritime transport sector can catalyse a cascade of positive externalities. Emission reductions directly contribute to environmental gains, ameliorating air quality and mitigating climate change. This, in turn, fosters public health advantages for communities in proximity to maritime activities. This dynamic interplay between environmental responsibility, economic growth, and societal well-being underscores the compelling potential of transitioning towards a cleaner future for maritime transport.

According to Table 2, the data analysis of the second research objective is to identify the impact of a zero-emission policy on Malaysia's shipping industry can be divided into two topics: Economy and training.

Table 2: Open coding process for objective 2

Government/ Expert	Topic	Code	Interview Statement
Marine Department Malaysia	Economy	RO2MDEC	... for the short-term duration, there is a negative impact on the economy but for the long-term duration, this can have a positive impact...
			RO2MDEC01
	Training	RO2MDTR	...in terms of economic performance, if we have gone green with zero-emission, this will stimulate the economy because we have started investing in technology and infrastructure...
			RO2MDTR01
			...the system is different, we want to train people using the old engine to use the new engines, that is necessary for training...
			RO2MDTR02
			...for a smooth transition, it is fine because there is a party that can supply training at the beginning. Will need to start the training.
			Design the training; training needs and assessment.
			RO2MDTR02

Therefore, the data analysis for the second aim showed the impact of a zero-emission policy on Malaysia's shipping industry from economy and workforce training. Early changes for greener technology may have short-term economic effects, but the policy can boost economic growth in the long term. To successfully transition to zero-emission technologies, personnel training is essential.

Results and Discussion

The first objective was to evaluate the readiness of Malaysia's shipping industry to adopt a zero-emission policy in terms of policy, technology, cost, and alternative fuel. The data analysis disclosed the industry's moderate readiness for policy adoption, advancements in technology adoption, concerns regarding cost considerations, and a rising interest in alternative fuels.

The second objective identified the impact of a zero-emission policy on Malaysia's shipping industry in terms of the economy and workforce training. The data analysis provided an in-depth picture of the economic impact, highlighting both short-term concerns and long-term prospects for economic development through cleaner technologies. In addition, the importance of workforce training in supporting the integration of zero-emission technologies was emphasised, providing policymakers with valuable insights for effectively addressing this aspect.

Conclusion

In conclusion, implementing a zero-emission shipping policy in Malaysia presents several significant challenges. The findings indicate that policy clarity and effective government action are essential for a successful transition to zero emissions. Policy, technology, cost, alternative fuel, and propulsion present challenges that must be addressed.

The successful implementation of a zero-emission policy requires clear government action along with the coordination of national legislation with international conventions. Investments in new technologies and infrastructure are required to reduce pollution and transition to greener maritime practices. Governments are critical in accelerating the transition to zero-emission policy. Clear and decisive government action entails developing strong policies, defining emission reduction targets, and putting in place regulatory structures. This proactive approach lays the groundwork for long-term behaviours. It is vital to coordinate national legislation with international conventions. Aligning local regulations with global initiatives, such as those established by the International Maritime Organization (IMO), ensures a coordinated effort in addressing emissions on a larger scale and encourages a shared commitment to environmental goals.

The cost of the zero-emissions transition is significant. Finding cost-effective solutions and incentives for ship owners and operators is essential for implementation success. Ammonia and hydrogen have the potential to supplant conventional fuels and reduce greenhouse gas emissions. It is critical to embrace new and sustainable technology in order to reduce pollution.

Governments should encourage and invest in R&D for creative solutions such as green fuels, energy-efficient propulsion systems, and emission-reduction technology. However, the availability and accessibility of these fuels and the development of supporting infrastructure must be considered. An important factor for minimising emissions in the shipping industry is propulsion systems, particularly electric propulsion or battery cells. To support the adoption of sustainable power systems, logistics, and infrastructure issues about charging or refuelling stations must be resolved.

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