Research Article

Implementation of Indonesia Ship Reporting System (IndoSRep) in the Archipelagic Sea Lanes Passage of Indonesia (ALKI)

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Abstract.

As an archipelagic country, Indonesia holds a highly strategic position in international trade and shipping routes. This is reflected in the Indonesian archipelagic sea lanes (ALKI) designation as primary shipping routes connecting international waters in the Southeast Asian region and the Pacific Ocean. However, the high intensity of vessel traffic in these waters poses significant risks to safety, including maritime accidents and threats to navigational security. Therefore, an effective and integrated maritime traffic management system is essential. The ship reporting system (SRS) is one of the key navigational instruments that play a vital role in monitoring vessel movements in real-time by reporting dynamic information—such as position, course, and destination of ships—to authorized shore stations, such as coast radio stations (SROP) and vessel traffic services (VTS). This study aims to evaluate the effectiveness of SRS implementation in Indonesia using a quantitative approach through policy document analysis and field observations. Additionally, the study examines the utilization of the automatic identification system (AIS) and electronic navigational charts (ENCs) in supporting reporting functions and ensuring navigational safety. The findings indicate that human factors highly influence the success of the SRS, the quality of communication between ships and shore stations, and the integration of maritime information technology. These insights provide essential contributions to the formulation of strategic navigational policies that are adaptive to technological advancements and the evolving dynamics of shipping within the ALKI region.

Keywords: ALKI (archipelagic sea lanes passage), ship reporting system (SRS), vessel traffic services (VTS), coastal radio station, safety navigation

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1. Introduction

Indonesia is the largest archipelagic country in the world, strategically positioned as a connector between the Indian Ocean and the Pacific Ocean, as well as between the Asian and Australian continents. This geographical location makes Indonesia one of the key transit points along major international shipping routes. To ensure ships' smooth and safe passage, the United Nations Convention on the Law of the Sea (UNCLOS) recognizes the Indonesian Archipelagic Sea Lanes (ALKI). It grants Indonesia the authority to regulate maritime traffic within its waters, without obstructing the rights of innocent passage and transit passage granted to foreign-flagged vessels.

The ALKI has been formally designated as a legitimate shipping route, equipped with navigational systems to support safe and efficient maritime navigation. Through the establishment of ALKI, Indonesia can manage and monitor international shipping traffic and ensure compliance with national and international regulations. Additionally, ALKI offers Indonesia an opportunity to leverage its strategic geographic position to foster economic growth and enhance maritime security. In this context, Indonesia should have an effective system for the rapid and accurate exchange of information through the Ship Reporting System (SRS), which allows vessels to coordinate with other ships, port authorities, and monitoring centers. SRS provides essential information such as sea conditions, weather, and the position of nearby vessels to enhance maritime safety. However, the high intensity of vessel traffic along the ALKI also raises concerns about marine environmental pollution and an increased risk of maritime accidents. As a state that adheres to international regulations, Indonesia is required to develop a robust navigational system, particularly through the enhancement of the Ship Reporting System (SRS). The ship reporting system is a relatively new element explicitly discussed in this study, with the goal of improving situational awareness, communication quality between ship stations and shore stations, and real-time traffic monitoring. The following section presents vessel reporting data from ALKI I (Sintete Gateway), ALKI III, and ALKI at the Northern Entrance of North Sumatra (Figure 6, Figure 2, Figure 3).

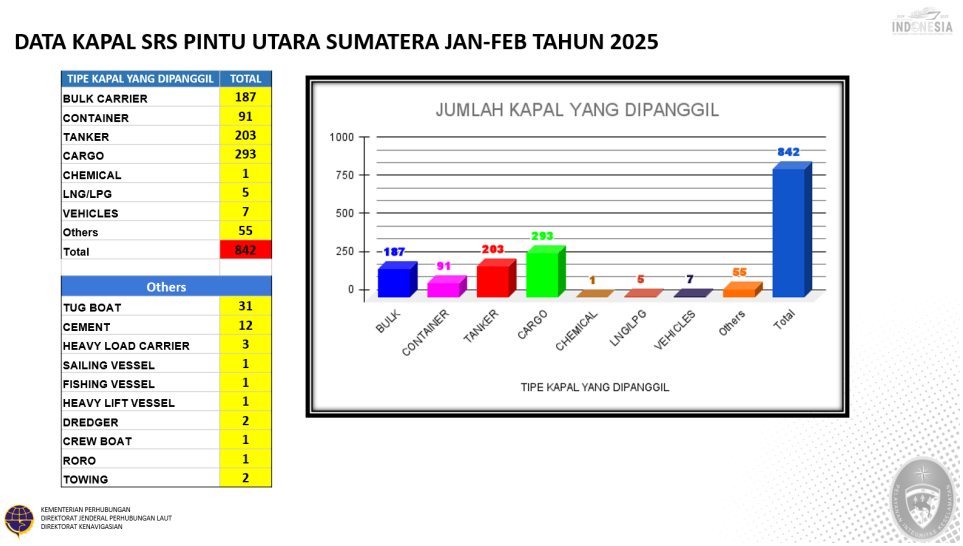

Figure 1: Ship data of SRS North Sumatra Gate.

The data obtained from the Ship Reporting System (SRS) at the Northern Entrance of Sumatra (ALKI I) demonstrates a marked disparity in reporting compliance between foreign and domestic vessels. From August to December 2024, 2,282 foreign vessels

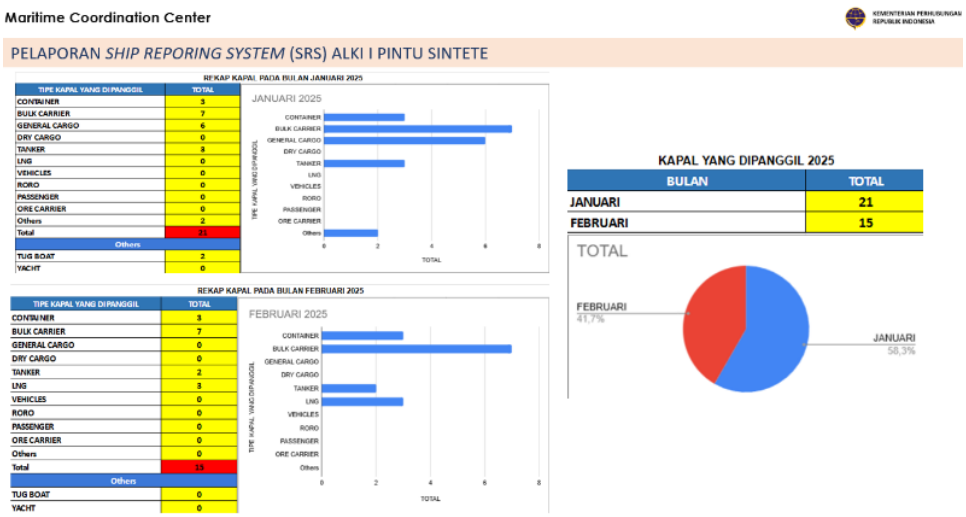

Figure 2: Ship Data of SRS Sintete Gate.

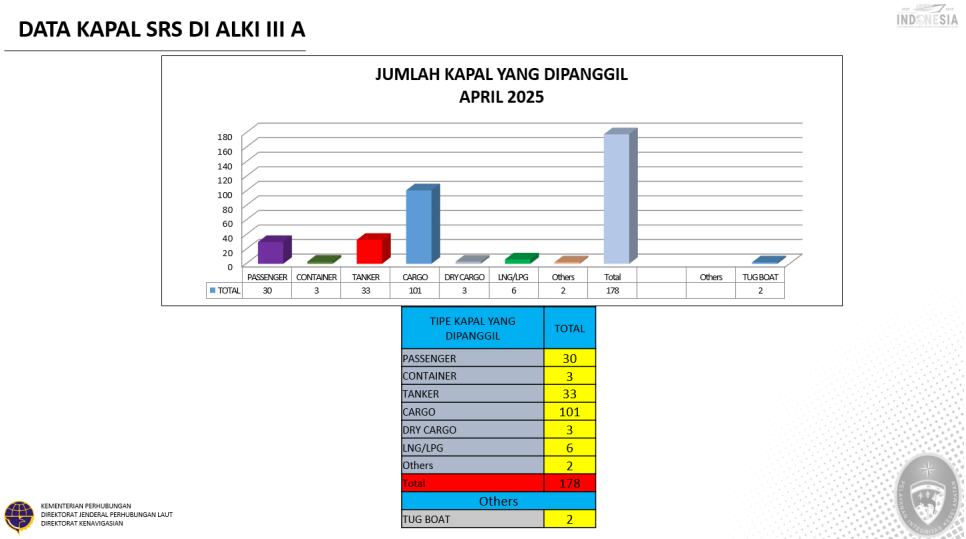

Figure 3: Ship data of SRS Archipelagic Sea Lanes Passage (ALKI III).

submitted reports through the SRS, while only 502 domestic vessels complied with the reporting requirement. This trend continued in the same period of 2025, with 646 reports from foreign vessels and only 196 from domestic vessels. These results suggest a consistent gap in reporting participation, particularly among domestic vessels. The discrepancy may be attributed to factors such as limited technical capacity, administrative challenges, or insufficient awareness of reporting obligations. The clear differentiation in reporting behavior between vessel types underscores the need for targeted analysis and policy interventions to enhance compliance rates, especially within the domestic shipping sector, The following is the presentation of data comparing the number of domestic and foreign vessels reporting through the Ship Reporting System (SRS) at the Northern Entrance of Sumatra (ALKI I) (Figure 4).

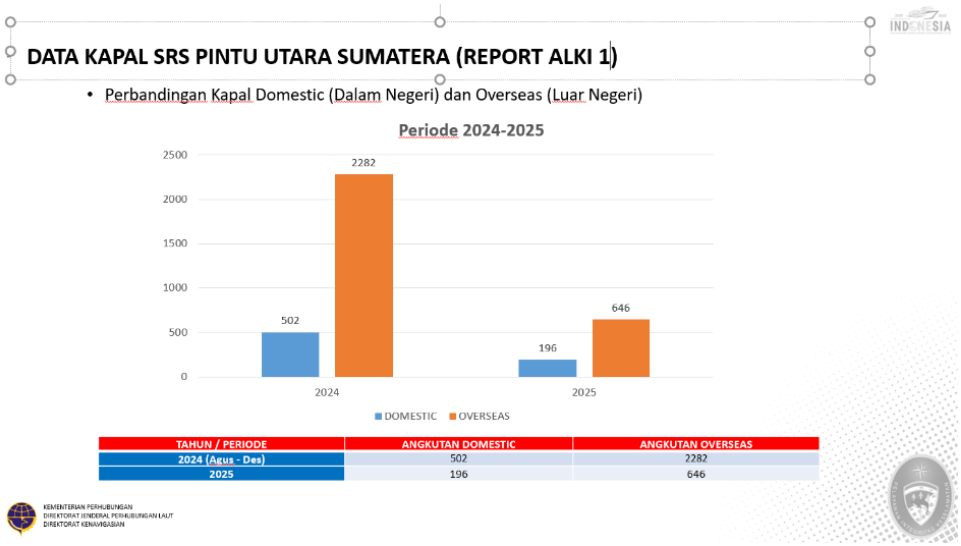

Figure 4: Comparison of the Number of Domestic and Foreign Vessels Reporting through the SRS at the Northern Entrance of Sumatra (ALKI I).

The Ship Reporting System (Indonesia Ship Reporting System) is one of the key instruments in supporting maritime safety within Indonesian waters. This system collects and monitors vessel movement data, both from domestic and foreign (overseas) ships, to enhance maritime traffic supervision and detect potential risks that may arise along shipping routes. Through this system, maritime authorities are expected to have sufficient information to conduct real-time monitoring, provide navigational guidance, and take preventive measures against potential maritime accidents.

As an archipelagic country with extremely high volumes of maritime traffic, Indonesia relies heavily on the reliability of the ship reporting system as a primary effort to improve maritime safety. However, the SRS has not been fully implemented across the ALKI, resulting in insufficient oversight of vessels transiting Indonesian waters. According to data from the Maritime Coordination Center (MCC) in 2024, several maritime accidents occurred due to the lack of SRS implementation, highlighting the urgent need for this system to be deployed to reduce accident risks and ensure the smooth flow of international trade.

Many maritime accidents (Figure 5) in Indonesia involve vessels that are not covered by, or do not comply with, the procedures of the Ship Reporting System (SRS), particularly local ships operating in remote areas. This shortcoming reflects a gap between the existence of the system and its practical implementation in the field. In fact, the SRS plays a crucial role in providing real-time vessel movement information, enhancing navigational safety, and preventing marine environmental pollution. Although the Regulation of the Minister of Transportation of the Republic of Indonesia No. PM 4 of 2023 regulates the

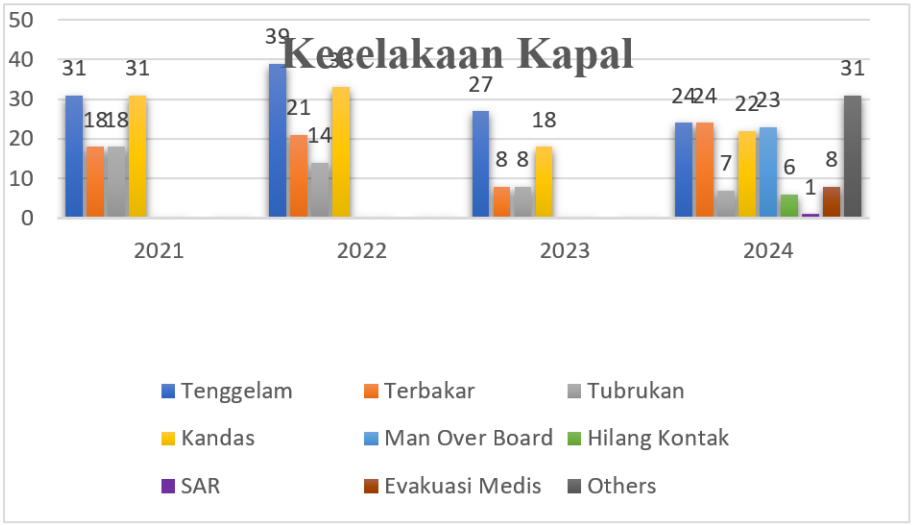

Figure 5: Ship accident. Source: Directorate General of Sea Transportation and Maritime Coordination Center (MCC), (2024).

implementation of the SRS; its enforcement in Indonesia remains suboptimal compared to countries such as Japan, South Korea, China, and Australia.

Therefore, a comprehensive evaluation is needed regarding the participation of domestic vessels in the system, improvement of education and supervision, and integration with navigational technologies such as the Automatic Identification System (AIS), as well as strengthening inter-agency coordination as strategic steps toward safer and more sustainable maritime operations.

This study aims to analyze the role of navigational systems, including the Ship Reporting System and coordination with shore-based stations such as Vessel Traffic Services (VTS) and Coast Radio Stations (SROP), in enhancing navigational safety and preventing marine pollution along the Indonesian Archipelagic Sea Lanes (ALKI). Theoretically, this research is expected to enrich the literature on maritime traffic management in archipelagic states. At the same time, practically, the findings may serve as a basis for formulating navigation management policies that are adaptive to the dynamics of shipping, in accordance with international and national regulations. It will also offer strategic recommendations concerning the strengthening of infrastructure and the improvement of human resource competencies in the field of navigation.

A reliable maritime telecommunications system is essential in emergency situations to facilitate rescue efforts, reduce accident risks, and improve coordination between vessels and relevant authorities. Therefore, this study will examine vessel monitoring

along the ALKI by utilizing navigational dimensions to enhance the safety of navigation, and develop a model that considers factors such as Maritime Safety Information, Radiocommunication, Aids to Navigation, Ship Routeing, Ship Reporting System, and Human Factor to evaluate their influence on maritime safety. The results of this study are expected to provide strategic recommendations for the effective implementation of the Indonesia Ship Reporting System.

2. Methods

2.1. Navigation

Navigation is an important discipline in maritime safety that involves techniques, processes, and systems to accurately determine a ship's position, course, and movement until it reaches its destination. According to James [1], navigation is a technique used to precisely determine the position and course of a journey through charts or in the actual field. The person responsible for navigation is called a navigator, who is assisted by various indicators such as aids to navigation, maritime telecommunications systems, hydrography, meteorology, shipping routes, piloting, and other supporting systems (Government Regulation No. 5 of 2010).

According to Jurdzi [2], navigation involves the process of acquiring and processing navigational information while considering certain constraints and the planned route. This process includes main functions such as ship route planning, ship traffic control, determining the ship's position and actual movement (CMG, SOG), avoiding collisions, and mitigating environmental impacts on the ship and its cargo.

Formela et al [3] emphasize that navigation is not only a technical aspect but also an integral part of a complex maritime safety system, involving interactions between humans and systems. Factors influencing navigation include the type and task of the ship, maneuvering ability, environmental conditions, and crew competence.

Internationally, navigation includes activities across borders and is governed by international maritime law. Ntovas [4]and Keyuan [5] explain that the principle of freedom of navigation is part of international law, as outlined in the United Nations Convention on the Law of the Sea (UNCLOS). This convention regulates the right of innocent passage for foreign ships in various maritime zones and requires coastal states to support navigational safety. Additionally, the SOLAS 1974 convention from the IMO serves as the primary reference for setting global maritime safety standards.

Thus, navigation is a crucial element in the maritime safety system, involving technical, operational, legal, and human aspects. This theoretical understanding serves as a foundation for constructing navigation models to be tested in further research.

2.2. Ship Reporting System (SRS)

The Ship Reporting System (SRS) is a vessel reporting mechanism designed to enhance the safety and efficiency of navigation. It constitutes an integral part of the international maritime safety system as regulated by the International Maritime Organization (IMO) under SOLAS Chapter V Regulation 11 and Resolution MSC.43(64). The primary objective of the SRS is to facilitate the exchange of information between ships and coastal authorities, such as Vessel Traffic Services (VTS) and Coastal Radio Stations, to monitor maritime traffic, provide navigational guidance, and prevent marine accidents and environmental pollution.

As an archipelagic state, Indonesia faces specific challenges in managing maritime traffic, especially along designated international sea lanes known as Archipelagic Sea Lanes (ALKI). Within this context, the SRS becomes a crucial component of the navigational system to ensure safe and efficient maritime operations. In accordance with Law No. 17 of 2008 concerning Shipping, the government is authorized to supervise foreign vessels traversing ALKI and to establish effective communication and vessel reporting systems. The SRS enables authorities such as VTS to receive real-time data on vessel positions and conditions, allowing for continuous monitoring of maritime traffic.

A study by Zhongzhou Fan [6] indicates that increasing vessel traffic in the Cheng Shanjiao area resulted in higher workloads for VTS operators, thereby necessitating automated reporting systems that not only reduce VHF communication congestion but also enhance monitoring efficiency and decision-making. This finding is consistent with Silber [7], who emphasizes that the effectiveness of SRS relies on three key factors: mariner compliance with reporting points, the operational burden on crew members, and their perception of the system's benefits in preventing collisions. Silber and Gregory also underscore that SRS—transmitted via media such as INMARSAT-C or radio communications—raises mariner awareness of collision threats and reinforces the value of maritime conservation information.

Rojek and Wawruch [8] highlight that the SRS contributes not only to navigational safety but also to marine environmental protection through early incident detection and activation of search and rescue (SAR) procedures. Data obtained from radar, VHF, AIS,

and other media are critical in identifying vessels and executing prompt responses during maritime emergencies. This demonstrates the SRS's role in supporting the broader navigation system, which includes Maritime Safety Information (MSI), Radio-communication, Aids to Navigation (AtoN), and Ship Routeing.

According to IMO [1], ship reporting systems assist maritime authorities in detecting navigational hazards and disseminating up-to-date information to vessels underway. SRS communications are typically conducted via AIS (Automatic Identification System), VHF radio, and other electronic reporting systems.

Macdonald [9] explains that SRS requires ships to report while transiting designated areas under VTS coverage, such as the Torres Strait and the inner route of the Great Barrier Reef (Australia's REEFREP system), to enhance navigational safety and protect ecologically sensitive areas.

The SOLAS Convention affirms that SRS contributes to the safety of life at sea, navigational efficiency, and marine environmental protection. SOLAS mandates that the respective government establish such reporting systems and ensure their effective dissemination and utilization once implemented.

In line with Indonesia's Regulation of the Minister of Transportation No. 4 of 2023 on the Administration of Maritime Telecommunication and Vessel Traffic Management in Indonesian Waters, SRS is defined as a ship reporting system involving vessels entering and exiting Indonesian waters to provide real-time information through Coastal Radio Stations, VTS, AIS Base Stations, and/or the National Data Centre (NDC) for Long Range Identification and Tracking (LRIT). The regulation states that the purpose of the SRS is to provide current vessel movement information, enhance navigational efficiency, protect the maritime environment, reduce intervals in communication with vessels, facilitate quick location of vessels in distress, and ensure the safety of life and property at sea.

The SRS is implemented by mandating vessels to report their real-time positions and movements while entering or leaving designated waters, under nationally and internationally agreed regulations, using Coastal Radio Stations (SROP), VTS, and the National LRIT Data Centre.

2.3. Safety of Navigation

Safety of navigation refers to the condition in which the risks of accidents, collisions, groundings, or other maritime incidents are minimized through the fulfillment of technical

and operational standards, sea traffic monitoring, and the preparedness of personnel and navigational equipment. According to Grech et al [10], maritime safety is influenced by three main factors: technology, human factors, and the environment.

Kopacz et al. [11] argue that safety of navigation results from secure and stable sailing conditions supported by technical, organizational, economic, social, and legal regulatory systems at both national and international levels. The aim of this system is to reduce and prevent maritime accidents, ensure the safety of life and property at sea, and protect the marine environment. Navigational safety, therefore, depends not only on the ship's ability to navigate but also on the systemic framework that governs and supports vessel operations across various sailing conditions.

This perspective is reinforced by Torskiy, Topalov, and Chesnokova [12], who emphasize that navigational safety should be understood as a condition achieved through accurate and appropriate navigational practices, supported by a conducive operational environment. This environment includes the readiness of navigational equipment, the competence of ship crews, and shore-based monitoring and communication systems such as Vessel Traffic Services (VTS). Furthermore, the safety culture and adherence to standard procedures significantly contribute to the achievement of overall navigational safety.

Formela, Neumann, and Weintrit [3] add that the concept of navigational safety encompasses not only direct navigational threats such as collisions or groundings, but also other risks, including vessel instability, hazardous cargo, and the potential for onboard fires. Thus, safety of navigation represents a multidimensional component of maritime safety, requiring integration of technology, procedures, and human elements within a secure and reliable maritime system. In the context of Indonesia as an archipelagic state, implementing these principles is crucial to ensure the safety of vessels transiting through the Indonesian Archipelagic Sea Lanes (ALKI). Global standards for navigation safety refer to IMO regulations, including the utilization of modern navigational equipment and vessel reporting systems that facilitate two-way communication between ships and shore stations.

2.4. Human Factor

The human factor has been identified as the primary cause of the majority of maritime accidents. According to Makarowski et al. [13], over eighty percent of maritime incidents are directly linked to human error, predominantly influenced by psychological aspects

such as personality traits and the aggressiveness level of seafarers. This finding highlights the importance of understanding the psychological dimensions of crew members, particularly those in leadership roles such as captains, as part of a comprehensive strategy to reduce accident risk and enhance maritime safety.

Chowdury et al. [14]expand on this understanding by demonstrating that workplace behavior in maritime environments is influenced not only by individual character but also by structural and contextual factors such as organizational culture, work design quality, and overall working conditions. Within the operational context of a ship, these factors include the configuration of the engine room, internal communication systems, and work management practices, all of which can impact the health and safety of the crew.

Considering both perspectives, addressing human factors in maritime navigational safety should not be limited to identifying individual errors but must also encompass systemic and organizational interventions. This is especially relevant for Indonesia as an archipelagic country with dense and complex maritime routes. Therefore, strengthening maritime human resource capacity and implementing behavior-based safety management are critical priorities to be realized.

Approximately 80% of maritime accidents are attributed to human error. In fact, it may be more accurate to state that virtually all incidents at sea involve human factors, as human input remains integral despite the increasing automation in ship design and operation. These human factors can be influenced by various elements, including:

1. Physical and Environmental Factors

- Fatigue resulting from sleep deprivation or excessive workload.
- Physical discomfort or health issues caused by harsh maritime conditions, such as storms and cold weather.

2. Communication Errors

- Failures in communication between crew members or with pilots.
- Language barriers leading to misunderstandings in critical exchange

2.5. Previous Research Studies

Research on the Ship Reporting System (SRS) and maritime safety has been conducted in various countries and strategic areas:

• Zhou et al. [15] in Marine Policy found that implementing the SRS significantly reduced maritime incidents in congested areas like the Malacca Strait and the South China Sea.

• Kristiansen [16] in the Journal of Navigation stated that integrating SRS with Vessel Traffic Services (VTS) reduced human errors and increased traffic efficiency.

• Shu & Lam [17] in Transportation Research Part D found that coordination between AIS (Automatic Identification System) and SRS reduced the risk of incidents by 27% over three years in East Asia.

• Heij et al. [18] in the European Journal of Transport and Infrastructure Research showed that areas requiring reporting systems had a lower rate of maritime accidents.

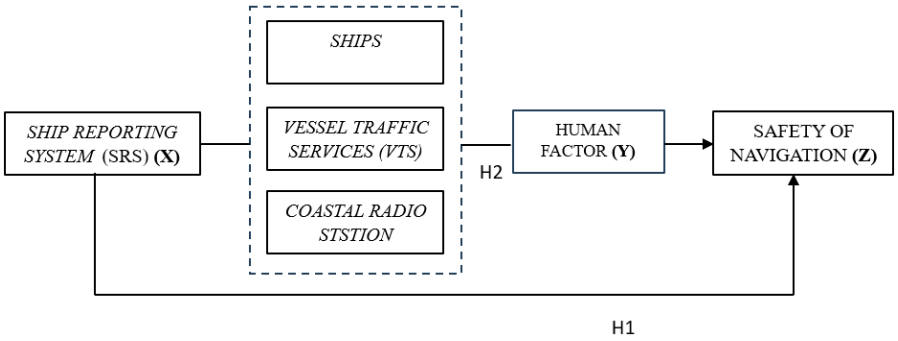

Figure 6: Frame work.

• Budiman & Wahyuni [19], through a national symposium, stated that digital-based ship reporting supports the situational awareness of foreign ships in the ALKI III (Indonesian Archipelagic Sea Lane III).

Based on the theoretical foundation and previous research findings, the hypotheses for this study are as follows:

• H1: The Ship Reporting System (SRS) has a positive impact on the safety of navigation for vessels transiting the Archipelagic Sea Lanes (ALKI).

• H2: The Human Factor significantly mediates the impact of SRS on the safety of navigation.

2.6. Research Objectives

This study aims to analyze the impact of the Ship Reporting System (SRS) on the Human Factor for vessels transiting Indonesian waters, particularly the Archipelagic Sea Lanes

(ALKI). The research approach uses a quantitative method with an explanatory research design that combines survey techniques and statistical analysis based on Structural Equation Modeling (SEM) using Partial Least Square (PLS-SEM).

2.7. Research Design

The research design is causal-comparative, aiming to determine both direct and indirect effects between the variables of Ship Reporting System (X), Human Factor (Y), and Safety of Navigation (Z). The study is conducted through the distribution of a five-point Likert scale questionnaire to respondents representing the population of vessels over 300 GT transiting ALKI.

2.8. Population and Sample

The study population consists of all vessels with a gross tonnage (GT) above 300 GT that entered Indonesian waters from January to August 2024, totaling 517,692 vessels. The sample includes 143 vessels.

The sample size was determined based on the number of indicators of latent variables, multiplied by a factor ranging from 5 to 10. Based on this theory and supported by previous research, 13 questionnaire indicators were multiplied by 10, resulting in 143 respondents as the research sample. To anticipate the possibility of unusable data during analysis, the researcher added 10 percent to the total sample,with the following criteria:

- Vessels reporting to the VTS Centers of Batam, Tanjung Priok, Merak, Samarinda, Balikpapan, and Benoa.
- Vessels registered at the relevant KSOP ports.
- Vessels with technical information: Ship Name, Call Sign, MMSI, Port Register, Year of Construction, GT, Draft, Type of Ship, Type & Quantity of Cargo, Port of Departure-Destination, and Position Coordinates.
- Vessels with crew information: Name of Captain, Crew Number, Crew Nationality.

2.9. Data Collection Techniques and Instrument Development

- Data are collected through:

• Field observations and pre-research surveys.

• Literature review from journals, laws, and maritime policies (UNCLOS, Law No. 17 of 2008).

• Development of the questionnaire based on research variables (Ship Reporting System, Human Factor, Safety of Navigation), with validity and reliability tested using Pearson Product Moment.

• The research instrument uses a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) because this scale provides a wide range of answers, is easy to understand, and is consistent for answers above 100 respondents.

TABLE 1: Likert Scale Weight.

No	Alternative Answer	Code	Score
1	Strongly Disagree	STS	1
2	Disagree	TS	2
3	Neutral	N	3
4	Agree	S	4
5	Strongly Agree	STS	5

2.10. Data Analysis Techniques

The analysis will be conducted in several stages:

• Testing the validity and reliability of the instrument using Confirmatory Factor Analysis (CFA), Average Variance Extracted (AVE), discriminant validity, and construct reliability.

• Building a structural model using PLS-SEM.

• Converting the model into regression equations and testing the Goodness of Fit Index (GFI).

• Hypothesis testing is carried out by examining the t-statistic value (CR > 1.96) and the significance level with a p-value < 0.05.

If any instrument items are found to be invalid or unreliable, revisions will be made to the instrument and research design model until the required statistical criteria are met.

2.11. Specifications of Tools and Data

This study will use SmartPLS 3 software for data analysis. Additional data will be obtained from the VTS system, AIS, and vessel records from the relevant KSOP. The questionnaire instrument will be developed digitally to ensure efficiency and accuracy in respondent completion.

3. Results and Discussion

3.1. Results

Based on the data analysis conducted using Structural Equation Modeling (SEM) with Partial Least Squares (PLS-SEM), the following results were obtained for the hypotheses tested:

a. H1: The Ship Reporting System (SRS) has a positive impact on the safety of navigation for vessels transiting the Archipelagic Sea Lanes (ALKI).

◦ The analysis shows a positive and statistically significant relationship between the Ship Reporting System (SRS) and the safety of navigation. The t-statistic value for this relationship is higher than 1.96, and the p-value is below 0.05, confirming the hypothesis. This suggests that implementing the SRS significantly contributes to enhancing navigational safety. The system provides crucial real-time information, enabling better coordination between vessels and land-based authorities such as VTS and coastal radio stations, which improves safety measures in the navigational process.

b. H2: The Human Factor significantly mediates the impact of SRS on the safety of navigation.

◦ The results of the analysis also support the second hypothesis. Human factors, including the professionalism, training, and communication skills of the crew, significantly mediate the relationship between the SRS and the safety of navigation. The t-statistic value for this mediation effect is significant, with a p-value less than 0.05. This indicates that the effectiveness of the SRS in improving safety is strongly influenced by the actions, decisions, and behavior of the human operators involved, particularly in terms of adherence to protocols and the ability to respond to dynamic maritime conditions.

4. Discussion

a. Impact of Ship Reporting System on Safety of Navigation:

The positive impact of the SRS on the safety of navigation underscores the importance of technological and operational systems in ensuring maritime safety. The SRS facilitates real-time communication, provides vital data for monitoring vessel positions, and supports efficient traffic management in critical maritime routes, such as ALKI. This finding is consistent with previous studies, such as those by Zhou et al. [15] and Kristiansen [16], which highlighted the role of ship reporting systems in reducing accidents and improving navigational safety. The ability of vessels to report their positions and movements contributes significantly to preventing collisions and ensuring safe passage, particularly in congested areas.

b. Role of Human Factor in Mediating the SRS-Safety Relationship:

The human factor remains a critical element in ensuring maritime safety, despite technological advancements. The positive mediation effect of human factors implies that while the SRS provides essential information and guidelines for safe navigation, the behavior and decision-making of the crew play an equally important role. Effective communication, situational awareness, and adherence to safety protocols are all aspects of the human factor that influence the effectiveness of the reporting system. This aligns with the findings of Formela et al. [3] and Jurdzi [2], who emphasized the importance of human behavior in the execution of navigational systems.

Additionally, this result highlights the need for continuous training and capacity-building for maritime personnel, ensuring they understand how to utilize systems like the SRS to their fullest potential. Training in communication skills, emergency response, and safety procedures will enhance the SRS's overall impact on safety outcomes.

c. Implications for Maritime Safety Practices:

The findings from this study have significant practical implications. For instance, the study suggests that improving the effectiveness of SRS, combined with reinforcing the human element through training and awareness programs, can lead to better safety outcomes in maritime navigation. This can be achieved through:

- Regulatory Measures: Maritime authorities should strengthen regulations and encourage compliance with reporting systems to ensure that all vessels transiting the ALKI areas are part of the SRS, ensuring a more comprehensive safety net.

◦ Human Factor Integration: Emphasizing the human factor's importance in the operational environment will require increased investments in crew training, decision-making support tools, and situational awareness development. As human behavior significantly influences the success of SRS in ensuring navigational safety, fostering a culture of safety and responsibility among maritime personnel is crucial.

d. Recommendations for Future Research

Considering the importance of environmental factors and crew training, further studies are recommended to develop a more comprehensive research model with a multivariate or mixed-methods approach. Adding environmental variables as external factors and crew training as a moderator variable will provide a complete picture of the factors affecting navigation safety in strategic waters such as ALKI.

5. Conclusion

Based on the research conducted on 143 vessels over 300 GT navigating the ALKI areas of Indonesia, the following conclusions can be drawn:

1. Ship Reporting System (SRS) has a positive and significant impact on the Safety of Navigation. This means that the ship reporting system plays an important role in enhancing navigational safety by providing dynamic information and improving coordination between vessels and land authorities such as VTS and Coastal Radio Stations.

2. Ship Reporting System (SRS) also has a positive and significant impact on the Human Factor (Y). This system encourages more professional working behavior, more effective communication, and better compliance with safety procedures.

3. The Human Factor significantly influences the Safety of Navigation. This shows that human aspects remain a dominant factor in ensuring maritime safety, in addition to the technologies and systems in place.

Overall, the study demonstrates that improving the quality of the Ship Reporting System and strengthening the Human Factor are two key pillars in supporting navigational safety in Indonesian waters.

6. Implications

The results of this study have practical implications as follows:

1. For the Government and Maritime Authorities: Strengthening regulations and supporting infrastructure for ship reporting systems is necessary, especially in the ALKI areas, to ensure the system becomes more comprehensive and operates in real-time.

2. For Ship Operators and Shipping Companies: There is a need to enhance crew training regarding the importance of reporting and safety, as well as integrate a reporting culture as part of the ship's safety management system.

3. For VTS and Coastal Radio Station Operators: It is necessary to improve monitoring capacity, response speed to ship reports, and make use of reporting data for strategic maritime traffic planning

7. Limitations of the Study

This study has several limitations that need to be considered:

1. Limited Data Scope: Data was only collected from vessels registered at specific ports and VTS centers representing ALKI I and II, and does not cover ALKI III.

2. Dominant Quantitative Approach: The study predominantly used a quantitative approach based on SEM-PLS, and did not delve deeply into the subjective perceptions of ship crews or authorities using a qualitative approach.

3. Limited Variables Studied: The study focused only on three main variables (Ship Reporting System, Human Factor, and Safety of Navigation), while factors like navigational technology or environmental conditions were not analyzed.

8. Suggestions for Future Research

Based on the limitations, the following suggestions are made for future research:

1. Expansion of Study Area: Future studies are recommended to cover the ALKI III area and smaller ports to provide a more comprehensive overview of the national ship reporting system.

2. More In-Depth Mixed Methods Approach: Combining quantitative and qualitative methods will enrich the interpretation of human behavior dynamics and implementing reporting systems on the ground.

3. Inclusion of Additional Variables: Future researchers are advised to consider other variables such as ship technology (AIS, ECDIS), early warning systems, or even weather and sea conditions as external factors that may influence navigational safety.

This study confirms that the Ship Reporting System (SRS) and human factors are the two main components that contribute to shipping safety in the ALKI. While the SRS has proven effective in improving communication and surveillance of marine traffic, its effectiveness is strongly influenced by the readiness of the crew to operate the system. However, no automated reporting system currently can reduce the communication burden at the VTS. Therefore, the development of ship reporting automation technology is needed as a strategic step to improve navigation efficiency and safety, especially in busy lanes such as ALKI.

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