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The Effect of The Implementation of Traffic Separation Scheme (TSS) In Maintaining Maritime Environment Safety of Lombok Strait

Abstract: Ships must meet marine pollution prevention requirements according to applicable regulations. The government regulates the separation scheme of ship shipping traffic in the Lombok Strait with the Traffic. Separation Scheme (TSS) system as an effort to improve shipping safety and security and protection of the maritime environment in Indonesian territorial waters. The purpose of this study is to determine the application of the Traffic Separation Scheme system in maintaining the safety of the maritime environment in the Lombok Strait and the effect of the application of the Traffic Separation Scheme system in maintaining the safety of the maritime environment in the Lombok Strait. This study used a comparative descriptive method with a quantitative approach. The result of this study is the implementation of the Traffic Separation Scheme system aimed at facilitating more effective traffic management and prioritizing shipping safety and marine environment protection. All Indonesian-flagged vessels are obliged to implement these rules, foreign-flagged vessels can adjust. The implementation of the TSS system has an impact on maritime development in Indonesia. From the results of testing the research hypothesis, there is a partial positive and significant influence. The implementation of *the* Traffic Separation Scheme system in the Lombok Strait has helped reduce and manage Traffic.

Keywords: Maritime, Environmental Safety, Traffic Separation Scheme

INTRODUCTION

Lombok Strait is a waterway located in the southern part of Indonesia and is included in the status of the Indonesian Archipelago Sea Channel (ALKI) II, which was established after the United Nations Convention on the Law of the Sea in 1982. In 1996, through Law Number 6, and in 2002, through Government Regulation Number 37, it was regulated that the Lombok Strait was crossed by ALKI II. ALKI II is a sea route that connects travel from the Sulawesi Sea through the Makassar Strait, Flores Sea, and Lombok to the Indian Ocean, and vice versa (Parthiana, 2016). Lombok Strait and Makassar Strait are included in the deep-sea category, while the Sulawesi Sea has a depth of almost 6,200 meters.

There is unique geological feature of Lombok Strait as one of the Archipelago Sea Channel. It is referring to the network of navigable passages threading through the

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Alexsandros Bosoz[®] Rotterdam Mainport Institute E-mail: alexbozos11@gmail.com Komang Artha Dewi² Politeknik Ilmu Pelayaran Semarang, Indonesia E-mail: arthadewi0@gmail.com archipelagos of various islands. This channel serves as crucial maritime routes, facilitating trade, transportation, and communication between islands and mainland ports. They also play significant ecological roles, enabling the exchange of marine life, thus fostering biodiversity.

Lombok Strait has a strategic position and is known in the field of transportation geography as "choke points", which are locations that limit circulation capacity and are difficult to pass because they are easily blocked (Maritim T, 2017). Alternatives to *these* "choke points" involve longer routes or the use of alternative routes, which have significant implications for costs and time delays. Geographically, Lombok Strait has a greater area and depth than the Strait of Malacca. Although shipping lanes in the Strait of Malacca are more congested, the minimum lane width in the Lombok Strait is 11.5 miles with a depth of more than 150 meters. Therefore, the Lombok Strait becomes a safe passage for large super tanker ships.

Lombok Strait has the threat of environmental pollution around tourist areas and conservation areas, so precisely in Lombok Strait, TSS will function as *Associated Protective Measures* (APMs) on PSSA in the waters of Tiga Gili, so that the Government regulates the separation scheme of ship shipping traffic in the Lombok Strait through the *Traffic Separation Scheme* system (TSS) as an effort to improve the safety, security, and protection of the maritime environment in Indonesian waters. Lombok Strait as PSSA. In this regard, the Lombok Strait is included in an area that requires special protection because it has ecological, and socio-economic potential, as well as areas that are vulnerable to damage caused by maritime activities. The TSS concept is indeed prioritized in the Lombok Strait, which is the safest passage for large ships (Rustam, 2018).

Traffic Separation Scheme (TSS) is one of the mechanisms for directing ships through regulated / mandatory routes to certain sea areas to reduce the risk of collisions, founders, and other accidents (Fadli, 2021). TSS is a maritime traffic management system regulated by the *International Maritime Organization* (IMO). TSS is designed to help reduce and regulate vessel traffic in areas with opposite traffic flows, such as around congested waters. The aim is to improve shipping safety by providing direction and guidance on safe distances between ships, assisting the management of ships in and out of the port area, and providing special routes for ships with large draft sizes (*deep draught vessels*) (Sea Transportation Directorate, 2020; 2)

The Ministry of Transportation, through the Directorate General of Sea Transportation, has compiled guidelines for ships that will cross the Lombok Strait, which is regulated in the Decree of the Minister of Transportation of the Republic of Indonesia Number KM. 129 of 2020 concerning the Establishment of Route Systems in the Lombok Strait. This decree establishes a system of routes that must be followed by ships passing through the Lombok Strait to ensure safe and smooth sailing. With established guidelines and route systems, ships can follow procedures that have been determined by the authorities, maintain shipping safety, and minimize the risk of collisions or traffic disturbances in the Lombok Strait. This decision is an important step in maintaining the security and efficiency of sea transportation in Indonesian territorial waters.

While TSS is designed to regulate vessel traffic and reduce the risk of collisions in busy waterways, its effectiveness in the Lombok Strait is subject to various factors. One key concern is the compliance of vessels with the designated routes and regulations outlined in the TSS. Instances of non-compliance, whether due to human error, navigational challenges, or deliberate disregard, can undermine the safety objectives of the scheme, leading to potential accidents and environmental hazards such as oil spills or ship groundings. Additionally, the dynamic nature of the marine environment, including unpredictable weather patterns, strong currents, and geological features, further complicates the implementation and efficacy of TSS in ensuring safe navigation through the Lombok Strait. Addressing these challenges requires enhanced enforcement mechanisms, improved navigational technologies, and collaborative efforts among relevant stakeholders to mitigate risks and safeguard the maritime environment in this vital waterway.

METHODS

This study used a comparative descriptive method with a quantitative approach. The main focus of the study to measure the effect of the *Traffic Separation Scheme* (TSS) implementation system on maritime environmental safety in the Lombok Strait with data processing was carried out using the SPSS (*Statistical Program for Social Science*) program version 26.0 (Ghozali, 2018).

Every day, at least 100 ships from various countries pass through the waters of the Lombok Strait (Hubla Dephub, 2020). Bali Island and Lombok Island are two islands that are the most tourist destinations in Indonesia. Therefore, many ships, such as sailing craft, pleasure craft, and fast boats, pass through this area. In addition, passenger ships departing from Benoa or via the Padang Bai route to Lembar, and vice versa, also have high intensity. These islands also have conservation areas, such as the Nusa Penida Area and the Gili Island Area, which consists of Gili Air, Gili Trawangan, and Gili Meno. The following presents the position of ALKI II and the location of the Lombok Strait in Figure 1 below.



Gambar 1. Posisi ALKI II dan Lokasi Selat Lombok

Figure 2, which shows the traffic density in the Lombok Strait area, it can be seen that the route with the highest intensity is the Padang Bai - Lembar route, as well as the route from north to south.



Figure 2 Traffic density di daerah Selat Lombok

RESULT AND DISCUSSION

Lombok Strait

Lombok Strait is a waterway connecting the Java Sea with the Indian Ocean. Located between the Indonesian islands of Bali and Lombok, the strait has a minor point at its southern opening, which is only 18 km wide, while at its northern opening, it reaches 40 km. The total length of the strait is about 60 km. The Lombok Strait is known as one of the main routes in Indonesia's *throughflow*, where there is a water exchange between the Indian Ocean and the Pacific Ocean. In addition, this strait is also included in ALKI II (Indonesian Archipelago Cross Channel II), which makes it have quite dense shipping traffic, and in a day, at least 100 ships from various countries pass through the waters of the Lombok Strait (Trisakti, 2023). Moreover, the ALKI route is the choice of large ships from all over the world to connect the Australian continent with Southeast Asia / East Asia (Maritime, 2017).

The ALKI II channel is a sea lane that connects shipping from the Sulawesi Sea across the Makassar Strait, Flores Sea, and Lombok Strait to the Indian Ocean and vice versa. Lombok Strait and Makassar Strait are included in the deep-sea category, while the Sulawesi Sea has a depth of almost 6,200 meters. The ALKI II channel is the second alternative route after the Strait of Malacca, which connects the Pacific Ocean and the Indian Ocean and geographically stretches from the south of the Makassar Strait to the north of the Sulawesi Sea.

The condition of the marine environment in the Lombok Strait can be known in terms of the quality status of light pollutants, which are influenced by dense ship activities. Unfortunately, not a few ships pollute the sea by disposing of dirty water or sewage, and this action often occurs at night. As a result, these conditions can have a negative impact on the quality of the surrounding marine environment. In addition, there is also the problem of garbage or dirt that can be seen on the coast. Garbage simply thrown away by ships or garbage carried by ocean currents can pollute beaches and have a negative impact on coastal ecosystems. Lombok Strait has the threat of environmental pollution around tourist areas and conservation areas, so specifically in the Lombok Strait, TSS will function as Associated Protective Measures (APMs) in Particularly Sensitive Sea Areas (PSSA) in the waters of Tiga Gili (Directorate General of Sea Transportation, 2018). The PSSA Determination Policy must be able to support and guarantee maritime security so that the greater the benefits obtained from the policy itself (Praditya, 2016). This indicates that waste management and pollution control efforts in the Lombok Strait need to be improved to maintain the cleanliness and sustainability of the marine environment in the region.

Research result

The results of the study are described as follows

		Non-standardized Residual	
N		58	
Normal	Mean	.0000000	
P arameters ^{*,b}	Std. Deviation	.94401569	
Most Extreme	Absolute	.194	
Differences	Positive	.116	
	Negative	094	
Test Statistic		.194	
Asymp. Sig. (2-tailed)		.096	

Table 1 Normality Test Results One-Sample Kolmogorov-Smirnov Test

Based on table 1 of the normality test results above, Sig. (2-tailed) of 0.096 (Sig. 0.096 > α 0.05) conclusion can be drawn to accept the H1. So that the samples/data that the researchers test are normally distributed

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	21.464	1	21.464	48.009	.000 ^b
Residual	25.036	56	.447		
Total	46.500	57			

Table 2 Simultaneous	Test Results
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a. Dependent Variable: Total_Y

b. Predictors: (Constant), Total_X

Based on Table 2. above, the result of the F value from the SPSS calculation is 48.009 with a sig value. 0.000. While the Ftable is 3.162, it can be concluded that the Fcalculate value is greater than the Ftable, and the sig value in SPSS is smaller than 0.05. From these results, it can be said that the variable application of the TSS system has a simultaneous influence on the safety of the maritime environment in the Lombok Strait.

Tabel 3 Partial Test ResultsCoefficients								
Model		Non-stan Coeffi B	dardized cients Std. Error	Standardized Coefficients Beta	t	Sig.		
1	(Constant)	4.316	1.617		2.670	.002		
	TOTAL_X	.477	.069	.679	6.929	.000		
D	1 . 17 . 11	TOTAL						

a. Dependent Variable: TOTAL_Y

Based on Table 3. above can be obtained the results of the statistical test t in the table above show that the variable application of the TSS (X) system has a calculated value greater than table (6,929 > 2,004) with a significantly lower value (0.000 < 0.05). So, it can be interpreted that the "use variable" of the TSS system (X) has a significant influence on the environmental safety variable (Y). So, Ho was rejected, and H1 was accepted. The procurement of *a Traffic Separation Scheme* (TSS) system can contribute to the monitoring and improvement of maritime environmental safety.

The optimization of TSS implementation in the Lombok Strait, an important *chokepoint* in the world, can help in handling the safety of the maritime environment in the area. This shows that the procurement of the TSS system has a great and positive impact on the safety state of the maritime environment in the Lombok Strait. This statement provides a better understanding of the effect of TSS application to preserving the maritime environment in the area, and it shows that marine area protection is important in ensuring the environmental security of a navigable area, especially related to the vulnerability of the region to damage caused by international shipping activities (Lestari, 2019). Bueger (2015) states that maritime security also includes marine *environment* dimensions and can be related to safety at sea, where the sea is free from threats in the form of pollution, ship accidents, and climate change.

On the reporting activity to TSS (Traffic Separation Scheme) system must consist the information of the size of vessel, both ballast and loaded, as well as whether the ship is carrying toxic and dangerous cargo, as defined in relevant international conventions. It aims to facilitate more effective traffic management and prioritize shipping safety and marine environment protection. All Indonesian-flagged vessels are obliged to implement these rules, and foreign-flagged vessels can adjust. Lombok Strait is an international traffic lane with a high density. The implementation of the TSS system has a great impact on maritime economics development in Indonesia. From the results of testing the research hypothesis, there is positive and significant influence of the TSS implementation with the safety marine environment. The implementation of *the Traffic Separation Scheme* system in the Lombok Strait has helped reduce and manage traffic in this channel.

CONCLUSION

The implementation of the Traffic Separation Scheme (TSS) in the Lombok Strait presents a multifaceted approach to enhancing the safety of the maritime environment. Implementation of the Traffic Separation Scheme (TSS) in the Lombok Strait presents a multifaceted approach to enhancing the safety of the maritime environment. With the analysis of quantitative statistical theories, it becomes evident that the TSS has contributed positively to reducing the risk of maritime accidents and environmental incidents in the region. Statistical analysis indicates a potential correlation between the implementation of TSS and a decrease in accident rates or environmental hazards, although further research may be necessary to establish causation definitively. Qualitative assessments perceived effectiveness of TSS among stakeholders, highlighting the scheme's role in regulating vessel traffic and reduce navigational risks. However, challenges such as compliance issues, dynamic environmental factors, and the need for continuous improvement in enforcement mechanisms. Therefore, while the TSS represents a vital step towards ensuring maritime safety in the Lombok Strait, ongoing monitoring, evaluation, and adaptation of the scheme are crucial to acknowledge the emerging threats and maintaining the long-term sustainability of the maritime environment in the region.

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