Foreign vessels' mobility crossing the Archipelagic Sea Lanes in the Karimata Strait

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Abstract. The mobility reliance of transnational vessels on Southeast Asia waters in favor of sustaining their economic development raises the necessity for All-Domain Naval Power to increasingly anticipate the challenges of an unpredictable future, specifically across the Archipelagic Sea Lanes in the Karimata Strait. This study aims to locate and spatially analyze the mobility of foreign-flagged vessels crossing the Indonesian Archipelagic Sea Lane (I), known as ALKI (I), in the Karimata Strait throughout 2017. Raw data appearing in vessel traffic records based on the Automatic Identification System (AIS) in the concerned study area were aggregated, grouped, and processed locally based on the targeted observations using ArcGIS v.10.6. Besides, this study also employed inductions analysis adopted from International Relations studies to enlighten the discussion. The results found 90 countries whose ships had crossed the Karimata Strait throughout 2017, including vessels originating from Indonesia. Cargo typically used for international trade was the vessel type that mainly was found crossing ALKI (I), amounting to 219,951 vessels, followed by tankers (127,885 vessels), tugboats (41,773 vessels), and passengers (22,357 vessels). Foreign ships' interdiction operations beyond the ALKI (I) reached 58.25%. Such violations emphasize that the law-enforcement authorities and military capabilities in disrupting malign activities, especially in ALKI (I), remain defenseless. As this writing completed, many activities that violate international law transpired in Indonesian waters. Unfortunately, such crimes cannot be suppressed effectively due to the lack of integration between law enforcement and technology operated by various authorities in enforcing security at ALKI (I). Therefore, this study recommends that Indonesia strengthen the proper legal sector in implementing the trans-archipelagic regime by establishing an integrated law enforcement agency to protect the ALKI territory, especially ALKI (I). A more comprehensive study of archipelagic sea lanes covering aspects of defense, security, economic, social culture, and the empowerment of coastal communities are extensively essential to be conducted in the future for achieving the grandiose goals of maritime-based development aspired by Indonesia.
Key Words: archipelagic sea lanes, Automatic Identification System, Karimata Strait, transnational vessels.

Introduction. One of many technologies with significant advancements that have been widely recognized in the maritime industry is Big Data, including the use of ArcGIS based on the Automatic Identification System (AIS). The AIS technology was first developed in 1990 with the primary objectives of preventing ship collisions, enhancing navigational safety, and improving traffic control by coastal authorities (Harati-Mokhtari et al 2007).

Originally, AIS data existed locally and was difficult to collect since the AIS communication between vessels to the beachfront or vice versa was limited, barely encompassing a range of 10-20 nautical miles. However, due to the high demand for ships and coastal authorities to communicate over long distances, many developments have been carried out for AIS technology. Consequently, every satellite equipped with AIS technology can currently receive AIS data from the onboard AIS transceivers worldwide (Stupak 2014).

Since the urgency for shipping safety is exceptionally high, the international maritime organization and local governments in various countries, including Indonesia, require registered ships to be equipped with AIS transmitters to improve safety and

security (IALA 2015). Therefore, the more ships equipped with AIS, the higher the security of sea transportation will become (Yang et al 2019).

The Karimata Strait is archipelagic water within the Indonesian Archipelagic Sea Lane (I), also known as ALKI (I). This route connects the South China Sea with the Indian Ocean and has two crucial choke points in global maritime politics in the Asia Pacific region (Sidharta 2021). Besides, ALKI (I) is also the closest alternative route to reach one of the infamously congested straits, the Malacca Strait.

Archipelagic waters are exclusive maritime zones not shared by all coastal countries. In other words, only coastal countries categorized as archipelagic countries have archipelagic waters. Article 49 of the 1982 United Nations Convention on the Law of the Sea 1982 (UNCLOS 1982) stipulated that archipelagic areas are waters enclosed by the archipelagic baseline regardless of the depth and breadth from the shoreline. Therefore, the Karimata Strait, with its status as archipelagic water, plays an essential role in enacting the trans-archipelagic regime (Barnard 2004).

Archipelagic Sea Lane (I) corridor gives foreign ships and aircraft the freedom to carry out voyages or flights in the normal way to travel continuously, directly, as quickly as possible, and without being restrained as regulated according to the agreed maritime laws. The UNCLOS (1982) divided the trans-archipelagic regime into three categories: peaceful passage, transit passage, and archipelagic sea lane passage. In addition, UNCLOS (1982) emphasizes that the procedure for transit is also regulated following the Archipelagic Sea Lane regime owned by country regulation whose waters are being crossed. Specifically, Article 54 further stipulates that foreign-flagged vessels may not deviate more than 25 miles to both sides of the archipelagic sea lanes and must not come close to less than 10% against the coast of islands bordering archipelagic sea lanes routes (Batongbacal 2004).

Furthermore, Government Regulation No. 37 of 2002 in Article 4 states that foreign ships or aircraft carrying out archipelagic sea lane crossings may not deviate more than 25 nautical miles to both sides of the archipelagic sea lanes. Also, ships and aircraft must not approach the coast less than 10% from the closest point of the islands bordering the archipelagic sea lanes.

Therefore, foreign ships must have functioning and safe navigation to pass directly, as quickly as possible, and continuously (Buntoro 2017). In light of the above theories, this study aims to track and spatially analyze the movement of foreign-flagged vessels crossing the Indonesian Archipelagic Sea Lane, known as ALKI (I), in the Karimata Strait throughout 2017. This research outcome is specifically expected to enrich the insights of relevant academics and government in their work related to AIS data. Besides, this study is desired to unlock the general public's viewpoints regarding the fruitful prospect of AIS technology in responding to the gap and limitation of ship analysis in Indonesia's maritime authority. The illustration of the above regulation is depicted in Figure 1.

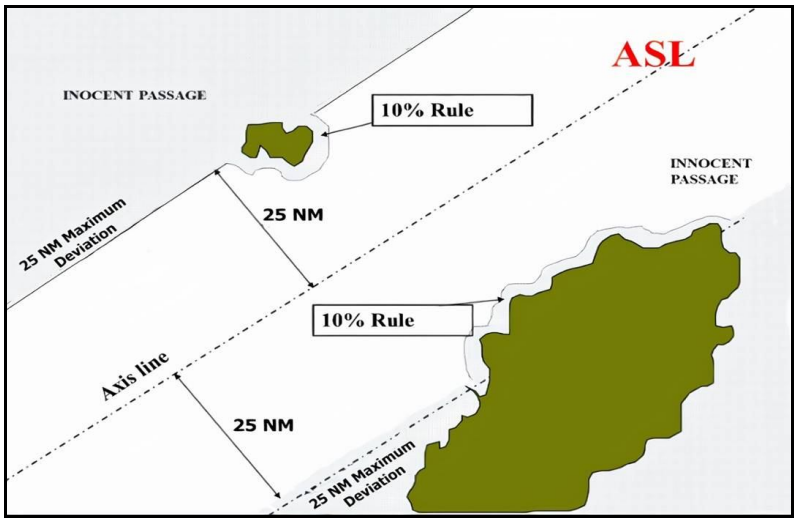

Figure 1. Law of Indonesian Archipelagic Sea Lane (I) (Buntoro 2017).

Material and Method. By employing a terrestrial-based monitoring system of ships equipped with an AIS, the vessel traffic records as primary data containing millions of registers created by the database management system of maritime traffic were later processed using ArcGIS v.10.6. Finally, the AIS records were aggregated by selecting location-specific AIS information fields and grouping observations according to targeted fields. This study also used induction analysis of the International Relations studies to intensify the discussion.

Given that the application of AIS technology is widely recognized and will always influence the success of shipping operating patterns in marine transportation, especially to avoid ship collision accidents and improve navigational safety (Zhao et al 2014; Sidibé & Shu 2017; Tu et al 2018), many academics, practitioners, and governments are starting to comprehend AIS maximization in multiple purposes focusing on the sustained operations on the seas with much-sophisticated navigation gears (Akanga 2006).

Results and Discussions. Countries categorized as archipelagic nations have full sovereignty over their archipelagic areas, including the air space, the sea, and the land, with all the assets contained therein (Krepinevich 2015). Although the Right of the Innocent Passage applies to foreign ships as regulated in Article 52 paragraph (2) of UNCLOS (1982), an archipelagic state can freeze the status of the Right of Peaceful Passage in its Archipelagic Waters without exceptions if issues related to security and defense come to surface (Al Imran Zani 2020).

The presence of ALKI (I), as stated in Government Regulation No. 37 of 2002 and later proposed to the International Maritime Organization (IMO), gives coastal authority to secure national marine areas in order to prioritize security and safety in ALKI (I). Steady security is carried out to defend the sovereignty of nationwide waters, especially the trajectory area enjoyed by the international community. Maintaining sovereignty through consolidated security requires the ability of the country to understand the phenomenon of ship trajectories in the existing domain. Thus, the officials with authority to maintain the security and safety of the country in the sea area from threats and violations can be better implemented.

Holding a position as a hub between the leading regions in the eastern part of the world requires Indonesia to respect the crossing of various types of foreign ships whose mobility can vary. This chance opens up possibilities for various law violations in many maritime scenarios, such as illegal fishing, human trafficking, piracy, water pollution, illegal migration, energy scarcity, and food security.

In the study of International Relations, Booth (2013) argued that states could increase their influence through various collaborations with other countries to complement diplomatic power related to law enforcement at sea. These efforts are intended to achieve the prestige and interests of the cooperative nations. Navies worldwide universally have three roles known as the "Trinity of Naval Roles," consisting of a Military Role, a Constabulary Role, and a Diplomacy Role (Diplomacy). Therefore, the quantity and quality of naval diplomacy determine the appropriateness of a country in upholding its sovereignty and advantage at sea (Dipua et al 2021).

Cross regime in the Karimata Strait. The guarantee for seamless and safe sea utilization for the benefit of allied countries is contained in the understanding that maritime countries must respect neighboring countries, including the security and smooth sailing in the ALKI (I). The international community has interests in two famous oceans; the Pacific Ocean and the Indian Ocean. In addition, Indonesia with sea sovereignty covering approximately 6,000,000 km^2 has a crucial role in bridging the interests of various countries in the international community (Djalal 2012). The Karimata Strait is archipelagic water categorized as inland waters in international sea law. In the Government Regulation of the Republic of Indonesia Number 37 of 2002, ALKI (I) has 15 points connecting the axis lines of the Archipelagic Sea Route described as follows:

1. Geographical positions (I-1) to (I-3) define the axis line from the South China Sea to the Natuna Sea;

2. Geographical positions (I-3) to (I-5) define the axis line from the Natuna Sea to the Karimata Strait;
3. Geographical positions (I-5) to (I-7) define the axis line through the Karimata Strait;
4. Geographical positions (I-7) to (I-12) define the axis line through the West Java Sea;
5. Geographical positions (I-15) define the axis line through the Sunda Strait to the Indian Ocean; and
6. Geographical positions (IA-1) to (I-3) define the axis line from the Singapore Strait through the Natuna Sea.

The connecting points for the Karimata Strait are the geographical position (I-5 to I-7), consisting of the following coordinates:

1. the point I – 5: 02º01'00 S, 106º44'00 E;
2. the point II – 6: 02º16'00 S, 108º27'00 E;
3. the point III – 7: 02º45'00 S, 109º19'30 E.

The connecting points of I-5 to I-7 are projected into the Karimata Strait area, shown in Figure 2. After a straight line of 25 nautical miles is drawn to the two sides of the axis line, the ALKI (I) corridor in the Karimata Strait was formed.

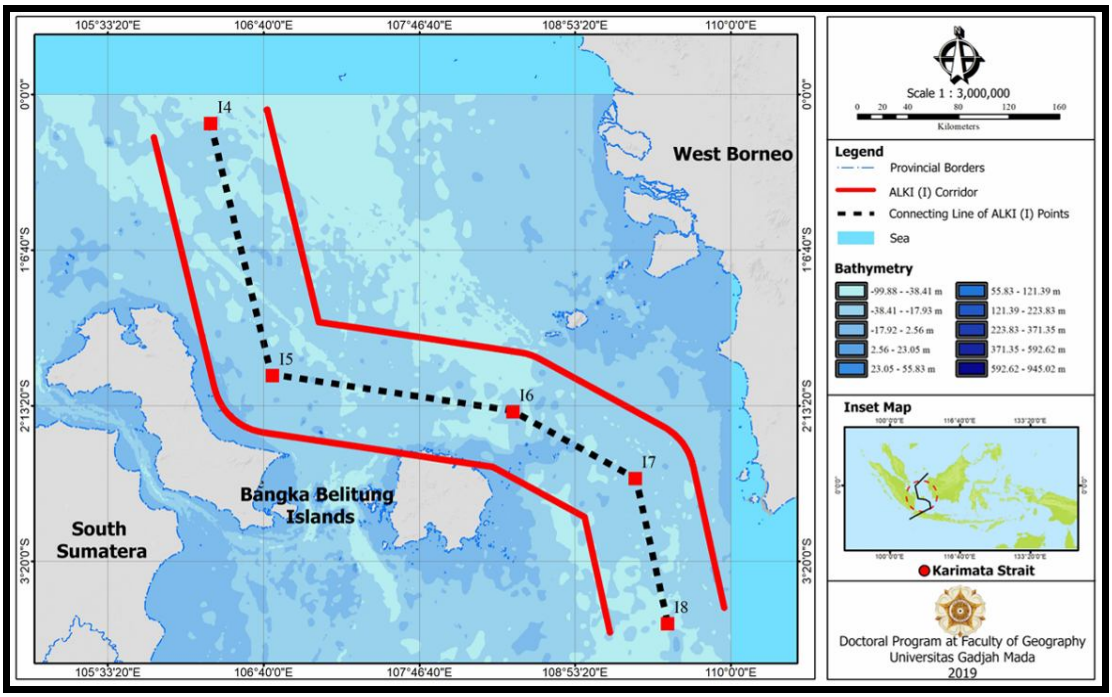

Figure 2. Corridor of Indonesian Archipelagic Sea Lane (I) in the Karimata Strait.

The presence of ALKI (I) provides benefits such as convenience in supervising and controlling foreign vessels crossing Indonesian waters. In addition, the established sea lanes can drive vessels more concentrated in certain regions where maritime industry and services in the underprivileged area can be developed. Given that the Karimata Strait and the waters of Southeast Asia are strategic areas enjoyed by trading vessels during the transit time quite often, the optimization of this seaborne regime can be accomplished by constructing entrance and exit gates appearing as checkpoints.

Indonesia needs to improve water area security along archipelagic sea lanes considering the high potential of threats from foreign countries related to global trade issues such as illegal fishing, piracy, and human trafficking (Niode et al 2021). Increasing security in archipelagic sea lanes will undoubtedly strengthen the marine economy in coastal areas. Such efforts can be made by shifting the continental-based development principle to maritime/sea-based development for achieving satisfactory economic growth and development in the coastal areas.

Coastal areas and fishers are two bounding elements. Therefore, the empowerment of coastal communities is expected to positively impact the security at sea. Moreover, Law No. 3 of 2002 concerning National Defense and Law No. 34 of 2004

concerning the Indonesian National Armed Forces have emphasized that the implementation and control of security at sea is the responsibility of all elements in the society.

Mobility of vessels in the Karimata Strait. The Indonesian Maritime Security Agency, also known as BAKAMLA, has developed a monitoring system for Indonesian waters named Monalisa (Monitoring and Analysis). This system is integrated with satellites and transmitters to witness the movement of vessels journeying in Indonesian water areas, be it suspiciously or unsuspiciously. One of the data generated from this system is AIS vessels consisting of MMSI (Maritime Mobile Service Identity), names, coordinates, types, flags, and times. Throughout 2017 (12 months), the AIS data records obtained from BAKAMLA showed that 415,048 vessels had crossed the Karimata Strait.

Besides, based on the uniqueness of the MMSI code, which can reveal the vessel's identity per unit, 7,816 IDs of vessels were found to have passed the Karimata Strait throughout 2017. The total, proportion, and daily average of vessels detected in the Karimata Strait throughout 2017 are presented in Table 1.

Table 1

Vessel monitoring results in the Karimata Strait throughout 2017

No	*Month*	*Total*	*Proportion (%)*	*Daily average*
1	January	8	0.002	< 1
2	February	10	0.002	< 1
3	March	16,023	3.86	517
4	April	34,202	8.24	1,140
5	May	23,494	5.66	758
6	June	31,712	7.64	1,057
7	July	29,429	7.09	949
8	August	28,433	6.85	917
9	September	20,547	4.95	685
10	October	26,026	6.27	840
11	November	32,251	7.77	1,075
12	December	172,914	41.66	5,578

Source: Research findings (2022).

Table 1 explains that December represents the period with ginormous activity, where the distribution of entire vessel traffic reached more than 41% in the Karimata Strait throughout 2017. However, in contrast to the end year as the busiest month, the beginning of the year (January) was when the vessel traffic only reached about 0.002% of the overall ship activity.

The average mobility of vessels passing through the Karimata Strait during 2017 was 1,137 vessels per day. The highest mean vessel traffic was found in December (5,578 ships per day), followed by April (1,140 ships per day), and the lowest one was in January and February (< 1 ship per day). Vessel traffic density during 2017 showed a positive trend as it continued to increase linearly from January to April. In order to understand the fluctuations of vessel movements during 2017 comprehensively, the vessels' distribution is divided into three quarters, as shown in Figure 3.

The cruise was relatively quiet in the first two months of the first quarter (January-April 2017). However, shipping lanes in March had started to get a little crowded with an average of 517 vessels per day and continued to increase consistently until April with an average of 1,140 vessels per day. As a result, April represents the month with the heaviest traffic in the first quarter.

According to Hidayat & Trenggono (2019), the waters area of the Karimata Strait is influenced by the Armondo Current (Indonesian Monsoon Current), which connects the South China Sea and the Java Sea. Although Monsoon winds blow at relatively low speeds, their steady gust can create extraordinarily favorable states for the formation of currents. In addition, ocean current patterns are an essential feature in ship navigation. Therefore, even though modern vessels have engines capable of complete navigation control, no misjudgments go to the role of the Monsoon wind system today.

During the West Monsoon (December-May), currents in Indonesian waters move from the South China Sea to the Java Sea (Belkin & Cornillon 2003). Therefore, if the vessels' distribution maps in the Karimata Strait in the first quarter of 2017 are projected with the Indonesian Monsoon Current, the vessel's mobility increased significantly following the escalation of the West Monsoon.

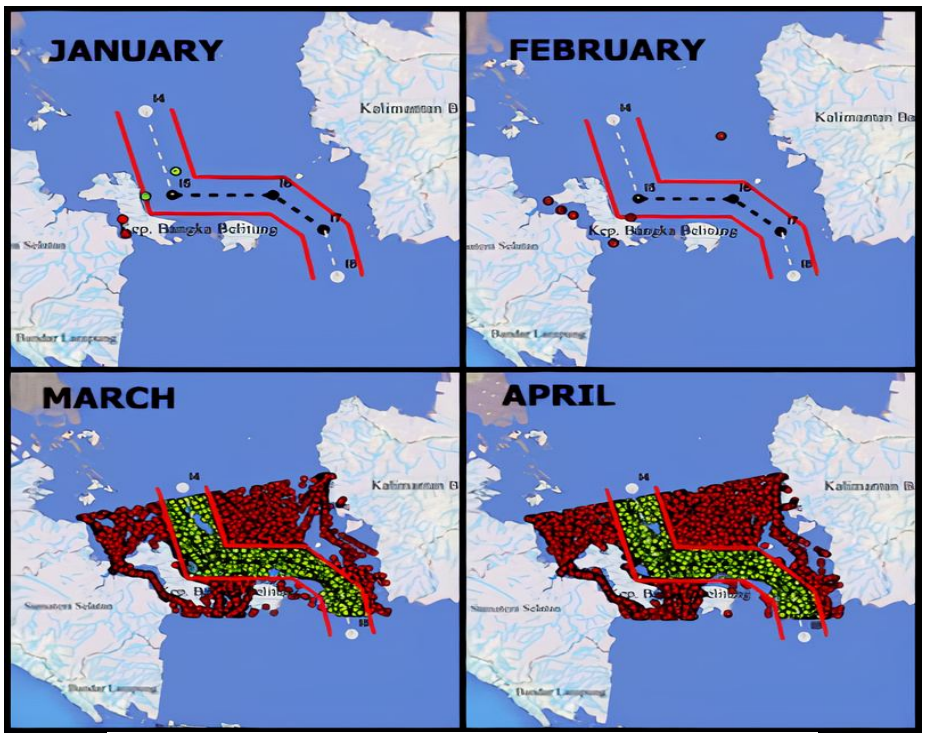

Figure 3. Vessels' traffic in the First Quarter of 2017.

In the second quarter map (May-August 2017), as shown in Figure 4, the vessel's activity was relatively a little busy, where traffic per month reached above 23,000 vessels despite fluctuations. Therefore, with the average traffic per day in the second quarter of 927 vessels, the traffic in the Karimata Strait from May to August 2017 is categorized as quite congested.

Over the quarterly vessels traffic development throughout 2017, the third quarter, starting from September to December, is the period with the heaviest vessel traffic in the Karimata Strait. As seen in Figure 5, shipping lanes in the third quarter were exceptionally crowded compared to the two previous quarters, with the mobility peak occurring in December.

Visualization of vessel density per month in the third quarter is not significantly different since the projected vessel symbols on the map have gone stockpiled. From September until October, the average number of vessels increased by 1.2 times in the third quarter. Surprisingly, the increase in vessel activity from November to December surged up to 5.3 times.

From the comprehensive data on ship mobilities in the Karimata Strait throughout 2017, January and February were the quietest sailing periods. Data obtained from BAKAMLA in January shows that only eight vessels were recorded to have crossed the Karimata Strait during the quietest sailing periods, and all of them were Indonesian-flagged vessels traveling on 8, 11, 16, 23, and 24 February 2017. Unfavorable wind conditions likely cause such possibilities due to the transition between the East Monsoon to the West Monsoon.

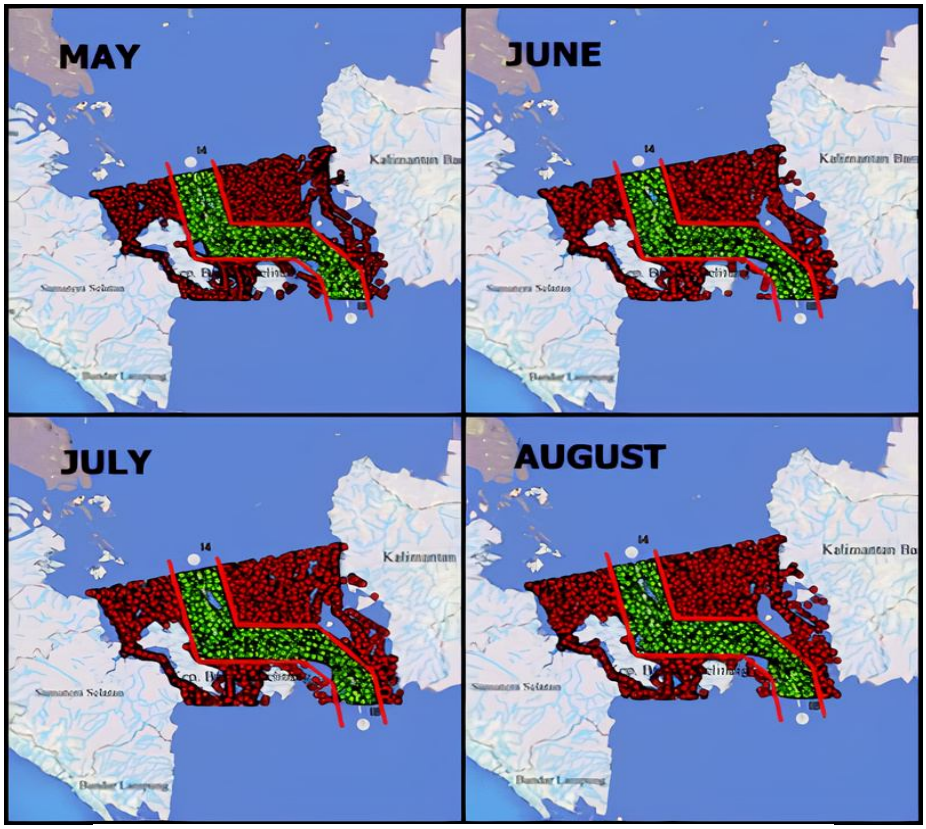

Figure 4. Vessels' traffic in the second quarter of 2017.

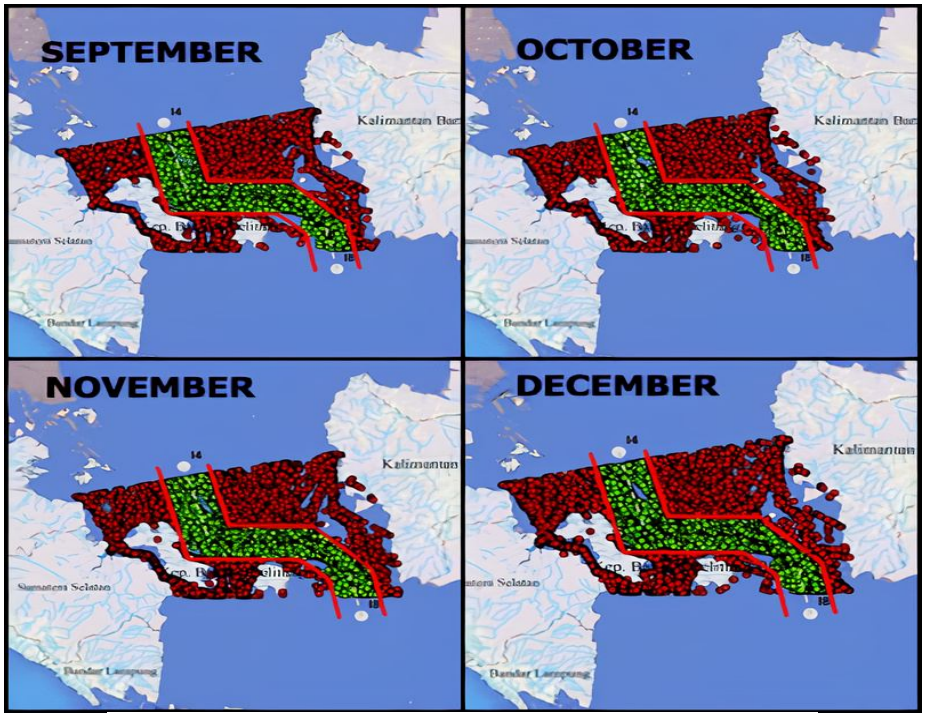

Figure 5. Vessels' traffic in the third quarter of 2017.

Distribution and types of vessels. The ship classification process was carried out based on popularity and usage, described as follows:

1. Types of vessels go into the main category: Cargo, Fishing, Military, Passenger, Tanker, Tourism, and Tugboats;
2. Military/Naval Ships include Military Ships and Ships Not a Party to Armed Conflict;
3. Types of Tourism Vessels include Pleasure Craft and Sailing Vessels;

4. Types of Barge Towing Vessels include Towing and Tugboats Vessels; and
5. Other vessels include Diving, Dredging, High-Speed Craft (HSC), Spare, Pilot, Port Tender, Reserved, Search and Rescue (SAR), and Wing-in-ground (WIG) vessels.

The most dominating types of vessels are cargo (52.99%), tanker (30.81%), and tugboats (10.03%). When the vessels' units are sorted from most significant to the least, cargo and tanker are two types of vessels with considerable dominance, implying that those vessels are often used for international trade. More exact proportions of the vessels' distribution in the Karimata Strait throughout 2017 are described in Table 2.

Table 2

Total and percentage of vessels distribution in the Karimata Strait throughout 2017

Vessel types	*Total*	*Percentage (%)*
Cargo	219,951	52.99
Tanker	127,885	30.81
Tugboat	41,733	10.05
Passenger	22,357	5.39
Tourism	2,363	0.57
Fishing	680	0.16
Military	79	0.02

Source: Research findings (2022).

From Table 2, it can be understood that cargo is the dominant vessel with 219,951 units, followed by tankers reaching 127,885 vessels. Cargo ships serve in distributing goods between countries, while tankers are widely used to transport large quantities of liquids, such as petroleum, chemical liquids, and liquefied natural gas. Therefore, the dominance of those two vessels implies that the intensity of the maritime business is exceptionally high in the Karimata Strait. Marine business productivity corresponds to the distribution of vessel types as they influence the capacity, effectiveness of routes, ports, and transit time to maximize logistics distribution.

Thus, the elements mentioned above are significant considerations that influence decisions for every country in operating their vessels. Operational problems faced by shipping companies will always be associated with the ship's physical carrying capacity. Thus, the data projection provided by AIS information allows observers to examine the mobility of the shipping market and vessel types per region in a better configuration.

Since the shipping business is synonymous with high mobility and cross-border operations, the governance of regulations related to cross-border operations must always be emphasized. The use of AIS helps observers validate information to overcome challenges caused by errors and inaccuracies in ship records to improve the marine traffic management system (Fournier et al 2018).

Distribution of vessel types per region. The BAKAMLA data shows that there were 90 countries whose ships had been recorded crossing the Karimata Strait throughout 2017, including Indonesia. Those countries are grouped into nine regions classified into Asia and Non-Asia.

1. Asia: Indonesia, ASEAN Region, East Asia, South Asia, and West Asia (including the Middle East).
2. Non-Asia: Australia (including Oceania), America, Europe, and Africa.

The list of countries in Asia whose ships have crossed the Karimata Strait throughout 2017 is presented in Table 3.

Meanwhile, vessels originating other than Asia:

1. America: 15 countries;
2. Europe: 22 countries;
3. Australia and Oceania: 12 countries;
4. Africa: 14 countries.

Table 3

Vessels originating from Asia

No	*ASEAN*	*East Asia*	*South Asia*	*West Asia*
1	Indonesia	China	Bangladesh	Cyprus
2	Brunei	Hong Kong	India	Egypt
3	Cambodia	Mongolia	Pakistan	Iran
4	Malaysia	Japan	Sri Lanka	Jordan
5	Myanmar	South Korea		Qatar
6	The Philippines	Taiwan		Saudi Arabia
7	Singapore			Turkey
8	Thailand			United Arab Emirates

Source: Research findings (2022).

Given that ALKI (I) in the Karimata Strait is the closest area to the ASEAN and East Asia regions, the recorded data also shows that ASEAN and East Asia countries occupy the dominant position after Indonesia and America. Data on the distribution of vessels' types and their origin are described in Table 4.

Table 4

Distribution of vessels by types and regions

Regions	*Cargo*	*Fishing*	*Military*	*Passenger*	*Tourism*	*Tanker*	*Tugboat*
Indonesia	61,572	372	42	21,002	1,993	58,393	29,916
America	52,308	0	20	61	111	14,715	37
ASEAN	29,780	262	3	18	53	24,595	9,981
East Asia	25,017	42	9	997	29	8,187	81
Europe	17,574	0	0	86	75	6,831	1,041
Australia	14,656	1	0	119	89	8,574	666
Africa	15,250	3	0	0	0	5,894	8
West Asia	2,798	0	0	74	0	544	3
South Asia	996	0	5	0	13	152	0
Total	219,951	680	79	22,357	2,363	127,885	41,733

Source: Research findings (2022).

After the above countries were categorized, America and the ASEAN were found to be the most enthusiastic regions whose vessels have been crossing the Karimata Strait throughout 2017. Besides, countries classified with moderate intensity are vessels originating from Europe and East Asia. Meanwhile, Indonesia is the highest contributor by sorting the dominance per country or region. Data related to vessels dominance by country or region that had crossed ALKI (I) throughout 2017 is presented in Table 5.

Table 5

Vessels dominations sorted by country or region

Country/Region	*Domination (%)*
Indonesia	41.75
America	16.20
ASEAN	15.59
East Asia	8.28
Europe	6.17
Australia	5.81
Africa	5.10
West Asia	0.82
South Asia	0.28

Source: Research findings (2022).

Indonesian-flagged vessels dominated with 41.75%, followed by American-flagged vessels (16.20%), ASEAN-flagged vessels (15.59%), and East Asian-flagged vessels (8.28%). Ironically, the difference between Indonesian and foreign-flagged vessels combined shows that foreign vessels were predominant crossing the ALKI (I) throughout 2017.

The Karimata Strait is a part of the waters connecting the South China Sea and the Indian Ocean. Several terms define a strait, such as artificial canals (channels) and passageways. The presence of ALKI (I) in the Karimata Strait has a significant influence as passageways in giving access to various countries to traverse freely (freedom of navigation). According to Buntoro (2017), the strait greatly influences countries whose economic and military interests rely on the ocean. However, various threats can still occur in the strait within a short time, such as illegal fishing, drug transactions, human and guns trafficking, piracy, and illegal migration (Schbley & Rosenau 2013).

Therefore, foreign vessels wishing to pass through ALKI (I) must have satisfactory, well-equipped, and safe navigation so that they can pass the concerned route directly, as quickly as possible, and continuously. Buntoro (2017), in his study, defined continuous trajectory as the activity of foreign ships crossing and respecting the maritime regulations of the concerned archipelagic country, including applicable regulations such as laws governing the Economic Exclusive Zone and the continental shelf. Therefore, foreign ships must always report before entering the port of an archipelagic country until the journey is completed.

The volume of foreign ships passing the Karimata Strait. The proportion of all foreign vessels combined versus Indonesian-flagged vessels passing through the Karimata Strait shows that foreign ships dominate at 58.25% over Indonesia's (41.75%). From this comparison, it can be comprehended that the dominance of international traffic representing the international trade in the ALKI (I) passageway is exceptionally high.

By referring to the regulations of the ALKI (I) corridor in the Karimata Strait area, where a straight line of 25 nautical miles is drawn to the two sides of the ALKI (I) axis line, the movement of foreign ships sailing both inside and outside the ALKI (I) route was spatially analyzed, as illustrated in Figure 6.

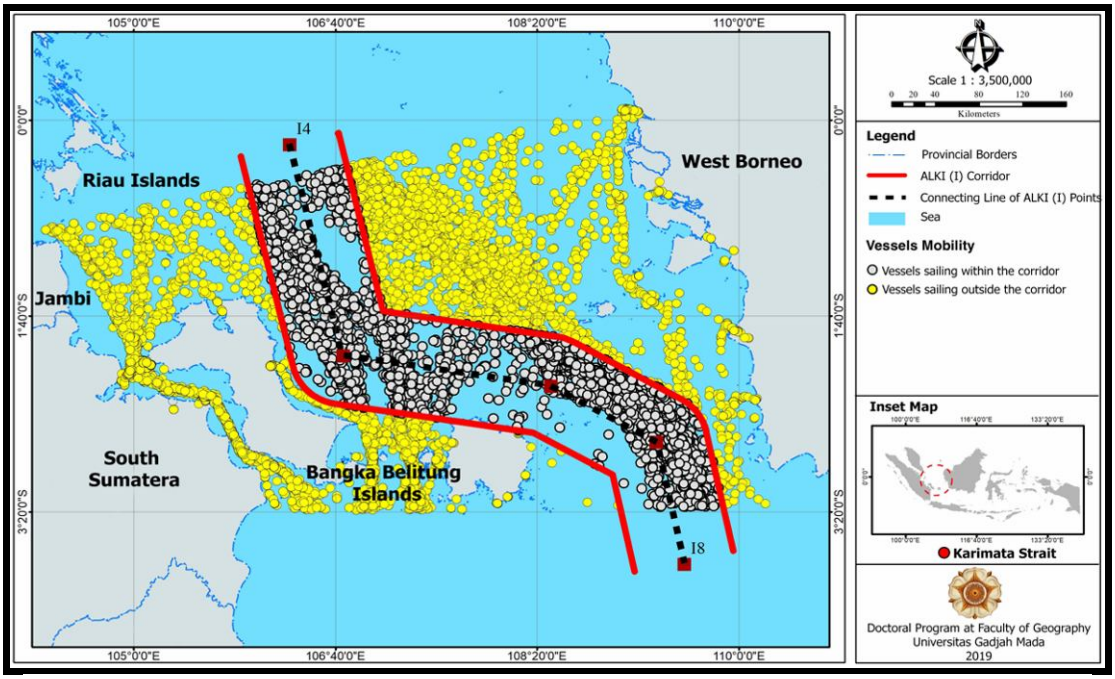

Figure 6. Distribution of vessels in the most crowded period (December 2017).

The gray dot symbol represents ships sailing within the ALKI (I) corridor as mandated by UNCLOS (1982). On the other side, the yellow represents ships sailing outside the ALKI

(I) route. Figure 6 explains that foreign vessels passing outside the ALKI (I) route dominated the total vessel number, implying strict law enforcement, especially regarding foreign ship traffic regulations related to the ALKI (I) route in international standings, nevertheless weak. The comparison of total vessels versus total foreign vessels passing the ALKI (I) corridor is presented in Figure 7.

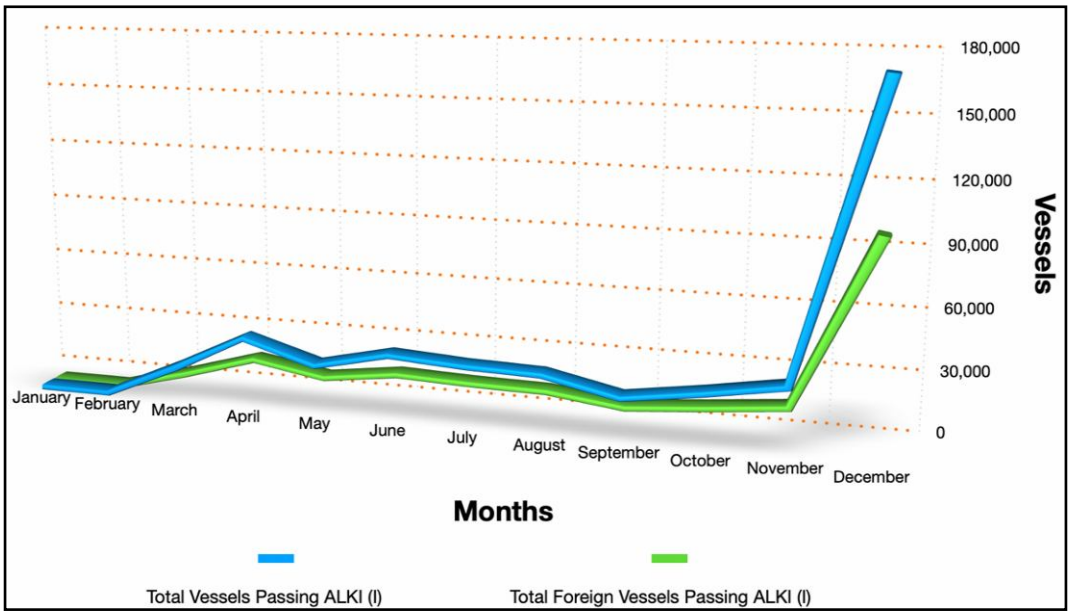

Figure 7. The comparison of vessels passing the ALKI (I) corridor throughout 2017.

Given that the dominance of foreign vessel traffic in the ALKI (I) route reached 58.25% (Figure 7), a thematic spatial analysis was conducted to find the relevance between the activity of foreign vessels and international strategic issues, especially in the Asia Pacific region. The vessels' data (cargo, tankers, and fishing vessels) were processed employing spatial analysis and grouped based on their country of origin.

A. Chinese cargo vessel. The ALKI (I) corridor is an essential area in Indonesian geopolitics as it contains the second busiest waterway in the world, the South China Sea. According to the world's annual cargo ship tonnage, more than 50% of cargo ships pass through the Malacca Strait, Karimata Strait, and Sunda Strait. In the Malacca Strait, which also intersects with the Karimata Strait, more than 1.6 million cubics (10 million barrels) of crude oil pass every day (Akanga 2006). The AIS technology in maritime studies has three advantages commonly discussed in the academic domain: 1) opens the accessibility of AIS data and expands the scope of vessels studies broadly, specifically on mapping vessel activities (Kaluza et al 2010) and their impact on the environment (Winther et al 2014); 2) improves accuracy and analysis of vessel movements and vessel trajectory prediction (Arguedas et al 2018) and traffic monitoring (Perera & Mo 2016); 3) analyzes global oil trade and shipping volume at sea (Adland et al 2017), port performance (Chen et al 2016), and the impact of the shipping industry on the environment (Gerritsen et al 2013).

The focus of AIS extends from navigational safety to becoming a more advanced technology and is applied in various fields of science related to comprehensive maritime research. With the application of AIS data, communication between ships and operators on the coast can be carried out word-for-word. Most importantly, AIS data has now collaborated with advanced techniques to detect ship activity, especially related to cargo ships that are often used as international trade vessels.

As illustrated in Figure 8, Chinese-flagged vessels are categorized into two nations: Mainland China and Hong Kong SAR. Cargo vessels from China that crossed the Karimata Strait were 21,843 units (92% belong to Hong Kong SAR). With a total cargo of 25,017 from the entire East Asia region, Chinese cargo dominates up to 87.31%.

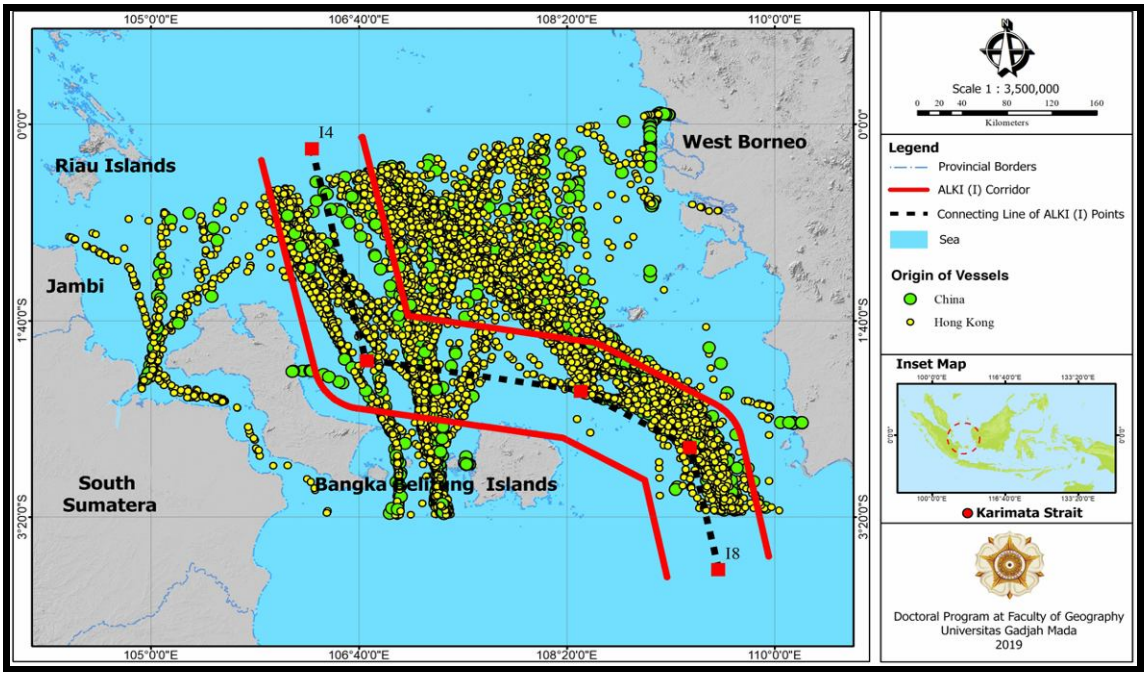

Figure 8. Chinese Cargo Vessels Distribution in the Karimata Strait throughout 2017.

Domain detection is one of the popular methods in maritime navigation, carried out by coastal authorities to detect illegal, suspicious, or unsafe behavior (Mascaro et al 2014). Detection of activity using AIS in monitoring ship behavior is carried out using a historical data approach. The data is then used to construct ship movement patterns using real-time data resulting in ship detection, tracking, position estimation, and grouping/ trajectory prediction (Zhen et al 2017). Therefore, optimizing AIS data makes it easier for authorities to amplify the maritime traffic monitoring system (Venskus et al 2017; Zhao & Shi 2019).

Several studies have been conducted focusing on the spatial and temporal distribution of vessel traffic analysis (Kaluza et al 2010; Vespe et al 2016; Breithaupt et al 2017; Sheng & Yin 2018). In their study, Breithaupt et al (2017) built the boundaries of shipping routes between ports along the Atlantic Coast to understand the distribution of vessel traffic. Later, Kaluza et al (2010) created a global and regional cargo vessel movement network using AIS data for shipping network density analysis. China's maritime silk route initiative/Belt and Road Initiative and Chinese workers' mobility in Indonesia make Chinese vessels' high traffic relevant in global trade issues.

The development of AIS applications in marine transportation significantly begins with data collection, data processing, and its applications to navigational safety. Over time, the quality and accessibility of AIS data have improved because the development of AIS technology has been able to detect ship domain construction, collision risk assessment, and route planning for many cases (Hörteborn et al 2019). Therefore, this technology is undoubtedly a critical element that can study the activities of cargo ships passing through ALKI (I).

B. Tankers from East Asia. As an archipelagic country, Indonesia has rights and obligations regulated in UNCLOS (1982). Article 46 of UNCLOS (1982) defined an archipelago as a group of closely related islands, including parts of islands and waters. The archipelagic concept expresses that the state becomes integrated geographically, economically, politically, along with defense and security (Bialasiewicz et al 2007). Therefore, the International Maritime Organization (IMO) meeting through the Maritime Safety Committee (MSC) resulted in one effect that helped tanker's operation for the international community: the regulation of the Indonesian Archipelagic Sea Lane (I), also known as ALKI (I), connecting the South China Sea with the Indian Ocean through the Karimata Strait, Java Sea, and the Sunda Strait (Balkin 2000).

Energy security issues from industrialized countries that are highly dependent on oil imports from the Persian Gulf make the high activity of tankers from East Asia countries relevant to be identified and monitored further. The Karimata Strait is part of ALKI (I), which connects the South China Sea and the Indian Ocean through the Sunda Strait or vice versa. ALKI (I) is a product of Indonesia as an archipelagic country after the Indonesian government ratified the 1982 UNCLOS International Law of the Sea through the Republic of Indonesia Law No. 17 of 1985 (Buntoro 2017).

Alfath et al (2019) argued that the legal principles and the concept of an archipelagic state have reciprocal consequences, which means that the right of passage for foreign countries must be provided so that Indonesia can also enjoy its rights when passing through the seas of other countries. This opinion is emphasized by previous researchers (Prescott & Schofield 2005; Forward 2009), who believed countries that have declared themselves as archipelagic states must have a high awareness of responsibility to the international community in providing the right of sea passage in archipelagic and territorial waters. Thus, when a country is negligent in ensuring the security of its marine area, the concerned country is considered a danger to the international community.

As shown in Figure 9, ALKI (I) is the main shipping route for tankers through the Malacca Strait. Since Hong Kong relies heavily upon its natural gas needs from the Middle East, this route is extremely important. In addition, trade routes and transportation of raw materials from East Asia and the West Part of America also pass ALKI (I) as an alternative route to reach the Persian Gulf. Therefore, the presence of ALKI (I) in the Karimata Strait for merchant ships in carrying out their trading activities has a significant influence.

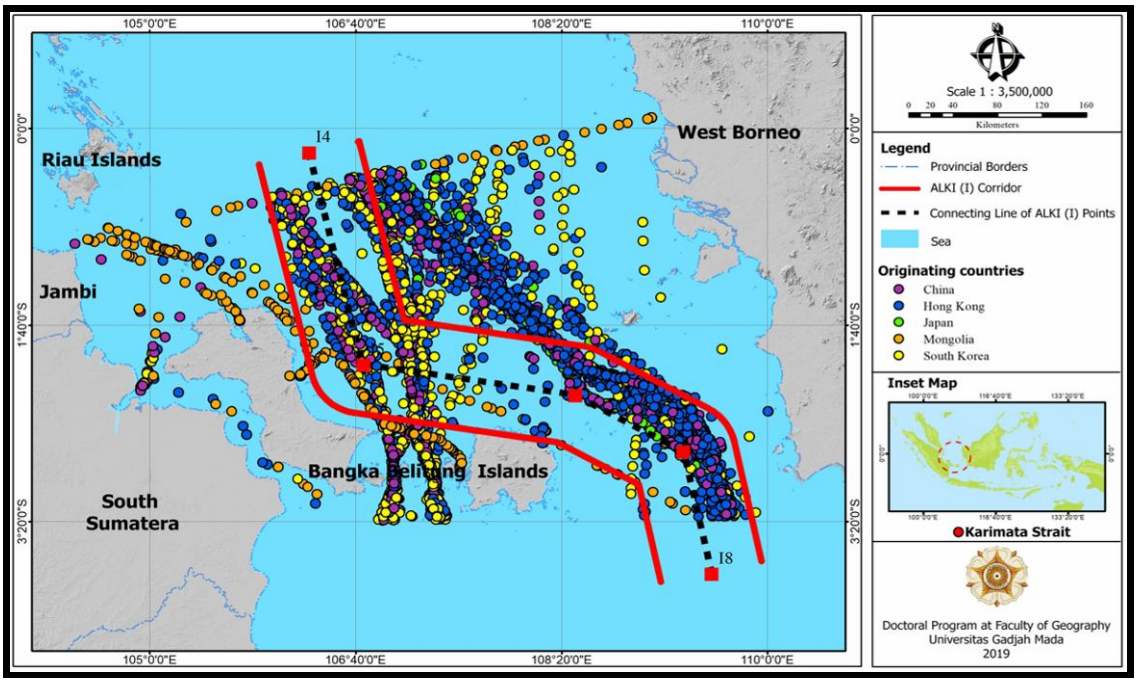

Figure 9. Tankers distribution from East Asia in the Karimata Strait throughout 2017.

The East Asian-flagged vessels consisted of China, Japan, Mongolia, and South Korea. BAKAMLA data found that 8,187 tankers with East Asian flags had crossed the Karimata Strait throughout 2017, accounting for 6.4% of the total tankers. The proportion of tankers in East Asia consists of China (60%), Mongolia (19%), South Korea (18%), and Japan (3%). The number of ships crossing the Karimata Strait through the Malacca Strait from 2000 to 2009 showed a significant increase, and the increase is predicted to double after 2020 (Li & Kwa 2011).

The Karimata Strait, essential access in transporting goods and energy supplies from the Middle East to Asia, Southeast Asia, and East Asia, is a route that can massively bring together various regions and connect the Asian continent with the other continents

like Australia (Jae-Hyung 2002; Storey 2009). Therefore, the activities of tankers in the Karimata Strait are highly dependent on the virtue of Indonesia in providing passage rights for other countries.

Since the route in the Karimata Strait is mainly enjoyed by international tankers, the Research and Development Center for Sea, River, Lake, and Crossing Transportation through the Ministry of Transportation of the Republic of Indonesia is increasingly paying attention to the passage in these waters using AIS data to avoid potential accidents due to collisions (Dinariyana et al 2018).

Shicun & Nong (2006) stated that the South China Sea could produce up to 1.9 million barrels of oil and gas per day. Furthermore, according to research conducted by The Committee for Coordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas, the South China Sea, where ALKI (I) is located, has the potential for fish species biodiversity due to the very strategic location for marine animals migrating, mating, and hatching (Machesky 1987). Therefore, in addition to its function as trade traffic and shipping lanes, various areas in the ALKI (I) route also have the potential for high-value natural resources. Savvy international thought and determination to ensure safety and security along archipelagic waters for vessels crossing archipelagic sea lanes are very much needed. Moreover, ALKI (I) is one of the critical and strategic zones for considerable international interests.

C. Foreign fishing vessels. Decree of the Ministry of Fisheries and Marine Affairs of the Republic of Indonesia No. 45 of 2011 concerning Estimation of Fish Resources Potential in Indonesian Regional Fisheries Management stated that the Regional Fisheries Management-711 covering the Karimata Strait, Natuna Sea, and the South China Sea have the enormous potential fish resources in Indonesia (1,059 tons/year). Therefore, the issue of illegal fishing, which has become the spotlight of Indonesia's Ministry of Fisheries and Marine Affairs for many years, has made the identification and monitoring of fishing vessels, especially from foreign countries, very important.

Malaysia, China, Japan, Namibia, New Zealand, and Singapore are countries whose fishing vessels frequently pass through the ALKI (I) area. The BAKAMLA data recorded that 333 foreign fishing vessels have crossed the Karimata Strait throughout 2017, originating from Malaysia (67%), Singapore (12%), and Japan (8%), while the rest are fishing vessels from China, Namibia, and New Zealand. Therefore, the detection of foreign fishing companies can assist the supervisory authorities in taking decisive action against the perpetrators of illegal fishing.

Foreign vessels' mobility strongly correlates with the phenomenon of illegal, unreported, and unregulated fishing (IUU fishing) violations. Shen & Huang (2021) used AIS data to estimate the number of fish caught due to IUU fishing activities. They used a logistic regression model to classify, identify, and analyze vessel trails to determine fishing area and intensity. In the IUU fishing study, fishing trails in various areas can be explored using AIS data. Their study was then supported by Vespe et al (2016), who mapped fishing footprints in the European region by extracting fishing activity from AIS data.

According to Hansen et al (2013), AIS data in maritime studies can detect ships' current location and history besides their usefulness in quantifying collision risk and estimating collision frequency in a particular area. Indonesia's geographical location is very strategic, with two-thirds of its territory standing as the sea, making the issue of illegal fishing a complex problem threatening state sovereignty. The geopolitical concept underlying the insight of Indonesian nationality is crucial and can be strengthened by AIS data (Malihah & Tanshzil 2018). Therefore, the capacity of coastal authorities in monitoring maritime traffic must be maximized, considering that sovereignty, honor, and national security must be maintained, particularly when it comes to the exploration and exploitation of fishery resources. The visualization of foreign-flagged fishing vessels from the East Asia region passing through the ALKI (I) is shown in Figure 10.

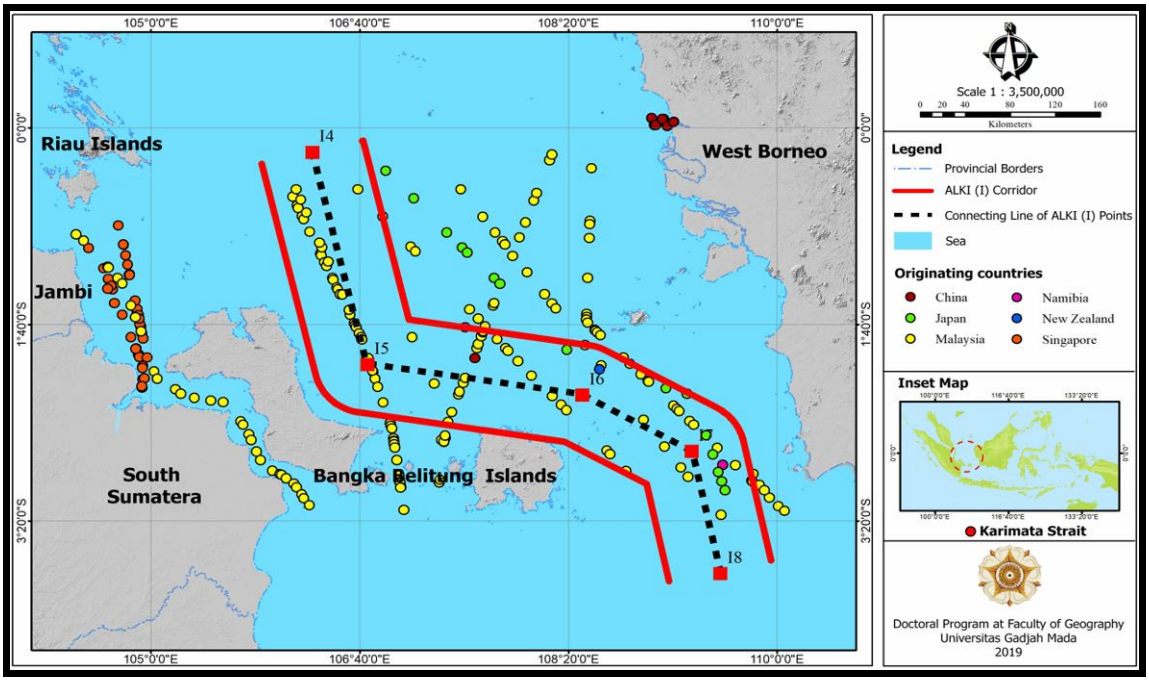

Figure 10. Foreign fishing vessel distribution in the Karimata Strait throughout 2017.

Berkes et al (2006) stated that the exploration and exploitation of fishery resources always trigger problems between nations since the fishing industry is one of the crucial players affecting the country's economy. The emergence of competition at sea between the fishing industry partakers often causes fishery resources to become a bone of contention. The circumscription of the sea area suffered by foreign countries forces them to eagerly take control of the fishery resources owned by other nations, and this event poses a significant threat like illegal fishing activities against Indonesia.

In addition to illegal fishing that occurs because foreign vessels enter Indonesian territory without a permit, other violations are also often exacerbated by the use of fishing gear which causes fishery resources to become increasingly scarce, like trawling. The high use of trawls in fishing activities happens because such tools are practical for catching all-sized fishery resources until the bottom of the fishing area.

Murillas et al (2008) found that trawling can provide abundant catches but also bring problems that can damage the sustainability of fishery resources in the long term. When fishery resources are misguidedly exploited, local fishers who solely operate traditional fishing gear will have difficulty meeting their future needs. In addition, the use of trawling can also damage coral reefs and destroy the entire ecosystem since all types of juvenile animals are gone forever with ungenerous fishers. Maritime security seen from International Fisheries Law and International Relation Studies is defined as steps taken as maritime delimitation by prioritizing access for local fishers while ensuring security concerns at sea. Such strategic steps are intended to reduce piracy by actively engaging with the regional and international organizations where political relations cannot go through negotiation for intractable issues due to overlapping maritime claims (Kim 2004; Belhabib et al 2019; Mitchell 2020). In light of the previous theory, law enforcers in the ALKI (I) region must be synergized in maintaining sovereignty by preparing and strengthening the required maritime security to its core, including aspects of readiness, sustainability, modernization, and organizational structure. Thus, conditions that threaten the country's security at seas, specifically the IUU fishing, will be further suppressed.

Conclusions. There were 90 countries whose vessels crossed the Karimata Strait throughout 2017, including Indonesia. These countries are grouped into nine regions and classified into Asia and Non-Asia. In terms of vessel types, cargo that performs international trade is dominant (219,951 vessels), followed by tankers (127,885 vessels),

tugboats (41,773 vessels), and passengers (22,357 vessels). Considering that Chinese vessels' mobility representing the East Asia region reached up to 87.31%, it can be understood that shipping and maritime business activities in the ALKI (I) region are vibrant and lively. Furthermore, most foreign vessels have been trespassing the ALKI (I) corridor (58.25%) throughout 2017, emphasizing that weak enforcement in implementing the trans-archipelagic regime in the Karimata Strait, especially in the ALKI (I) route, remains to exist.

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