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PLANNING FOR COMMUNITY ADAPTATION TO THE RISK OF FOREIGN SHIP TRAFFIC ON INTERNATIONAL SHIPPING LANES IN THE INDONESIAN ARCHIPELAGO SEA ROUTE

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Abstract

The International Convention Law on the Sea, which was adopted by the United Nations in 1982, granted foreign-flagged ships the right to pass safely and smoothly through the Indonesian Archipelago Sea Route/Alur Laur Kepulauan Indonesia (ALKI). The density of the shipping lanes has triggered risks such as accidents and environmental pollution caused by ship exhaust carbon emissions. Therefore, this qualitative research aimed to determine the possibilities of coastal communities to adapt to the risk in accordance with the policy of ship traffic regulation with international shipping lanes through the Traffic Separation Scheme. There is still limited research on the community's adaptation due to ship exhaust carbon emissions and the lack of adaptation actions taken in response to environmental pollution from foreign ship exhaust emissions. Adaptation efforts recommended include the preparation of collaborative measures and strategies to ensure the carbon management has a net zero emission value on foreign ship traffic in ALKI. The result showed that adaptation effort can be used to ensure Indonesians Nationally Determined Contribution (NDC) can prevent global temperature rise from the shipping sector through carbon management, decarbonization, and energy transition programs.

Keywords: Indonesian Archipelago Sea Route, Ship Emissions, Carbon Management, Nationally Determined Contribution, Net Zero Emission.

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INTRODUCTION

Indonesia is an archipelago characterized by 17,001 islands and a water area of 6,400,000 km^2 functioning as a unifier thousands of cities (Geospatial Information Agency, 2023). As a result, the transportation network in these domestic waters unites with those on land and overseas routes (exports and imports). In addition, there are also international shipping lines in Indonesian territorial waters that globally permit the legal crossing of foreign-flagged ships from various countries (Hidayat, *et, al*, 2019). These ships cross through an international shipping lane called the Indonesian Archipelago Sea Route/Alur Laur Kepulauan Indonesia (ALKI) agreed on during the United Nations Convention on the Law of the Sea (UNCLOS) session of the International Maritime Organization (IMO) in 1982. There are three international shipping lanes, and based on data from the Directorate General of Sea Transportation of the Ministry of Transportation of Indonesia in 2019, 53,068 ships belonged to the countries passing through ALKI I. Meanwhile, 36,773 and 18,028 foreign-flagged ships passed through ALKI II and III, annually (Alamsyah & Sikumbang, 2023).

Hundreds of ships that passed through the ALKI daily posed a risk to coastal communities and the environment (Hadi, 2023). These oil-fueled foreign ships cause traffic, alongside thousands of red and white flagged ships for domestic and inter-island transportation (INCAFO, 2014). A review of the preferred adaptation efforts in responding to the risks of foreign ship traffic density on the community and coastal environment adjacent to the international shipping lane has never been carried out in depth. Therefore, this research adopted a descriptive qualitative method (Denzin, 2009) to investigate the obligations of foreign shipping in protecting the environment and coastal areas while freely crossing the ALKI, as mandated by the Indonesian government.

LITERATURE REVIEW

The Indonesian Archipelago Sea Route as an International Shipping Route

The review on maritime data acquired in 2023 by the United Nations Conference on Trade and Development (UNCTAD), stated that the use of this transportation mode to convey various world trade commodities covered approximately 91% of other transportation modes (UNCTAD, 2023). Indonesia, characterized by the strategic position between the Asian and Australian continents as well as the Indian and Pacific Oceans, plays an important role in influencing international shipping lanes to support world trade (INSA, 2023).

This led to the implementation of the UNCLOS agreement for traffic regulation in 1982. Additionally, the IMO maritime safety committee approved the proposal submitted in respect to the three ALKI lanes on May 19, 1998 to regulate the rights and obligations of ships and aircraft that would crossing it as stated in the Indonesian Government Regulation Number 37 of 2002 (Simanjuntak, 2018). This was aimed to support the smooth traffic of foreign ships in the three channels (Hutagalung, 2019), namely ALKI I, II and III. Furthermore, the Indonesian government set the following geographical coordinates, latitude and longitude as the connecting axis of the archipelago flow depicted on the map as a reference for ship crews during voyage as shown in Figure 1.

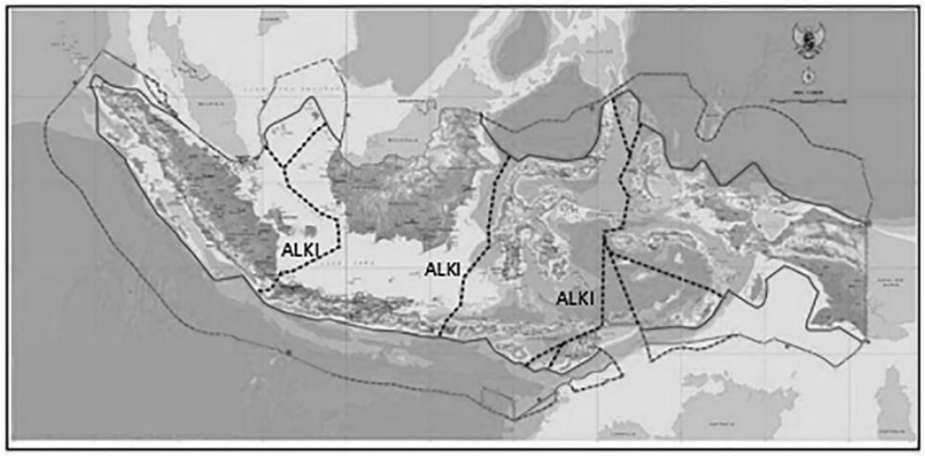

Figure 1. Map of the Indonesian Territory and the Indonesian Archipelago Sea Route (ALKI)
Source: BAKORSURTANAL-Indonesian Navy,2003

Adaptation of Coastal Communities on the ALKI Line

The main problem caused by the density of traffic along the ALKI was accidents consisting of collisions, fire outbreak, sinking, and ships running aground. Based on data from the Indonesian National Transportation Safety Committee (NTSC) in 2022, approximately 108 cases of accidents were reported in Indonesian waters. The lack of regulatory policy, and increased traffic proved risky for the community, including certain activities carried out along the ALKI coast, which intersects with domestic shipping lanes.

Table 1: Number of shipping accident investigations Based on Type of Accident 2018-2022

No.	Description	Year					
		2018	**2019**	**2020**	**2021**	**2022**	**Total**
1	Drowning	10	6	3	5	5	29
2	Burned	12	6	2	6	5	31
3	Collision	3	9	2	4	1	19
4	Grounding	7	0	4	2	2	15
5	Miscellaneous	7	4	1	2	0	14
Total		39	25	12	19	13	108

Source: NTSC, 2022

The risk of accidents caused by the density of traffic, especially on international shipping lanes in ALKI, motivated people to embrace various adaptation options for the purpose of survival, including avoiding detrimental risks. Several adaptation options are preferred by the community, government, and business actors as a form of strategy in responding to environmental changes associated with the trigger factor, namely the risks caused by the density of international ships (Siswono, 2015). Furthermore, these options can be in the form of awareness or knowledge, attitude, and action or practice (Notoadmodjo, 2012).

The reaction to a risky phenomenon leads to a variety of responses (Adger & Vincent, 2005). Some people do not respond despite being aware of the risks or careless about the impact on survival. Certain adaptation options carried out included actions taken through policy initiatives. These could be in the form of regulatory and supervisory actions, as well as field activities to anticipate or reduce the risks that occur in Indonesian waters due to shipping traffic in ALKI (Bakti & Sukartono, 2022; De Araujo Pereira Babo Martins, 2022). This research focused on the phenomenon of traffic density in Indonesian waters caused by the thousands of foreign ships passing through the ALKI route, in relation to the adaptation options preferred by the community in addressing the associated risks.

Ship Exhaust Gas Emissions

CO_2 emission is urge issue in the transportation sector (Yola et all., 2024).The research on IMO greenhouse gas conducted in 2020, reported that CO_2 emissions from the shipping sector increased by 9.6%, amounting to a total of 1,076 million tons compared to 977 million tons recorded in 2019. Furthermore, this figure reportedly increased from 2.76% to 2.89% of total global carbon emissions (IMO, 2020). The condition became a concern when the United Nations Framework

Convention on Climate Change (UNFCC) published a review of the Sustainable Development Goals in 2023. In respect to climate change, a significant increase in global temperature of 1.1℃ was recorded for the past 10-years and is expected to continue increasing from 1.5℃ to 2℃ if proper initiatives are not adopted (MPEC, 2023).

The adopted strategies to reduce gas emissions from the shipping sector worldwide referred to the Marine Pollution Regulation Annex VI and the resolution of the 80th IMO Marine Environment Protection Committee - MPEC session held in 2023 (MEPC, 2023). These included 1) reducing the carbon intensity of shipping, 2) and emissions by 40% by 2030 compared to 2008, 3) increased initiatives towards zero to low emission with the support of substitute technologies, fuels or energy sources by 5% to 10% by 2030, and, 4) the implementation of strategies towards emission-free shipping by 2050 was in line with the targets of reducing greenhouse gas emissions by 30% by 2030 and 70% to 80% by 2040.

Carbon Management Toward Emission Reduction Targets in International Shipping

In 2020, the Institute of Environmental Management and Assessment (IEMA) submitted a review on the Carbon and GHG Management Hierarchy relevant to the IMO 2023 strategy towards sustainable low and emission-free shipping. Furthermore, the carbon and greenhouse gas governance/management were explained through the following stages. First, reduce or abstain from using ship fuel, this effort is aimed to prevent the generation of carbon and greenhouse gas emissions such as the use of energy supply from the port (Onshore Supply Power). Second, reduce the generation of carbon emissions (decarbonization) and greenhouse gases through operational excellence efficiency strategies both technically and on board. Third, substitute with low-emission energy such as non-fossil fuels including LNG, Biodiesel, Hydrogen, and Ammonia. Fourth, compensate the remaining carbon produced by the ship through offset mechanisms, and development of carbon markets (carbon tax), (EIMA, 2020).

The carbon and greenhouse gas governance is in line with the adaptation efforts embraced by stakeholders in archipelagic countries. This is in anticipation of the risk associated with coastal and marine environmental damages caused by the density of foreign ship traffic in ALKI.

RESEARCH METHODOLOGY

The research was conducted using qualitative methods supported by data obtained quantitatively. This included the exploration of information through interviews held with communities along ALKI and other resourceful people that influence the objective. Data from field observations in the Lombok Strait on the

ALKI II route were obtained from February to March 2024. This was combined with quantitative data, constituting information on ships passing through ALKI II in 2022 captured by satellite based on the Marine Traffic and other applications at the Directorate General of Sea Transportation of the Ministry of Transportation of Indonesia. Furthermore, the ministry is authorized to regulate ship navigation in Indonesian waters. The analyzed ship specification data focused on type, size, fuel consumption, and flag. In order to ensure accurate results, various information was extracted from several literatures as well as comparative research in different countries, reviews from IMO and from previous scientific evaluations that supports the implemented objectives (Denzin, 2009).

ANALYSIS AND DISCUSSION

The processed data in table 2 showed that 35 foreign ship units passed through ALKI II daily, with a total of 2,189 ships recorded in 2023. These foreign ships whose passage is legally protected and authorized by Indonesia are mostly commercial. The vessel types included bulk and liquid cargos for conveying commodities such as coal iron ore, and processed palm oil. Additionally, the passenger and special ships supported the conveyance of offshore oil work supply equipment.

Bulk and liquid transport ships, including passenger ships are generally large with dimensions of 175 meters to 360 meters, and depth of approximately 12 meters. These were categorized as supramax and panamax ships with a fuel tank capacity of relatively 1800 metric tons. The fuel tank capacity enabled the seaworthiness requirements for undergoing voyages with lengthy intercontinental and interoceanic shipping routes (Seithe, 2020). The enormous dimensions of the large cargo tend to be in line with the fuel consumption capacity as the ships pass safely and smoothly along the relatively 800 nauticalmiles of ALKI II (Listiyono et al., 2022).

Table 2. Recapitulation of Monitoring of Ships Crossing ALKI II in the Lombok Strait on December 31, 2023

Ship Type/Vessel Length	Number of Ships	Estimated Ship Daily Consumption	Ship Flag
Bulk carrier (150-350m)	30	27-31 KL	• English, Panama, Liberia, Malta, Bahamas, Marshalles, Hong Kong, Greece, Madeira, Cyprus, China, Singapore
Liquid cargo ship/tanker (150-350 m)	1		
Passenger Ship/Cruise Ship (250-330m)	2		
Specialized ships supporting offshore Activities	2	3-5 KL	
Total	35	Minimum 945 KL	

Source: Processed Data of the Directorate of Navigation of the Ministry of Transportation of the Republic of Indonesia, 2024

The large size of foreign ships with dimensions less than 150 meters affected the traffic order in Indonesian water. Moreover, fishing boats owned by coastal communities encountered difficulties in dealing with sea waves caused by large ships. The ship flag was also used to identify the country where it was registered, binding all rights and responsibilities of the owner to that nation. Foreign-flagged ships passing through ALKI II are registered in diverse countries ranging from those in Asian Continent such as China, Hong Kong, Singapore, and European nations, namely the United Kingdom, Malta, and Cyprus. This also included nations around Panama and Liberia, regarded as the alliance members of convenience flag countries. Additionally, Indonesian waters, especially ALKI II offered safety, smooth traffic, and economical rights, without passage payment for more than 40 years since the UNCLOS convention in 1982. In accordance with processed data through direct observation (*emic*) at the port, review of IMO ship satellite and criticized information from interviews held with community members, business actors, and government, it was proven that the biggest risks posed by the density of international ship traffic in ALKI II, included accidents and environmental pollution by carbon emissions. These tend to adversely affect marine ecosystems and coastal environments.

Community Adaptation to the Risk of Ship Accidents in ALKI

Foreign ships report and transmit data to VTS officers at coastal radio stations or ports located in the straits of the ALKI, through predetermined frequency as well as AIS. The information which constituted ship type, IMO identity number, type of cargo categorized as either dangerous and risky to the environment or not, and other facts related to the condition. This navigational information assistance from the government proved helpful for foreign ships that only passed the ALKI route through nautical charts available on board as shown in Figure 2. The regularly updated manual and electronic charts provided virtual coordinates that monitor the movement of ships in the ALKI. These virtual or geographical coordinates connect the axis lines of the ALKI channel in Government Regulation of Indonesia Number 37 of 2002, including areas where Indonesian domestic sea transportation ships cross the Lombok Strait.

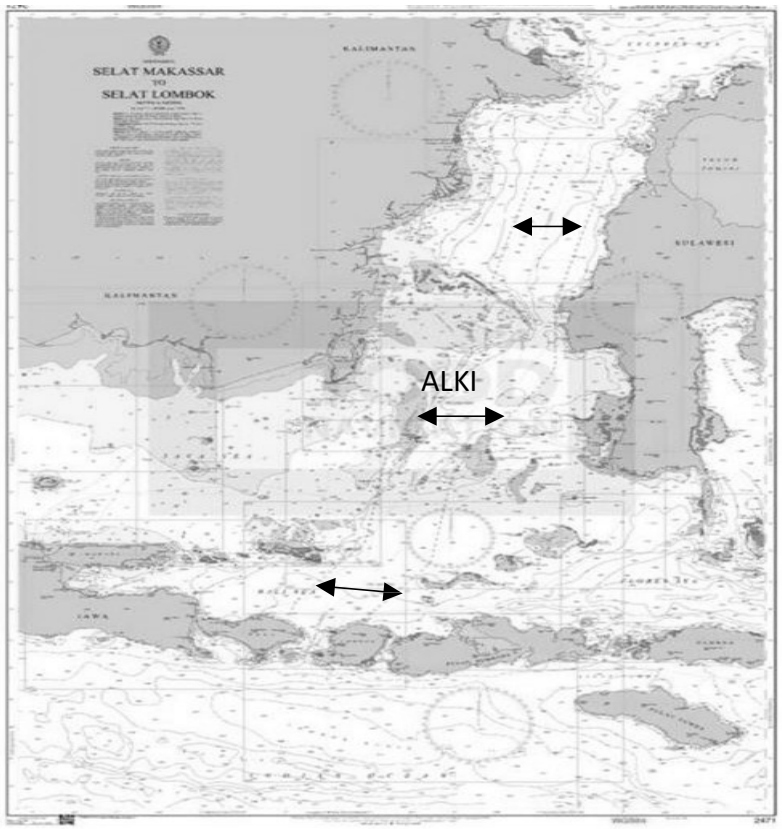

Figure 2: *Admiralty Chart* 2471: ALKI Line from Makassar Strait to Lombok Strait
Source: *Toddchart*, 2024

In situations where there are problems, disturbances or needs from foreign ships along the ALKI, the captain independently contacts the nearest port authority through the VHF radio or communicates with the nearest Indonesian-flagged ships. Similarly, if the public witnesses any foreign ships causing problems or disturbances in coastal waters and environments, these people are expected to manually use the telephone network without a system to report to the nearest port authority. The disturbances include discharging waste and excess emissions, leaving the permitted 25 nautical mile width of ALKI and entering territorial waters without permission, as well as various other acts violating the jurisdiction.

Community Adaptation to the Risk of Environmental Pollution in ALKI

Another concern felt by coastal communities was the risk of environmental pollution caused by exhaust emissions in the form of smoke produced by foreign-flagged ships when passing through ALKI. This carbon emission has a Global Warming Potential (GWP) value of one, due to the adverse impact on climate change and global warming (Winebrake, *et.al*., 2007). In addition, another pollutant of concern to the IMO is sulfur detected in the fuel of large ships due to the high risk to the environment, especially the occurrence of acid rain. This tends to have a negative impact on the environment and human health, including acting as disturbance to plants (Nevers, 2000). Both pollutants are components of Marine Fuel Oil with High or Low Sulfure, consumed by large foreign ships. The IMO stated that limited sulfur content of fuel was released into the environment (Chatzinikolaou, *et.al.*, 2015).

Based on data from the Cosco Shipping Heavy Industry Design and Research Institute in 2023, the specification for inter-oceanic and country ships with a dimension of 200 meters was equipped with a fuel tank of approximately 1800 m^3. This ensured the cruising area for shipping lines was approximately 22,000 nautical miles with speed and fuel oil consumption of 13.5 knots and 21 to 27 kilo liters/day (COSCO, 2023). The fuel consumption was greatly influenced by the dimensions of the ship, the capacity of the cargo, type and size of the main engine adjusted to suit the actual measurement of the vessel. From the average of 35 international ship per day in December 2023 that crossed ALKI II, the fuel consumption of the MFO type was approximately 945 kilo liters per day, equivalent to the consumption rate of relatively 47,250 cars. Therefore, the amount of fuel needed by ships to cross ALKI II within a period of three days was approximately 2,895 kiloliters of MFO. The amount of greenhouse gas, especially carbon emissions generated by ships, can be calculated using the following formula (IPPC, 2007):

$$E\ (CO2) = DA \times FE$$

Where:
E = Emissions tons of CO_2
DA = Activity Data (TJ)
= Fuel (Kilo liter) x Fuel specific gravity x Fuel net calorific value
FE = Emission Factor (tons/TJ)

Table 3. Potential Carbon Emissions of International Ships in ALKI II
As of December 31, 2023

Ship Fuel Consumption Details	**Consumption (tons @27 kL/day)**	**Emission Factor (tons CO_2/ton)**	**CO_2 Emissions (tons)**
Ship Daily Consumption (35 ships/day)	945	3,15	2.976
Consumption while crossing ALKI II (Three Day Voyage)	2.835	3,15	8.930
Consumption of 12,189 ships in 2023 for three shipping days in ALKI	987.309	3,15	3.110.023

Source: Data Processed by Researchers, 2024

The total emissions generated by 12,189 units of foreign ships in 2023, when passing through international shipping lanes in ALKI II was 3.11 million tons of CO_2. This is equivalent to 0.28% of the total carbon emissions from all international ships generated in 2020, amounting to 1,076 million tons of CO_2. The process does not include the 53,000 and 18,000 foreign ships passing through ALKI I and III per year, respectively.

The total carbon emissions from the ship exhaust tend to be in line with the sulfur emitted (Nahlik, 2016). Therefore, the safe limit of 0.5% or normal requirement of sulfur content in MFO fuel according to IMO refers to the Marine Pollution Convention Annex VI, regulation 14, effectively adopted by all international ships since January 1, 2020 (European Commisions, 2022). This policy also needs to be strictly verified by the Indonesian government for foreign ships entering ALKI. Furthermore, the inspection process is in line with the carbon management of ship fuel, due to the possibility that each ship was provided with two types of MFO fuel, namely low (maximum content of 0.5%) and high-sulfur standard oil (greater than 0.5%). This may violate IMO regulations, but at a procurement price 15% to 20% cheaper than low-sulfur MFO oil. In Indonesia, high-sulfur MFO was commonly used due to economical reason (Wahyudi & Fachruddin, 2020).

The government is mainly concerned about the Prevention of Maritime Environmental Pollution which regulates efforts to avert and overcome pollution to the sea and air such as oil spills, toxic liquid materials, or dangerous cargo in packaging, sewage waste, garbage and exhaust gas (emissions). Based on the regulation, every ship that crosses ALKI will be monitored, ensuring it uses fuel with an energy efficiency level referred to the Energy Efficiency Existing Ship Index (EEXI) and Energy Efficiency Design Index (EEDI) for ships built before and after 2015, respectively (Budiyanto MA et al., 2022). Another carbon management effort adopted was to ensure all ships crossing ALKI used low-sulfur fuel with a maximum content of 0.5% or equipped with a scrabber that functions to normalize sulfur emissions contained in MFO fuel with sulfur content greater than 0.5%. This adaptation effort was embraced by the Indonesian government to ensure the use of foreign ships passing through ALKI used MFO with a low-sulfur content below 0.5% as an international obligation since January 2020. In accordance with the acquired data and records, carbon management could be implemented by a carbon tax based on the validation results of the ALKI supervisory authority and the funds used to compensate ship owners in the form of certificates to finance the conservation maritime environment along ALKI (Aisyah et al., 2020; Lembang et al., 2012).

CONCLUSION

In conclusion, the main risks encountered by the communities along the ALKI included accidents and environmental disturbances caused by carbon emissions. The diverse communities alongside the government and business actors had adapted to the risk of accidents by following the rules of the separation scheme, as well as regulating traffic on ALKI that intersect with inter-island shipping lanes, although limited to areas in straits. Other regions along the ALKI had not been regulated in an integrated and systematic manner, depicting that along the ALKI there was risk of foreign ship accidents with Indonesian-flagged ships. Additionally, air pollution caused by carbon emissions lacked adaptation effort, including the adoption of appropriate actions to control and reduce or avert the emissions produced by thousands of foreign ships. The amount of emissions in ALKI II constituted approximately 0.3% of the total carbon emitted from global ship exhaust, also equivalent to 900 million tons of CO_2. This could be used as Indonesians Nationally Determined Contribution (NDC) in reducing carbon emissions from shipping sector as reported by the United Nations.

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