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Analysis and Evaluation of Navigation Aids Maintenance in Tanjung Perak Port

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ABSTRACT

Tanjung Perak Port, Indonesia's second largest and busiest port, has witnessed a significant surge in incoming vessels and cargo handling activities in recent years. However, this growth has introduced problems such as increasingly complex navigational routes, berth depth, berth area, and pilotage services that impact maritime safety, comfort, and security. This research objectives to conduct a comprehensive analysis and evaluation of the maintenance of Navigational Aids and Facilities (SBNP) at Tanjung Perak Port, considering its broad impact on overall port performance. The study methods are structured in multiple stages. Initially, a thorough examination of the current state of SBNP is conducted, focusing on the condition of navigational facilities to understand their present status. Following this, data on maintenance activities undertaken by local port authorities are collected to evaluate the practices in place, including the frequency, methods, and effectiveness of SBNP maintenance procedures. Additionally, projections of future cargo handling volumes and vessel traffic at Tanjung Perak Port are made to understand the port's developmental needs. These projections help formulate SBNP requirements necessary to enhance operational efficiency and safety. Using a methodical and systematic approach, this research aims to provide valuable insights for stakeholders involved in managing and developing Tanjung Perak Port. The results and recommendations from this study can significantly contribute to optimizing navigational facilities, improving service quality, raising safety standards, and enhancing overall port productivity. By addressing the challenges brought about by increased port activities, the research seeks to ensure sustainable growth and efficiency at Tanjung Perak Port.

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INTRODUCTION

Indonesia is known as the world's largest archipelagic state, comprising thousands of widely spread islands. Due to this geographical characteristic, the country faces unique challenges in regulating transportation and maritime navigation. One of the issues that arises is that the management of port areas can hinder smooth transportation and may even lead to accidents. This is triggered by various factors, including unfavorable weather conditions, human errors, limited port infrastructure, and the need for coordination with multiple parties in the navigation process. One innovation introduced to minimize these issues is the implementation of Navigation Aids Facilities (NAF). The NAF are equipment or systems located outside the ship, designed and operated to enhance the safety and efficiency of ship navigation and/or vessel traffic. NAF plays a crucial role in the maritime industry by providing access and connecting island regions, including both developed and isolated areas (Lin et al., 2003). Several types of NAF include

electronic NAF such as the Global Positioning System (GPS) at Coastal Radio Stations, Vessel Traffic Services, Local Port Services, Differential Global Positioning System (DGPS), Radar Beacon, and Radio Beacon (Sjukri et al., n.d.).

As an archipelagic nation, Indonesia greatly requires NAF due to its 5.8 million square kilometers of island territory, connecting 17,667 islands. This necessitates the installation of navigational safety support to ensure safe navigation. One of the key areas for maritime activities in East Java is the Tanjung Perak Port in Surabaya, with an average daily operational total of 120-140 vessels (Katias & Muhammad, 2017), which can lead to issues such as delayed sailing times, vessel traffic congestion, and ship accidents (Prasetyo et al., 2014). The definition of a port is an area that serves as a connection between one location and another, consisting of land and water areas surrounded by predetermined boundaries (Quinn, 1972). This area is used for various governmental and administrative activities (Kalsum, n.d.) and is utilized as a center for economic development in a region (Dahuri, 2001) because it plays an important role as a port for docking ships, loading and unloading goods, and as a location for passenger embarkation and disembarkation activities from ships (Sunyowati, 2008). SBNP (Sarana Bantu Navigasi Pelayaran - Navigational Aids Facilities/NAF) is equipment or systems located outside the ship designed and operated to enhance the safety and efficiency of ship navigation and/or ship traffic (Rais et al., 2004). The types of SBNP consist of visual SBNP, electronic SBNP, and audible SBNP.

The legal basis for NAF is outlined in Ministerial Regulation No. 25 of 2011, which governs the technical requirements and standards for NAF equipment, including supporting equipment and their placement. Additionally, the planning process for NAF is regulated, as well as the procurement of equipment and related surveys or studies. Operational standards, equipment usage, including placement, color, distance, frequency, lights, and signals, are also detailed. The regulation also covers maintenance, repair, and replacement processes, including routine periodic inspections at intervals of 1 month, 3 months, and 1 year. Given the background of issues related to the increase in the number of vessels, the condition of navigation routes, and existing NAF in relation to the smooth operation, safety, comfort, and security of maritime navigation (Syarifuddin et al., n.d.), the installation of NAF in navigation routes is necessary to ensure adequate safety and security. The East Java regional government, through the Port Authority, has planned the procurement and maintenance of NAF at specific vulnerable points.

However, the maintenance of NAF is currently a topic of discussion due to the vested interests of all parties involved in maritime transportation, including the smoothness of cargo handling processes and the passage of vessels through port routes. Therefore, the maintenance of NAF is crucial, especially to support maritime safety (Hariastuti, 2013). This study aims to analyze and evaluate the maintenance practices of NAF at Tanjung Perak Port, focusing on their impact on maritime safety and operational efficiency. By assessing the current state of NAF and the adequacy of maintenance procedures, the research seeks to identify areas for improvement and recommend strategies to enhance navigational safety and reduce accidents. Insights gained from this study will inform stakeholders, including port authorities, policymakers, and maritime operators, on optimizing NAF maintenance to meet the growing demands of vessel traffic and ensure sustainable maritime operations. This is to prevent bottlenecks in navigation routes, ensure smooth transportation, fulfill safety and comfort requirements, reduce and prevent ship accidents in navigation routes and surrounding port areas. In this study, literature related to navigation aids, ports, navigation routes, vessel operations in ports, port facilities, ship movements, and electronic navigation, as well as journals related to forecasting and regression regarding vessel traffic and cargo handling, which directly and indirectly affect navigation aids, will be included.

The research methodology involves a comprehensive review of literature on navigation aids, port operations, vessel traffic patterns, and electronic navigation systems. Data collection includes examining maintenance records, conducting surveys with maritime experts and port authorities, and analyzing historical data on vessel movements and accidents. Statistical methods and qualitative analysis will be employed to evaluate the effectiveness of current maintenance practices and propose enhancements for NAF. The study's findings aim to contribute practical recommendations for enhancing navigational safety and efficiency at Tanjung Perak Port, thereby supporting Indonesia's maritime development goals. This structured approach will provide valuable insights into the maintenance of NAF, aiming to improve safety standards, operational efficiency, and overall port performance in East Java's vital maritime hub.

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METHOD

This research begins with an analysis of the existing conditions through primary and secondary surveys. The purpose of this study is to analyze the efficiency of the Navigation Aids Facility at Tanjung Perak Port in Surabaya in order to optimize safety and security in navigation. There are several stages involved in this research process. For more details regarding the flowchart, please refer to Figure 1.

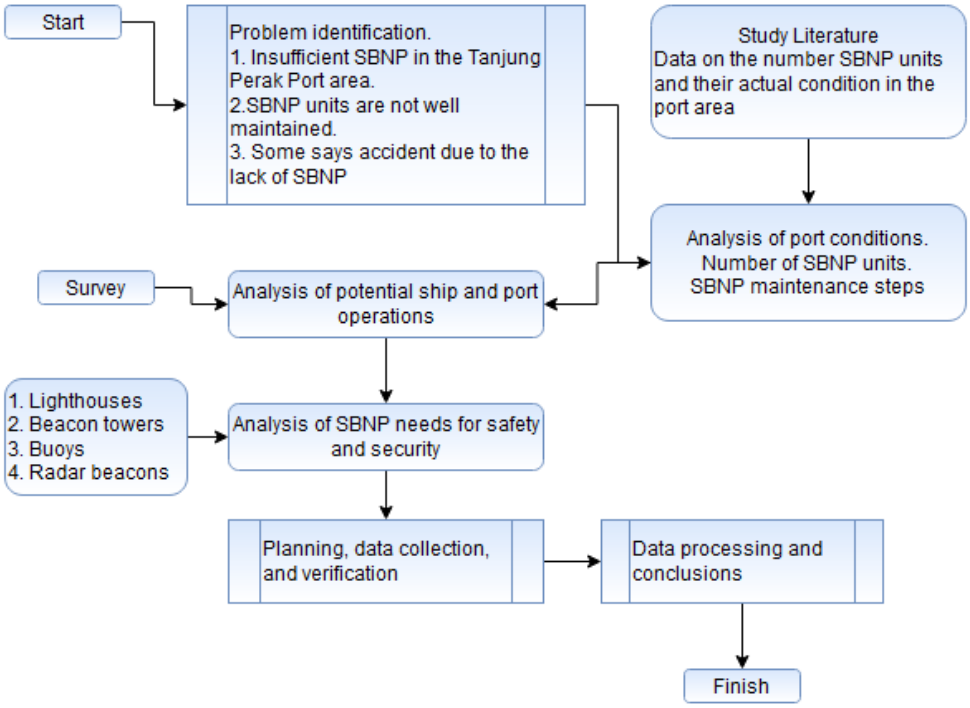

Figure 1 Research Flow Diagram

The research methodology consists of a series of steps followed in conducting the research process. The research to be conducted begins with an analysis of the current condition. This step entails a comprehensive understanding of the situation or context that forms the background of the research. During this phase, the researcher will analyze factors relevant to the problem being investigated. After completing the current condition analysis, the next step is to identify specific problems that need to be addressed within the research context. This aims to narrow the research focus and formulate clear research questions. Following problem identification, a literature review is conducted to gain a deep understanding of related theories and previous research. Key references include the Port Design Handbook from the International Association of Ports and Harbours (IAPH) and the Permanent International Association of Navigation Congresses (Permanent International Association of Navigation Congresses et al., 1997), research reports on the needs of port sea-side facilities detailing electrical requirements based on ship types and necessary aids to navigation (Fisu, 2018), studies on the feasibility of port basin areas (Ilham et al., 2016), factors supporting maritime safety (Windyandari, 2011), research on port development and its evaluation (Ariyanto, 2018), and performance of pilotage services in terms of waiting time (Andrianto et al., 2017). Additionally, the researcher collects information from various sources such as scientific journals, books, and articles to build a robust theoretical framework, including theories on ship maneuvering, electronic navigation, forecasting, and regression.

Ship maneuvering is a technique used to optimize ship movement at sea. According to research by (Manik, 2007), ship maneuvering can help reduce friction between the ship and water, thereby improving travel efficiency. Common methods include precise rudder angle adjustments and the use of automatic control systems. Research by (Hadi & Manik, 2012) shows that ship maneuvering plays a significant role in enhancing ship stability in rough waters, proposing an active stabilization system to reduce wave effects and minimize ship vibrations, enhancing travel comfort and safety. Furthermore, (Iqbal & Rindo, 2015) highlighted the importance of ship maneuvering in reducing greenhouse gas

emissions, proposing a hybrid propulsion system to optimize fuel efficiency and minimize environmental impact.

Electronic navigation has advanced significantly over recent decades. With devices like GPS (Global Positioning System) and navigation software, users can easily determine their location and plan routes. This technology has wide applications, from motor vehicle navigation to scientific research. Electronic navigation is crucial in modern transportation (Tsai & Lin, 2021). For instance, GPS is essential in motor vehicles, aircraft, and ships, providing accurate positional information and real-time navigation directions, reducing the risk of getting lost and optimizing travel efficiency. From (Hidayat & Mardiyanto, 2017) explains that GPS usage in motor vehicles has improved fuel efficiency and reduced traffic congestion. In exploration and research, electronic navigation is vital. Space explorers, marine research vessels, and military reconnaissance aircraft all rely on advanced electronic navigation systems. According to (Anggoro, n.d.) electronic navigation technology has enabled more accurate and efficient scientific research in diverse environments, from deep oceans to outer space. It also impacts business sectors like logistics and shipping, with companies like Amazon relying on electronic navigation systems to optimize delivery routes and reduce operational costs. As from (SARI et al., 2019) notes, electronic navigation in supply chains and logistics has helped companies improve efficiency and reduce delivery times. Despite its benefits, privacy and security issues must be considered. GPS systems can track individuals' locations, a significant concern in the digital age. Then (Pradikta & Wahyudi, n.d.) notes that privacy and data security are increasingly important with the rising use of electronic navigation technology.

Statistical data forecasting of ship traffic and cargo flow at ports is essential in logistics management and port operations. This helps ports and related stakeholders plan operations more efficiently, optimize ship and cargo flow, and avoid congestion that could impact productivity. Studies such as those by (Pandhit, 2016) indicate that forecasting models based on historical data and factors like weather, seasons, and economic trends can help ports anticipate ship traffic fluctuations and better plan resources. This forecasting enables ports to avoid ship congestion and enhance operational efficiency. Forecasting cargo flow is also crucial. Research by (Sujarwanto, 2015) suggests that forecasting cargo flow helps ports plan necessary facilities, labor, and equipment to meet fluctuating demands, avoiding shortages or surpluses that could increase operational costs. Advanced technologies like data analysis and artificial intelligence enable more accurate forecasting of ship traffic and cargo flow. Then according (Irfan Juanda Affan, 2020) notes that using automated sensors and real-time data analysis provides ports with a better understanding of port dynamics, improving forecasting accuracy.

Regression is a statistical method used to understand the relationship between one or more independent variables (predictors) and a dependent variable. This method is used across disciplines such as economics, social sciences, and natural sciences to analyze and model variable relationships. The research of (Fadillah & Intisari Haryanti, 2021) explores the use of multiple linear regression in economic data analysis, emphasizing the importance of predictor variables in forecasting economic outcomes and explaining regression coefficient interpretation steps. Multiple linear regression is an effective tool for economic data analysis, providing valuable insights for economic decision-making. Then (Adhita et al., 2023) (M Adha, 2022) focuses on logistic regression as a useful tool in social data analysis, illustrating its use in modeling event probabilities in categorical data analysis. Logistic regression helps researchers understand factors influencing social decisions and behaviors.

The data collection and analysis phase involve gathering data relevant to the research problem through surveys, interviews, observations, or secondary data collection. The gathered data forms the basis for further analysis. The data is then analyzed in-depth, using appropriate analytical tools to extract insights. In this research context, the analysis will focus on data related to the maintenance of aids to navigation. Evaluation is also conducted to measure how well the data supports the research questions. Based on the data analysis and evaluation results, the researcher will draw final conclusions. These conclusions must be objective and supported by the research findings, summarizing the answers to the research questions and drawing implications. The final step is completing the final research report, which will include all the steps undertaken, findings, conclusions, and recommendations.

RESULTS AND DISCUSSION

Tanjung Perak Port comprises several terminals, including Kalimas Terminal, Jamrud Terminal, Mirah Terminal, Nilam Terminal, Berlian Terminal, Surabaya Container Terminal, and Batang Multipurpose Terminal. Tanjung Perak Port in Surabaya is the largest port in Indonesia after Tanjung Priok, serving as the central terminal for export and import activities of industrial and economic commodities for East Java and the Eastern Indonesia region. The Surabaya Western Shipping Route (APBS) is the main entry channel to the port from the west. The APBS, serving as the main western entry channel to the port, stretches approximately 40 miles, with varying depths between 8 to 20 meters LWS, a channel width of 150 meters, and 95 installed aids to navigation (SBNP).

Table 1: Data on Navigation Aids Facilities (NAF) at ABPS (Alur Pelayaran Barat Surabaya – Shipping Lane West of Surabaya)

Navigation Aids Facilities	Units
SBNP(Navigation Aids Facilities) Lighthouses	2
SBNP Beacon Tower	4
SBNP Buoys	75
Harbor lights	3
Dolphin	8
SROP (Port Operator Radio Station) Gresik	1
SROP (Port Operator Radio Station) Surabaya	1
VTS (Vessel Traffic Service)	1

The need for aids to navigation (SBNP) facilities aims to enhance the safety and security of shipping, especially considering the high density in the waters of the Surabaya Western Shipping Route. Existing SBNP facilities include the distribution of navigation buoys (Rambu-Rambu Suar) around existing piers have been develop based on guidelines from the Ministry of Transportation and the Ministry of Maritime Affairs and Fisheries, which began to be communicated to users in 2016. Based on the internal document index of Kantor Distrik Navigasi Kelas I, port of Tanjung Perak, it is known that there are 11 Standard Operating Procedures (SOPs) directly related to this research, particularly regarding navigational aids for shipping. The standard operation procedure include the formulation of activity plans for navigational aids and fleet, provision of activity plans for navigational aids and fleet, operation of navigational aids and fleet, maintenance of navigational aids and fleet, supervision of navigational aids and fleet, request for component procurement, reporting of inventory of lighthouses (equipment 1), reliability reporting of navigational aids, maintenance reporting of buoys and beacon buoys (equipment 3), planning for the placement of shift officers and duty responsibility on each shift, and Standard operation procedure repair and maintenance of navigational aids.

An example of the detailed standard operation procedure for the maintenance of navigational aids and fleet includes the responsibility of the executor to receive maintenance plans for navigational aids and fleet based on requests and other urgent needs. They are also responsible for verifying the needs and creating a maintenance memorandum for navigational aids and fleet, which is then reported to the Section Head of Navigational Aids and Fleet. The Section Head will then review and correct the maintenance plan according to the ongoing program and report to the Division Head of Navigational Aids and Fleet. Subsequently, the Division Head will re-examine and correct the plan and report to the Head of the Navigation Office. At this stage, the Head of the Navigation Office will provide a disposition on the memorandum and evaluate and establish it. Then, the Head of the Navigation Office will pass it to the Division Head, then to the Section Head, and ultimately the executor who will receive and carry out the memorandum.

Responsibilities and Review Process: The detailed SOP for maintenance of navigational aids and fleet assigns the executor the responsibility to receive maintenance plans based on requests and urgent needs. The executor verifies the needs and creates a maintenance memorandum, which is then reported to the Section Head of Navigational Aids and Fleet. Subsequently, the Section Head reviews and corrects the maintenance plan, reporting to the Division Head of Navigational Aids and Fleet. The

Division Head further examines and corrects the plan, reporting to the Head of the Navigation Office. The Head of the Navigation Office provides a disposition on the memorandum, evaluates and establishes it, and then passes it through the hierarchy for implementation. Involvement of Multiple Parties: The structured SOP and detailed guidelines demonstrate the involvement of multiple parties in the maintenance, care, and replacement of navigational aids and fleet equipment components. The processes of planning, executing, monitoring, reviewing, and reporting are well-organized within the SOP, aligning with expected standards and successfully maintaining the capability and capacity of the navigational aids and fleet. Comprehensive Review and Accountability: The process involves multiple levels of review and correction to ensure that the maintenance plans align with operational requirements and are approved by relevant authorities within the organization. The division of tasks and the involvement of different departments ensure that the maintenance and repair procedures are comprehensive and thorough, taking into account the capabilities and expertise of each department. This systematic approach not only ensures the proper functioning of the navigational aids but also promotes accountability and quality control throughout the maintenance and repair processes. Transparent and Efficient Workflow: Additionally, the detailed guidelines and reporting mechanisms within the SOP contribute to a transparent and efficient workflow, enabling effective communication and coordination among the departments involved in the maintenance and repair of navigational aids and fleet. In summary, the detailed SOP for the maintenance of navigational aids and fleet at Tanjung Perak Port reflects a well-structured and comprehensive approach, involving multiple levels of review, accountability, and transparent workflow to ensure the proper functioning and maintenance of navigational aids and fleet equipment components.

Maintenance activities for SBNP are conducted in accordance with applicable regulations, including both routine maintenance and repairs. Routine maintenance is performed periodically, while repairs are carried out when there is damage to the SBNP. The maintenance activities as per the applicable regulations include are Painting of Aids to Navigation facilities, Cleaning of Aids to Navigation Facilities, Adjusting the rhythm of the lights, Checking and replacing the power supply, and Checking the position of the Aids to Navigation facilities. More specifically, the detailed maintenance activities are periodic maintenance conducted every three months, routine maintenance every three months, special maintenance for navigation buoys conducted once a year, covering the buoy body and anchoring, Ad hoc maintenance activities in case of damage due to ship collisions, theft, or natural events. Repair activities as per the applicable regulations include: replacement of bulbs and flashers, replacement of tower structures, replacement of buoy fenders, replacement of the buoy anchoring system, replacement of top marks.

Supervision activities, as described above, are carried out by SBNP personnel through periodic monthly monitoring, with results reported to the Director-General. For further details on the maintenance and repair activities of SBNP, refer to Table 2.

Table 2 Repair and Maintenance Activities

No	Repair and Maintenance Activities	Details
1	Regular maintenance is carried out every 3 (three) month	Maintenance activities as intended include:
		a. SBNP painting
		b. Cleaning SBNP
		c. Adjust the rhythm of the lights
		d. Checking and replacing the power supply
		e. Checking the position of shipping navigation aids
2	Regular repairs are carried out every 3 (three) months	The improvements referred to include:
		a. Replacement of light bulbs and flashers
		b. Tower structure replacement
		c. Fender replacement Flare buoy
		d. Replacement of beacon buoy anchoring system
		e. Replacement of peak marks

3	Special maintenance activities for beacon buoys are carried out every 1 (one) year	Maintenance of Buoy and Anchorage Bodies
4	Maintenance activities for emergency	Maintenance is carried out if damage occurs due to being hit by a ship, theft or natural events

From Table 2, it is evident that maintenance activities for the aids to navigation (SBNP) at the port are thoroughly conducted.

Based on the maintenance and repair records of the aids to navigation, the maintenance and repair activities at Tanjung Perak Port include several tasks, such as: monitoring and checking the lights and positions of navigation buoys in the Surabaya Western Shipping Route, Maintenance of the PELSU No. 22 electrical battery buoy, field verification for the relocation of the aids to navigation (SBNP) buoys (Dolphin) at PT Terminal Teluk Lamong multipurpose terminal, and Installation of a black-red-black isolated danger mark buoy at the shoal area in front of PT Petrokimia Gresik along the Surabaya Western Shipping Route (APBS).

From these activities, it was found that the navigation buoys in the Surabaya Western Shipping Route shifted by approximately 163 meters. The buoys were functioning normally, but their top marks were broken, and their wings were bent. The position of the PELSU No. 22 electrical battery buoy was accurate according to the map and the Indonesian buoy list (DSI). After replacement and maintenance, the buoy was left in good condition. Regarding the relocation at PT Terminal Teluk Lamong, due to the terminal's expansion, one navigation buoy (Dolphin) with DSI number 3549.1 will be relocated by PT Terminal Teluk Lamong. After relocation, PT Terminal Teluk Lamong will report to the Director of Navigation at the Directorate General of Sea Transportation and coordinate with the Class 1 Surabaya Navigation District. For the navigation buoy that has not received an Indonesian buoy list number, PT Terminal Teluk Lamong will request verification and numbering from the Director of Navigation at the Directorate General of Sea Transportation to update the DSI number and announce it through a navigation notice (Mapel) and include it in the Indonesian Mariners' Notice (BPI).

The evaluation of SBNP maintenance considers the activities performed by the government representative and stated owned company (DisNav and Pelindo) and private sectors (PT APBS-Alur Pelayaran Barat Surabaya/ West Surabaya Shipping line, PT APTS-Alur Pelayaran Timur Surabaya/ East Surabaya Shipping line). The effectiveness of the aids to navigation after maintenance and the associated maintenance costs are analyzed to ensure the navigational aids remain in optimal condition.

1. **Effectiveness of Aids to Navigation**

The evaluation of SBNP maintenance in terms of effectiveness involves assessing the current aids to navigation's ability to provide accurate and timely information to ship crews and their reliability in various weather and marine conditions. If current aids have limitations, updates or replacements might be necessary. The physical condition of the aids, such as wear and tear, potential damage, and obsolescence, must also be carefully considered. Continuous issues or high failure risks can negatively impact navigation safety and incur unexpected repair costs. Comparing current aids to newer technologies is essential as advancements in technology, such as 3D mapping, satellite integration, and improved data connectivity, can enhance navigation accuracy and decision-making while reducing human error risks.

In this study, the effectiveness of SBNP is considered very good based on ship accident data in Tanjung Perak. From 215 ship accidents reported by KNKT (Komite Nasional Kecelakaan Transportasi – National Transportation Safety Committee/ NTSC) between 2007-2022, there were 8 accidents in the port and shipping line area, the accidents are including capsizing, collisions, groundings, and fires. After analyse the accident reports we find that the accidents categorized as fires and capsizing were not related to SBNP. For accident collisions and groundings might be related to SBNP, but after further detailed check with National Safety Transportation Committee investigations revealed human factors were the cause, such as avoiding collisions in narrow channels or crew fatigue. Thus, the accidents were due to human error, not related with Navigation aids facility failures. It was proven and demonstrated that Navigation Aids Facilities functions and maintenance are performing as expected.

2. **SBNP Maintenance Costs**

Maintenance costs are a key factor in this analysis, encompassing routine repairs, component replacements, and periodic maintenance. Comparing these costs with those of newer navigation aids is necessary. If current maintenance costs are high and rising with the age of the equipment, transitioning to newer aids might be more economical. For Tanjung Perak port, there are 95 SBNP units managed by APBS, Pelindo, APTS, Maspion, and other private entities. In this study, due to data confidentiality and time constraints, the evaluation of SBNP maintenance cannot be based on financial aspects. However, the evaluation considers SBNP's contribution to the number of accidents in the Tanjung Perak port area. Maintenance activities include painting, cleaning, adjusting light rhythms, checking and replacing power supplies, and checking positions, followed by repair activities such as replacing bulbs and flashers, tower structures, buoy fenders, anchoring systems, and top marks.

This analysis aims to determine the significant differences in the amount of cargo unloaded and loaded at each terminal in Tanjung Perak. The amount of cargo impacts the number of ships passing through the APBS (Shipping line west of Surabaya) and APTS (Shipping line east of Surabaya) routes. Each of these shipping lanes has aids to navigation (SBNP) that ensure the smoothness, security, comfort, and safety of navigation. The projected results for general cargo, dry bulk, containers, and liquid bulk, based on data from 2017 to 2021 and projected up to 2041, show an increase. The growth ranges from a minimum of 3% to a maximum of 4.6%. For example, the following graph shows the potential increase in liquid bulk cargo:

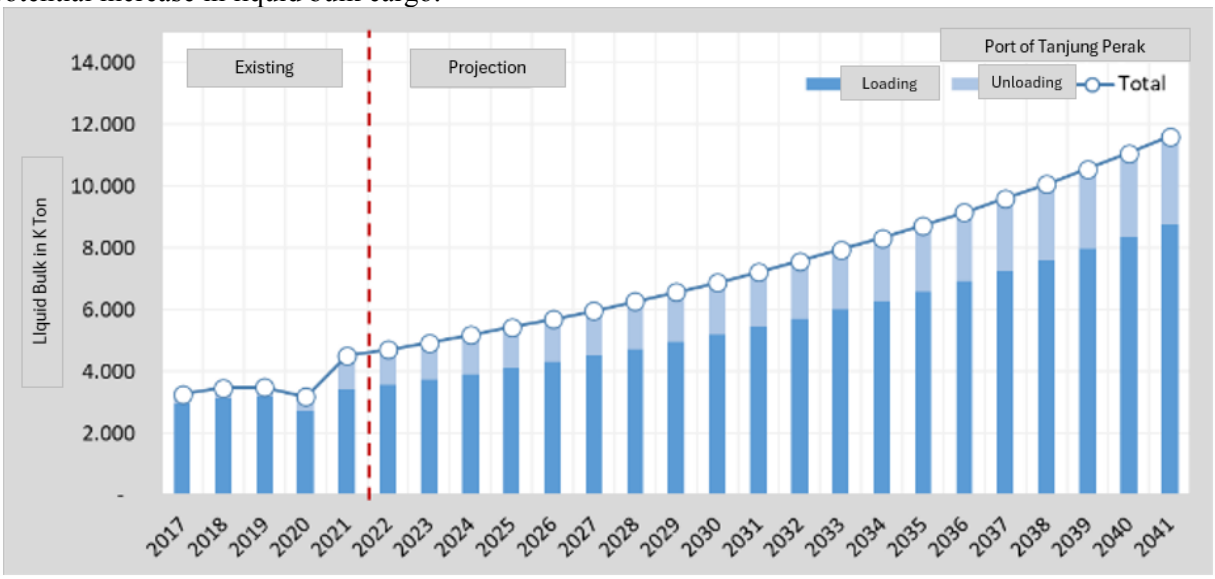

Figure 2 Cargo Projection at Port of Tanjung Perak

Data was collected and analyzed from the Jamrud terminal, Mirah terminal, Surabaya Container Terminal, and Teluk Lamong terminal in port Tanjung Perak Surabaya.

The analysis of projected ship traffic and estimation of ship movements are based on the cargo projections previously explained. This cargo refers to the types that will be transported by various types of ships suited to the cargo type. In this context, the prediction and analysis of ship visit traffic are conducted with reference to the dimensions of the largest ships. The data obtained outlines the size of the largest ships, which serves as the basis for analyzing and estimating the number of ship visits to be handled at different ports or terminals. The distribution of ships will be carried out at various terminals within Tanjung Perak Port, such as Kalimas, Jamrud, Mirah, Berlian, Nilam, and the Surabaya Container Terminal, as well as the Teluk Lamong Terminal. The following graph shows the projection results from 2017-2021, projected up to 2041.

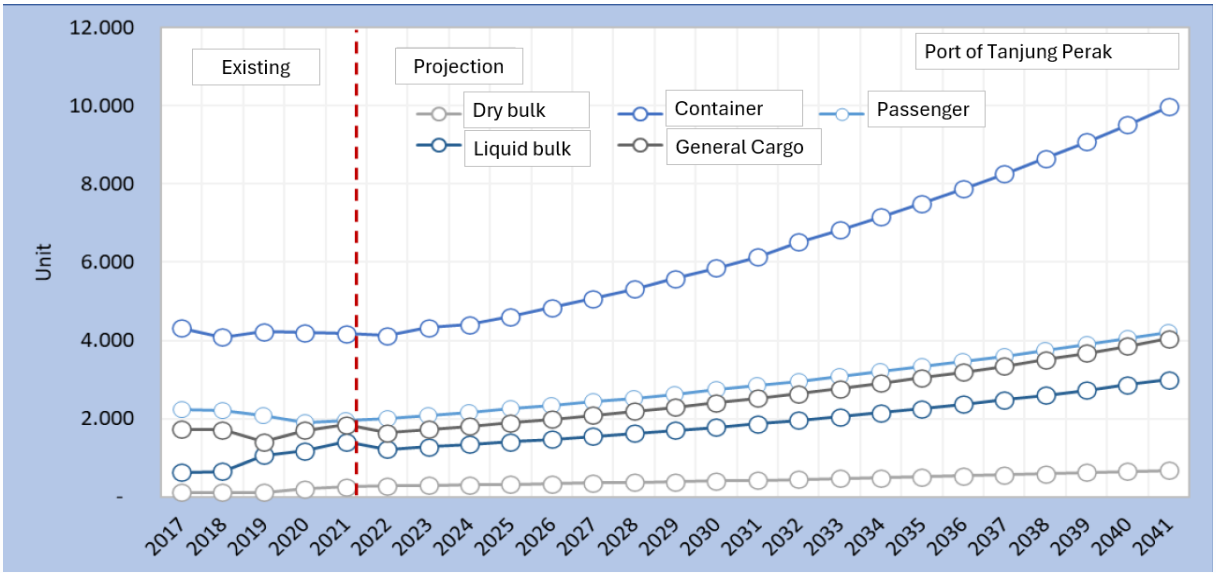

Figure 3 Ship Traffic Projection at Port Tanjung Perak

Analysis of SBNP requirements of the need for SBNP (Aids to Navigation) facilities is intended to enhance the safety and security of navigation, particularly considering the high traffic density in the Surabaya Western Shipping Channel. The SBNP plan includes the addition of buoy markers for anchorage areas in zones 4 and 5, as specified in the Tanjung Perak Master Plan, allocated for ships docking at Gresik Port, Manyar Terminal, Siam Maspion Terminal, and nearby TUKS. SBNP plays an essential role in ship traffic, guiding vessels entering and leaving the port. Equipment such as lighthouses, port beacons, and other navigational markers provide the visual guidance necessary for ships to follow safe and precise shipping lanes. By relying on SBNP, ships can avoid obstacles such as reefs or shallow waters, which could endanger the vessel, crew, and cargo.

Moreover, this relationship significantly impacts overall maritime safety. With proper and well-maintained SBNP, the risk of maritime accidents can be minimized. Ships can use information from SBNP to avoid collisions with other vessels, reduce the risk of oil or hazardous material spills, and manage navigation in poor weather conditions. Regarding security, SBNP also contributes to the surveillance and control of maritime areas. Good navigation systems help port authorities and related agencies monitor ship movements, detect suspicious activities, and maintain the integrity of national borders. When SBNP supports efficient shipping routes, the port becomes more productive. Ships can sail more smoothly and efficiently, reducing waiting times and operational costs. Therefore, the close relationship between SBNP, ship traffic, and port visits has significant implications for the overall safety, security, and productivity of the maritime and port system.

CONCLUSION

Based on the data obtained, it is known that the total number of Aids to Navigation (SBNP) around the Tanjung Perak Port area currently stands at 95 units. This includes 67 buoys, 4 lighthouses, 3 beacon towers, 11 port lights, and 8 dolphins. All SBNP units are reported to be in good condition and operationally fit. Through the analysis conducted, it was found that the 11 types of SOPs related to SBNP, prepared by DisNav Tanjung Perak, have significantly clarified the duties, authorities, and responsibilities of each implementing party, division, department, section head, and all involved parties. Specifically, in maintenance activities, including the regular maintenance and replacement of several SBNP units, conducted monthly, quarterly, and annually, as well as replacements when damage is found. This indicates that the SBNP maintenance process according to the standard operational procedure has been successfully implemented. By comparing the current number of SBNP units (95) with the SBNP development plan, it is known that an additional 38 SBNP units will be needed at various coordinate points. Assuming the same amount of time and cost for each SBNP unit, scheduling and budgeting will be required to accommodate a projected 40% increase in maintenance costs.

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