The Urgency of Establishing National Regulations on Reducing Greenhouse Gas Emissions from Maritime Transport in Indonesia

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Abstract. Maritime transport is one of the largest sources of greenhouse gas emissions, significantly contributing to global climate change. Various international instruments, including an Advisory Opinion from the International Tribunal for the Law of the Sea (ITLOS), which classifies anthropogenic greenhouse gas emissions as a form of marine pollution, have mandated the reduction of these emissions in recent years. However, there are currently no legal regulations specifically addressing reducing greenhouse gas emissions from the maritime transport sector in Indonesia. This study aims to understand the urgency of establishing national rules on reducing greenhouse gas emissions from maritime transport in Indonesia. The research method used is normative juridical, examining the technical aspects of emissions from maritime transport, the availability of environmentally friendly technology in the shipping industry, and Indonesia's global commitments to reduce greenhouse gas emissions. The study results indicate that given these findings, Indonesia has a high urgency to immediately create regulations that reduce greenhouse gas emissions in the maritime transport sector. Such regulations will align with global commitments and also support Indonesia's efforts to protect the marine environment and achieve national emission reduction targets.

Keywords: Greenhouse Gas Emissions, Maritime Transport, Environmental Regulation.

1 Introduction

Indonesia is the largest archipelagic country in the world, boasting the second-longest coastline globally, with 70% of its territory comprising a sea area of 5.8 million km² [1]. Given this context, sea transportation plays a vital role in connecting various regions and islands. The development of the maritime industry in Indonesia serves as an indicator of the nation's and state's progress [2].

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However, the environmental aspects of Indonesia are at risk due to the efforts to enhance maritime transportation coverage. In response, Indonesia has enacted several laws aimed at mitigating environmental damage caused by maritime transport. With the increasing focus on environmental issues and the recent International Tribunal for the Law of the Sea (ITLOS) Advisory Opinion regarding climate change, questions have arisen about Indonesia's compliance with its obligations under UNCLOS. This article argues that while Indonesia has made efforts to enact laws aimed at reducing greenhouse gas (GHG) pollution, it still needs to implement more comprehensive legislation to align better with current environmental and legal standards.

The research method employed in this study is normative juridical, focusing on the examination of legal norms and frameworks related to maritime transport emissions and environmental obligations. A normative juridical approach primarily analyzes legal rules, principles, and doctrines to understand how laws should regulate specific phenomena—in this case, maritime transport emissions. This method is particularly relevant for examining the alignment of Indonesian shipping practices with international commitments to reduce greenhouse gas emissions and for evaluating the role of legal frameworks in promoting the adoption of environmentally friendly technology within the industry. By evaluating the technical aspects of emissions, the availability of green technologies, and the legal mechanisms supporting these changes, this research method provides a structured approach to understanding both the current regulations and the potential legal reforms necessary to meet global environmental standards. This approach ensures that the research not only investigates the legal landscape but also addresses the practical challenges of implementing sustainable practices in the maritime sector.

2 Emission from Maritime Transport and Alternative

Maritime transportation is a cornerstone of the global economy, but it also significantly contributes to the climate crisis, according to Dominik Englert, a World Bank economist [3]. Approximately 3% of the world's anthropogenic greenhouse gas (GHG) emissions are attributed to international shipping, and this percentage is expected to increase in the future [4]. The primary greenhouse gases (GHGs) released during shipping include methane (CH_4), carbon dioxide (CO_2), and nitrogen oxide (N_2O), with CO_2 posing the greatest potential for global warming [5].

From 2019 to 2023, industrial factories have been the largest source of air pollution in Indonesia, followed by the transportation sector. Among various forms of transportation, sea transportation has been the most significant contributor to air pollution [6]. As traffic volumes continue to rise, stakeholders in the maritime industry bear the responsibility to address climate impacts and steer the sector towards a sustainable trajectory [7].

Greenhouse gas (GHG) emissions are undoubtedly linked to ship activities, both in the water and during port operations. Several factors can contribute to increased GHG emissions on ships, including the growth of biofouling. Biofouling refers to the accu-

mulation of microorganisms, plants, algae, or animals on submerged structures that attach to or develop on a ship's hull [8]. The presence of biofouling can lead to decreased engine performance, negatively impacting ship speed and increasing fuel consumption [9]. This rise in fuel consumption directly contributes to higher GHG emissions [10].

The GHG Report indicates that biofouling on ships can increase GHG emissions by 25 to 30%, depending on the ship's characteristics, speed, and other prevailing conditions [11]. Biofouling growth occurs more rapidly in tropical regions than in the Mediterranean, presenting a challenge for Indonesia, which is located in the tropics and has significant maritime industry activity [12]. Therefore, effective planning and management of biofouling are essential to mitigate its impact on rising GHG emissions.

Biofouling removal methods can be implemented during the dry-docking process, and preventive systems that include underwater cleaning should be considered during the selection process. Commercial ships typically undergo dry docking every three to five years, although for some vessels, this interval may extend to seven years. [13]. Therefore, the underwater cleaning system represents a strategic method for biofouling removal in Indonesia, utilizing either remotely operated vehicles (ROVs), which are a newer method in the country, or divers for cleaning purposes [14].

In addition to the performance impacts of biofouling on ships, other factors can also lead to a decrease in engine performance, resulting in increased fuel consumption. The age of the ship significantly affects the functionality of its machinery. Moreover, proper maintenance of ship machinery must be conducted according to applicable provisions and standards to ensure optimal performance. Inadequate maintenance can diminish the capabilities of the ship's machinery, further contributing to increased fuel consumption [15]. Additionally, ship operational activities must be conducted efficiently to promote fuel efficiency. Ineffective sailing times, prolonged docking periods, and inefficient loading and unloading processes can all lead to increased operational costs and fuel consumption [16].

Fuel consumption is not solely affected by the internal components of the ship and its construction; external factors such as weather also play a significant role. Adverse weather conditions, including strong currents and waves, can increase fuel use, subsequently contributing to higher greenhouse gas emissions [17]. When ships operate in these challenging conditions, the engines must exert more power to maintain forward momentum, resulting in increased fuel consumption.

Ship fuel plays a crucial role in determining the amount of greenhouse gas (GHG) emissions produced. Therefore, the appropriate use of fuel is essential. Currently, several mitigation actions are being implemented to reduce emissions from ship fuel, including regulating the sulfur content and exploring alternative energy sources [18]. Electrifying loading and unloading activities and utilizing power shore connections are among the strategies employed when ships dock and engage in port operations [19]. Connecting to an onshore power supply while at berth offers a viable option for significantly reducing local air pollutants emitted by auxiliary engines in port.

In shipping, the increased use of liquefied natural gas (LNG) and methanol provides a potential bridge to achieving low carbon [20]. Additionally, system advancements like electric propulsion systems exist that can be utilized to supply additional energy

for the ship's main gear [21]. Of course, the alternatives used continue to be in the process of development to support various policies to reduce the impact of GHG emissions on ships including the development of hydrogen energy.

3 Environmental Considerations

In recent decades, global concern over climate change has significantly intensified due to its detrimental impacts on the sustainability of life on Earth. Climate change, often referred to as global warming, denotes the gradual rise in the Earth's average surface temperature. This phenomenon results from the excessive release of greenhouse gases—such as carbon dioxide (CO2), methane (CH4), nitrogen oxides (NOx), chlorofluorocarbons (CFCs), and other pollutants—into the atmosphere. These gases trap long-wave infrared radiation and ultraviolet light that would typically escape into outer space. Instead, much of this radiation is reflected, as greenhouse gases in the atmosphere capture heat from the Earth, further increasing the planet's temperature. [22].

Global climate change has far-reaching effects on various aspects of life, particularly in Indonesia, an archipelagic country that is significantly impacted, especially within its maritime industry. Global warming leads to the melting of ice and glaciers in the Arctic and Antarctic regions, contributing to the thermal expansion of seawater and rising sea levels. This phenomenon poses threats to coastal communities, affects marine ecosystems and biodiversity, and directly disrupts the operations of the maritime industry. [23].

Coastal areas are especially vulnerable to the effects of climate change. According to the United States Environmental Protection Agency (2013), there are four primary impacts of climate change in these regions: rising sea levels, increased storm surges and rainfall, alterations in coastal water temperatures, and ocean acidification. These changing oceanic conditions, driven by climate change, significantly affect marine ecosystems and the human activities that depend on the sea. [24].

Building on these impacts, coral reefs in the Coral Triangle Initiative region—comprising Indonesia, the Philippines, eastern Malaysia, and Timor Leste—are facing significant threats due to climate change. This phenomenon has become the primary stressor on coral reefs globally. Climate change adversely affects coral reefs in multiple ways, with one of the most critical being widespread coral bleaching caused by rising sea surface temperatures [25]. In 1998, coral bleaching triggered by elevated temperatures led to an average loss of 16% of global coral reefs, with some areas experiencing damage ranging from 50% to 90%. [26].

For instance, within the Gili Matra Marine Tourism Park, a marine conservation area located north of Lombok Island, coral bleaching has affected 50% of the coral population. Additionally, 11% of coral colonies were found to be in a pale condition, while 31% remained healthy. Coral mortality due to bleaching was recorded at just 1%. The hard coral cover in the Gili Matra waters has decreased, with coverage dropping from 23.43% ± 2.61 SE in 2012 to 18.48% ± 4.14 SE in 2016. Coral bleaching also impacts reef fish populations, as assessed through their abundance and biomass. The average abundance of reef fish showed a significant decline ($P(20.84)=0.00053$, $P<0.001$) over

the years, dropping from 28,733.26 individuals per hectare ± 3,757.89 SE in 2012 to 11,431.18 individuals per hectare ± 702.53 SE in 2016 [27][28].

In addition to impacting the environment and wildlife, global warming also poses significant risks to human health. Fachmi Idris, the Chairman of the Indonesian Medical Association (PB IDI), stated that climate change leads to natural disasters, such as floods, which result in various health issues. The rise in global temperatures forces the heart to work harder to cool the body, leading to an increase in cases of asthma and skin cancer. Furthermore, air pollution raises carbon monoxide (CO) levels, which can lead to CO poisoning. When carbon monoxide enters the body, it forms carboxyhemoglobin (COHb) in the blood, impairing hemoglobin's ability to transport oxygen throughout the body. [29].

Other impacts of nitrogen oxides (NOx) exposure can lead to serious health issues in humans, including respiratory infections and irritation of the eyes and skin. Prolonged exposure to NOx can threaten fetal health, reduce fertility, increase the risk of mortality, and even contribute to cancer. High concentrations of NOx in the air can obstruct sunlight and trigger photochemical reactions that produce various chemicals and oxygen, particularly ozone (O3), which acts as a potent oxidant, contributing to the phenomenon of smog. [30].

Further consequences include lower fetal weight, reduced cognitive development in children, and an increase in infant and child mortality rates. Additionally, climate change contributes to the rise of vector-borne illnesses, such as dengue fever (DBD) and malaria. The prevalence of dengue fever is influenced by rainfall patterns and the number of rainy days; higher rainfall and more frequent rainy days correlate with increased incidents of DBD. Currently, a significant portion—approximately 45%—of the global population resides in areas at risk for malaria-carrying mosquitoes. [31].

4 Legal Consideration

In the legal context, several international and national legal instruments address gas pollution at sea, beginning with the United Nations Convention on the Law of the Sea (UNCLOS). This treaty establishes the foundation for the prohibition of marine pollution. Article 194, paragraph 1, states: “States shall take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce, and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and by their capabilities, and they shall endeavor to harmonize their policies in this connection [32].” This provision provides a general framework for state conduct, aiming to encourage states to take sufficient measures to prevent, reduce, and control pollution in the marine environment. However, it lacks specificity regarding the types of marine pollution, particularly concerning gas-based pollution, and does not impose detailed guidelines for addressing this issue.

Furthermore, the International Maritime Organization (IMO) has established the International Convention for the Prevention of Pollution from Ships (MARPOL), which serves as the governing regulation on marine pollution. This convention consists of six

annexes, including Annex VI, which addresses air pollution. However, this instrument initially did not impose specific prohibitions on greenhouse gases (GHGs). It was not until 2021 that the IMO's Marine Environment Protection Committee (MEPC 76), during a remote session held from June 10 to 17, adopted amendments to Annex VI of MARPOL, mandating ships to reduce their greenhouse gas emissions. [33].

This can be seen as a significant achievement in this sector, as it introduces more stringent requirements. The new regulations mandate that all ships calculate their Energy Efficiency Existing Ship Index (EEXI), implementing technical measures to enhance energy efficiency. Additionally, ships must determine their annual operational Carbon Intensity Indicator (CII) and obtain a CII rating. Carbon intensity measures the relationship between greenhouse gas emissions and the amount of cargo transported over a given distance. Each ship will receive an energy efficiency rating ranging from A to E, with A being the highest rating. Administrations, port authorities, and other stakeholders are encouraged to provide incentives for ships rated A or B, thereby sending a clear signal to the market and the financial sector.

However, this regulation focuses solely on air pollution induced by ships and does not address other marine-related pollutants. In this context, the Commission of Small Island States on Climate Change and International Law (COSIS) requested an Advisory Opinion from the International Tribunal for the Law of the Sea (ITLOS) regarding the specific obligations of member states under the United Nations Convention on the Law of the Sea (UNCLOS). This includes Part XII, which states [34]:

“(a) to prevent, reduce, and control pollution of the marine environment about the deleterious effects that result or are likely to result from climate change, including ocean warming, sea level rise, and ocean acidification, which are caused by anthropogenic greenhouse gas emissions into the atmosphere;

(b) to protect and preserve the marine environment from climate change impacts, including ocean warming, sea level rise, and ocean acidification?”

The ITLOS responded by issuing a landmark advisory opinion that provides several key findings regarding anthropogenic greenhouse gas (GHG) emissions within the context of the United Nations Convention on the Law of the Sea (UNCLOS). First, the Tribunal confirmed that GHG emissions qualify as "pollution of the marine environment" under Article 1(1)(4) of UNCLOS. This determination was based on the criteria that GHG emissions constitute a "substance or energy" introduced into the marine environment by humans, either directly or indirectly, and are likely to result in harmful effects. This analysis was bolstered by scientific consensus, particularly from the Intergovernmental Panel on Climate Change (IPCC), which provided authoritative assessments of the environmental impacts of GHG emissions.

The Tribunal further held that States Parties are obligated, under Article 194(1) of UNCLOS, to take all necessary measures to prevent, reduce, and control pollution from GHG emissions, regardless of the source. While the ultimate goal is to eliminate such pollution, the Tribunal acknowledged that this obligation does not necessitate an immediate cessation of GHG emissions. Additionally, under Article 194(2), states are bound by a due diligence obligation to prevent transboundary pollution and damage caused by GHG emissions. However, this obligation pertains to the effort rather than

the result, meaning that a state will not be considered in breach solely due to the occurrence of GHG pollution, provided it has taken appropriate actions within its capacities, such as enacting relevant legislation, regulations, and enforcement measures.

The Tribunal also emphasized that compliance with international environmental agreements, such as the Paris Agreement, does not necessarily satisfy the broader obligations required under UNCLOS [36]. The specific measures a state must implement are to be objectively determined based on its scientific, technical, economic, and financial capabilities. While UNCLOS does not explicitly reference the principle of common but differentiated responsibilities (CBDR), the flexibility embedded in its obligations allows for similar accommodations, particularly for developing states. The Tribunal highlighted the necessity for developed states to provide technical and scientific assistance to developing countries and to offer preferential treatment in efforts to address marine pollution resulting from GHG emissions.

Finally, the opinion emphasized the procedural obligations of states under UNCLOS concerning GHG emissions. These obligations include the responsibility to monitor the risks and effects of such pollution and to conduct Environmental Impact Assessments (EIAs) for activities that may result in substantial pollution or harmful changes to the marine environment due to GHG emissions [37]. This underscores the necessity for proactive and transparent environmental governance in addressing the challenges posed by climate change and marine pollution.

In contrast to the previously introduced MARPOL Annex VI, this decision clarifies the provisions of UNCLOS regarding state responsibility. However, it establishes a broader obligation for member states of UNCLOS. Rather than focusing solely on ships, this advisory opinion addresses other potential sources of pollution at sea. As a result, states have a clearer and more stringent obligation under UNCLOS.

In line with its international commitments and obligations, Indonesia has ratified both UNCLOS and MARPOL [38] [39]. This demonstrates Indonesia's commitment and willingness to comply with the regulations established by the international community. To implement these provisions, Indonesia is enacting laws to regulate the subject matter by the respective treaties. Furthermore, Indonesia is a party to the United Nations Framework Convention on Climate Change (UNFCCC), which obliges the country to reduce its greenhouse gas (GHG) emissions. In this regard, Indonesia has developed a policy aimed at reducing GHG emissions in the maritime transport sector. Under the Decision of the Minister of Transportation of the Republic of Indonesia Number Km 8 of 2023, regarding the establishment of climate change mitigation actions in the transportation sector to achieve Nationally Determined Contribution targets (the Ministerial Decision), the Indonesian government has outlined several detailed measures to reduce GHG emissions associated with maritime transport.

These efforts encompass various mitigation activities, including the modernization of ships (New Ships), implementation of onshore power supply, adoption of a Ship Energy Efficiency Management Plan (SEEMP), application of anti-fouling systems, electrification of loading and unloading equipment at ports, utilization of solar-powered street lighting at ports, solar power generation (PLTS) for transportation infrastructure, use of low-carbon fuels on ships, and the provision of navigation aids (SBNP) and maritime telecommunications services (such as weather information). These initiatives aim

to ensure compliance with the Paris Agreement, which emphasizes the reduction of GHG emissions. However, mere adherence to the Paris Agreement does not equate to full compliance with UNCLOS and its clarifications under the Advisory Opinion [40]. UNCLOS mandates that member states undertake three key measures: prevention, reduction, and control of marine pollution. To fulfill these obligations, states must establish more comprehensive regulations, particularly regarding prevention and control. Additionally, specific requirements, such as Environmental Impact Assessments (EIAs), have yet to be effectively implemented within Indonesia's domestic policy.

As Indonesia currently only has the Ministerial Decision addressing this issue, it should consider drafting a more comprehensive regulation to encompass other elements mandated by UNCLOS and the ITLOS Advisory Opinion, particularly concerning the marine transport industry.

5 Conclusion

The ITLOS Advisory Opinion adds a crucial legal dimension by identifying greenhouse gas emissions as a form of marine pollution under UNCLOS, thereby broadening state obligations beyond shipping alone. This opinion reinforces Indonesia's duty to not only reduce maritime emissions but also to control other sources of marine pollution resulting from climate change.

Given Indonesia's growing maritime industry, its status as a party to UNCLOS, MARPOL, and the Paris Agreement, as well as the country's significant vulnerability to climate change impacts, this study concludes that establishing comprehensive regulations is of paramount importance. Implementing these laws would not only ensure Indonesia's compliance with international obligations but also safeguard its marine environment and bolster efforts to achieve national emission reduction targets.

This research establishes a foundation for understanding the requirements of UNCLOS that apply to all member states. It underscores that Indonesia's existing legal framework regarding greenhouse gas emissions from maritime transport is inadequate, highlighting the urgent need for swift legislative action.

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