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The Effect Of Crew Qualifications, Vessel Readiness, And Port Supervision On Shipping Safety At Tanjung Emas Port

Wahyu Adisusila[1], Rudianto[2], Jones Zenas Rante[3]

[1,2,3]Institut Bisnis dan Multimedia asmi Jakarta

[*]Corresponding author: wahyuadisusila42@gmail.com

Abstract

This study aims to analyze the effect of crew qualifications, ship readiness, and port supervision on shipping safety at Tanjung Emas Port. The background of this study is based on the importance of crew competence, ship readiness, and effective supervision in supporting shipping safety and reducing the risk of maritime accidents. This study uses a quantitative approach with a survey method. Data were collected through questionnaires, observation, and documentation. The research variables consist of crew qualifications, ship readiness, port supervision, and shipping safety. Data analysis was conducted using statistical analysis to determine the partial and simultaneous effects of the independent variables on shipping safety. The results show that crew qualifications, ship readiness, and port supervision affect shipping safety at Tanjung Emas Port. Shipping safety can be improved through competent crew members, proper ship readiness and seaworthiness, and effective and continuous port supervision. This study is expected to provide input for shipping companies, ship crews, and port authorities in improving human resource competence, ship readiness, and supervision effectiveness to achieve optimal shipping safety.

Keywords: Crew Qualifications, Vessel Readiness, Port Supervision, Shipping Safety, Tanjung Emas Port.

INTRODUCTION

Indonesia is an archipelagic country whose geographical characteristics make maritime transportation essential for maintaining connectivity among its islands. Maritime transportation plays an important role in supporting population mobility, the

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distribution of goods, and domestic and international trade. Recent data indicate that sea transportation continues to support substantial passenger and cargo movements, while maritime and transport services remain closely interconnected with Indonesia's trade, logistics, production, and consumption activities (BPS, 2025; World Bank, 2026). Therefore, the availability of safe, efficient, reliable, and sustainable maritime transportation is essential for strengthening national connectivity, supporting economic activity, and promoting balanced regional development (UNCTAD, 2025; World Bank, 2026).

According to Law Number 17 of 2008 concerning Shipping, Chapter I Article 1 Paragraph 1, shipping is an integrated system consisting of transportation in waters, port affairs, shipping safety and security, and protection of the marine environment. Within this system, shipping safety is particularly important because it is directly related to protecting human lives, ships, cargo, and the marine environment. A high level of safety supports the smooth operation of maritime transportation, whereas inadequate safety can result in significant economic, social, and environmental losses.

The importance of shipping safety is also reflected in various international regulations and standards applied in the maritime industry. These include the International Safety Management Code (ISM Code), International Regulations for Preventing Collisions at Sea 1972 (COLREGS), International Ship and Port Facility Security Code (ISPS Code), and Standards of Training, Certification and Watchkeeping for Seafarers (STCW). These regulations emphasize that shipping safety requires effective safety management systems, competent human resources, seaworthy vessels, and adequate supervision.

Despite the implementation of various regulations, maritime accidents continue to occur in Indonesian waters. Investigation data from the National Transportation Safety Committee (KNKT) recorded 389 reported marine vessel accidents in 2023, an increase from 323 cases in 2022. Approximately 32% of these accidents involved passenger vessels, resulting in 32 fatalities and 43 missing persons. These figures indicate that shipping safety remains an important issue requiring serious attention from stakeholders in the maritime sector.

In general, vessel accidents may result from several factors, including human factors, technical conditions, environmental factors, and supervision. The International Maritime Organization (IMO) states that approximately 80% of vessel accidents are associated with human factors, while around 20% are related to technical factors. Furthermore, approximately 75% of human errors are associated with weaknesses in

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safety management systems within shipping organizations (Malik et al., 2025). These findings highlight the importance of crew competence, safety management, and safety culture in preventing maritime accidents.

In addition to human resources, vessel condition and seaworthiness are important factors influencing shipping safety. Operating vessels are required to meet seaworthiness requirements under Law Number 17 of 2008 concerning Shipping. These requirements include vessel construction, stability, machinery, electrical systems, safety equipment, communication equipment, and lifesaving appliances. Vessels that fail to meet seaworthiness standards may experience operational disruptions or accidents that endanger passengers, crew members, and the marine environment.

Port supervision also plays a crucial role in supporting shipping safety. The Harbourmaster and Port Authority Office (KSOP) is responsible for ensuring that operating vessels comply with applicable shipping safety standards. Under Minister of Transportation Regulation Number 16 of 2023, KSOP performs functions related to shipping safety and security supervision, vessel safety management inspections, cargo loading and unloading activities, vessel traffic regulation, and marine environmental protection. Inadequate supervision may increase the risk of accidents and operational disruptions within port areas.

One strategically important port is Tanjung Emas Port in Semarang, which serves as a major port in Central Java and an important part of the northern coast of Java shipping route, alongside Tanjung Priok and Tanjung Perak Ports. As a center for export-import activities, logistics distribution, and maritime transportation services, Tanjung Emas Port has a high level of shipping activity and therefore requires an optimal safety system. However, the port has experienced events that may affect safety and operations, including tidal flooding in May 2022 caused by damaged embankments and recurring tidal flooding during 2021–2025. In addition, KM Kirana I experienced a fire in 2024 during routine maintenance, reportedly triggered by sparks from welding or grinding activities. Although no fatalities occurred, the incident demonstrated the continuing risks within the port area; 21 crew members, 24 vendor workers, and 7 technicians were successfully rescued by a joint team from the Central Java Regional Police Water and Air Police Directorate and Pelindo tugboat personnel.

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Table 1.List of Marine Accident Incidents in the Tanjung Emas Port Area, Semarang

Year	Events	Victims		
		Survive	Died	Lost
2021	13	55	13	17
2022	52	376	22	10
2023	14	13	9	14
2024	20	68	6	20
2025	25	85	8	15

Based on the table and graph, the number of marine accidents at Tanjung Emas Port fluctuated significantly during 2021–2025. There were 13 incidents in 2021, increasing sharply to 52 incidents in 2022, with 376 survivors, 22 fatalities, and 10 missing persons. In 2023, accidents decreased substantially to 14 cases, involving 13 survivors, 9 fatalities, and 14 missing persons, before increasing again to 20 cases in 2024 and 25 cases in 2025. Overall, the data indicate that marine accidents at Tanjung Emas Port remain variable from year to year, while the increase in incidents during 2024–2025 demonstrates the need for continuous improvement in shipping safety, operational supervision, and risk management to reduce accidents and their potential impacts on crew, passengers, and other port users.

LITERATURE REVIEW

Marine Transportation Management

Maritime transportation management refers to the application of management principles to the planning, organizing, implementation, and supervision of all shipping activities, including vessel management, shipping operations, human resource management, port activities, and shipping safety and security. This management aims to establish a maritime transportation system that is safe, efficient, effective, and sustainable. Recent studies indicate that transportation efficiency and port performance are increasingly associated with technological integration, digitalization, connectivity, and coordination among maritime stakeholders. Alzate et al. (2024) emphasize that the development of smart ports can improve operational efficiency, safety, resource utilization, and sustainability in the maritime sector.

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From a safety perspective, maritime transportation management is not only concerned with operational efficiency but also with ensuring that vessels meet seaworthiness requirements, crew members possess appropriate competencies, and shipping activities are subject to effective supervision. The International Maritime Organization (IMO) places crew competency and training as important components of the human element in maritime safety. The Standards of Training, Certification and Watchkeeping for Seafarers (STCW) establishes international standards for seafarer training, certification, and watchkeeping, while IMO continues to review the STCW framework to address technological developments and emerging challenges in the maritime sector.

Maritime transportation management is also closely related to risk management, which involves identifying, analyzing, evaluating, and controlling potential hazards arising from shipping activities. This approach is important because maritime safety is influenced by the interaction between people, vessels, technology, procedures, and the operational environment. Fan and Yang (2023) emphasize that seafarer competencies need to be considered within a human–machine system, particularly as automation becomes increasingly integrated into maritime operations. Meanwhile, Shi et al. 92024) identify decision-making, situational awareness, communication, procedural knowledge, and maneuvering capabilities as important competencies associated with the prevention of maritime accidents.

The primary objective of maritime transportation management is to establish a shipping system that is safe, efficient, reliable, and sustainable. These objectives include protecting crew members, passengers, cargo, vessels, and the marine environment while optimizing the use of resources such as vessels, labor, time, costs, and port facilities. Operational efficiency is also important because maritime transportation constitutes a major component of logistics and international trade. Recent studies on port performance indicate that efficiency, governance, digitalization, and sustainability are important aspects of modern port management (Kishore et al., 2024).

The main elements of maritime transportation management examined in this study include human resources, vessels, port infrastructure, systems and regulations, and safety management. Human resources involve education, training, experience, certification, communication, and the safety culture of seafarers. Vessels are associated with vessel readiness and seaworthiness, including the condition of construction, machinery, navigation systems, and safety equipment. Port infrastructure encompasses port facilities and vessel supervision systems, while systems and regulations provide the

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basis for compliance with national and international safety standards. These elements are interconnected in establishing an integrated maritime safety system.

Safety management serves as an integrating element that connects all of these components through operational procedures, risk identification and control, safety training, supervision, and the development of a strong safety culture. Through the International Safety Management (ISM) Code, IMO emphasizes the importance of safety management and pollution prevention, including the assessment of identified risks and the implementation of appropriate safeguards. Therefore, an integrated approach to maritime transportation management involving crew competency, vessel readiness, port supervision, regulatory compliance, and safety management provides an important foundation for reducing accident risks and supporting safe and sustainable shipping operations (IMO, 2024).

Concepts of Crew Qualifications, Vessel Readiness, Port Supervision, and Shipping Safety

Crew qualifications are a fundamental factor in maritime safety because seafarers are directly responsible for navigation, machinery operation, communication, cargo handling, and emergency response. Crew qualifications include education, training and certification, work experience, communication skills, teamwork, discipline, leadership, and safety culture. These aspects are consistent with the Human Capital Theory, which views education, training, experience, and skills as investments that improve individual capabilities and productivity. Recent research confirms that seafarer competencies such as decision-making, situational awareness, communication, procedural knowledge, and maneuvering skills are closely associated with maritime accident prevention (Shi et al., 2024).

Internationally, crew qualifications are governed primarily by the Standards of Training, Certification and Watchkeeping for Seafarers (STCW), which establishes minimum requirements for seafarer education, training, certification, and watchkeeping. The importance of maintaining and updating these competencies has become increasingly significant because technological developments and automation are changing the interaction between seafarers and ship systems. In 2024, IMO initiated a comprehensive review of the STCW Convention to ensure that training and certification remain appropriate for developments in the maritime sector. Research in Indonesia also shows that employee competence and safety training have a positive and significant relationship with safety climate in shipping companies (Barasa et al., 2025).

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Vessel readiness refers to the condition in which a vessel fulfills the required technical, administrative, and operational requirements to conduct voyages safely. It encompasses the condition of the hull and structure, propulsion and auxiliary machinery, navigation and communication systems, safety equipment, documentation, and operational preparedness prior to departure. From a reliability and maintenance perspective, regular inspection, preventive maintenance, and condition monitoring are important for maintaining equipment availability, reducing unexpected failures, and supporting safe vessel operations (Karatuğ et al., 2025; Velasco-Gallego & Lazakis, 2023). Recent studies further emphasize the development of predictive and reliability-centered maintenance approaches to monitor marine equipment condition and prevent machinery failures (Karatuğ et al., 2024). In addition, safety management requires the integration of technical condition, maintenance practices, operational procedures, and risk management rather than relying solely on the physical condition of the vessel (Latt, 2024). Therefore, vessel readiness can be understood as an integrated outcome of maintenance, inspection, equipment reliability, documentation, operational procedures, and safety management.

Port supervision is another important component of maritime safety because ports represent the operational interface between vessels, passengers, cargo, logistics activities, and maritime authorities. In Indonesia, supervision is primarily conducted by the Harbourmaster and Port Authority Office (KSOP), including inspection of vessel documents and seaworthiness, monitoring of cargo operations, regulation of vessel traffic, safety management oversight, and enforcement of applicable regulations. Internationally, these functions are reflected in Port State Control (PSC), which serves as a second line of defence against substandard shipping. IMO updated the Procedures for Port State Control in 2025, including provisions related to the ISM Code, seafarer certification, ship manning, hours of rest, and deficiencies that may justify detention (IMO, 2025).

Shipping safety represents the overall condition in which maritime activities can be conducted safely and systematically while protecting crew members, passengers, cargo, vessels, and the marine environment. Based on System Theory of Safety, maritime accidents should be understood as the result of interactions among human factors, vessel conditions, the operating environment, and management or supervision rather than as the consequence of a single factor. Recent research supports this systemic perspective, identifying training, leadership, communication, decision-making, and safety culture as important factors influencing maritime safety outcomes. The Swiss

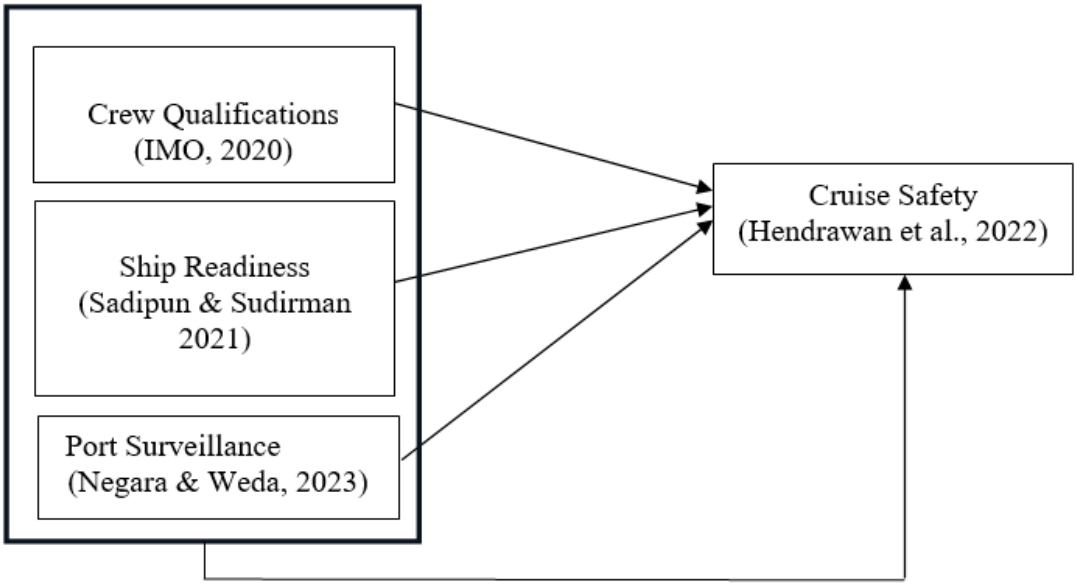
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Cheese Model further explains that accidents may occur when weaknesses in several layers of protection become aligned, making crew qualifications, vessel readiness, and port supervision interconnected safety barriers (Veltsin et al., 2025).

Based on these concepts, crew qualifications, vessel readiness, and port supervision constitute the three independent variables in this study, while shipping safety serves as the dependent variable. Crew qualifications are measured through education, training and competency certification, work experience, communication skills, and safety culture; vessel readiness through seaworthiness, safety equipment, technical condition, vessel documentation, and pre-departure readiness; and port supervision through seaworthiness inspections, document verification, vessel traffic control, operational supervision, and enforcement of safety regulations. Shipping safety is reflected in accident occurrence, casualties or losses, compliance with safety procedures, and operational reliability. The integrated relationship among these variables indicates that effective crew competency, adequate vessel readiness, and consistent port supervision can strengthen safety barriers and contribute to safer, more reliable, and sustainable maritime operations.

Conceptual Framework



Source : Processed by Researcher, 2026

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RESEARCH METHODOLOGY

The research uses a quantitative research method, which is grounded in the philosophy of positivism and is employed to examine a specific population or sample through research instruments and statistical data analysis to test predetermined hypotheses. According to Sugiyono (2020), quantitative research involves the selection of a particular population or sample, generally using random sampling techniques, data collection through research instruments, and statistical analysis to test formulated hypotheses. In this study, the quantitative approach is applied to examine the influence of crew qualifications, ship readiness, and port supervision on shipping safety for vessels operating at Tanjung Emas Port, Semarang. This approach was selected because it provides an objective, measurable, and systematic assessment of the relationships among the research variables.

The study employs both descriptive and inferential statistical analyses. Descriptive statistics are used to describe the conditions of each research variable, including crew qualifications, ship readiness, port supervision, and the level of shipping safety based on respondents' data. Meanwhile, inferential statistics are used to examine the relationships and effects among the variables, both partially and simultaneously. Through this analysis, the study aims to obtain empirical evidence regarding the factors influencing shipping safety and to test the proposed hypotheses. The findings are expected to contribute to improving shipping safety through enhanced human resource quality, ship readiness, and the effectiveness of port supervision at Tanjung Emas Port, Semarang.

Variable operationalization refers to translating research variables into measurable components through specific indicators, enabling the development of research instruments and objective statistical analysis. This study consists of independent variables, namely crew qualifications (X_1), ship readiness (X_2), and port supervision (X_3), and a dependent variable, namely shipping safety (Y). All variables are measured using a five-point Likert scale, ranging from 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, to 5 = Strongly Agree.

Table 2. Operationalization of Research Variables

Variables	Indicator	Measurement Scale
	Crew education level	Likert (1–5)

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Crew Qualifications (X_1)		Ordinal Scale and Ratio
	Ownership of competency certificate (STCW)	Likert (1–5) Ordinal Scale and Ratio
	Experience working on board	Likert (1–5) Ordinal Scale and Ratio
	Onboard communication capabilities	Likert (1–5) Ordinal Scale and Ratio
	Ship's operational technical skills	Likert (1–5) Ordinal Scale and Ratio
	Understanding of safety procedures	Likert (1–5) Ordinal Scale and Ratio
	Safety Awareness	Likert (1–5) Ordinal Scale and Ratio
Ship Readiness (X2)	Shipworthiness	Likert (1–5) Ordinal Scale and Ratio
	Boat engine condition	Likert (1–5) Ordinal Scale and Ratio
	Safety equipment fittings	Likert (1–5) Ordinal Scale and Ratio
	Availability of navigation tools	Likert (1–5) Ordinal Scale and Ratio
	Ship communication system	Likert (1–5)

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		Ordinal Scale and Ratio
	Completeness of ship documents	Likert (1–5) Ordinal Scale and Ratio
	Operational readiness before sailing	Likert (1–5) Ordinal Scale and Ratio
Port Surveillance (X3)	Inspection of the ship's seaworthiness by officers	Likert (1–5) Ordinal Scale and Ratio
	Vessel document surveillance	Likert (1–5) Ordinal Scale and Ratio
	Ship traffic arrangements	Likert (1–5) Ordinal Scale and Ratio
	Supervision of port activities	Likert (1–5) Ordinal Scale and Ratio
	Enforcement of shipping safety rules	Likert (1–5) Ordinal Scale and Ratio
	The role of syahbandar in supervision	Likert (1–5) Ordinal Scale and Ratio
Ship Cruise Safety (Y)	Ship accident rate	Likert (1–5) Ordinal Scale and Ratio
	Compliance with safety procedures	Likert (1–5) Ordinal Scale and Ratio
	Operational reliability of the vessel	Likert (1–5)

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		Ordinal Scale and Ratio
	Crew Safety	Likert (1–5) Ordinal Scale and Ratio
	Passenger and cargo safety	Likert (1–5) Ordinal Scale and Ratio
	Accident risk prevention	Likert (1–5) Ordinal Scale and Ratio

Source : Processed by Researcher, 2026

The study selects three indicators considered most relevant for each research variable. For crew qualifications (X_1), the indicators are STCW competency certification, work experience on board, and safety culture; for ship readiness (X_2), seaworthiness, completeness and condition of safety equipment, and proper functioning of ship machinery; for port supervision (X_3), pre-departure ship-document inspection, effective supervision of port activities, and effective regulation of shipping traffic; and for shipping safety (Y), crew compliance with safety procedures, safe and smooth ship operations, and efforts to prevent or minimize accident risks. These indicators are measured using a five-point Likert scale ranging from strongly disagree to strongly agree, allowing respondents' perceptions to be converted into numerical data. Each indicator is developed into questionnaire statements, with responses assigned numerical scores for subsequent descriptive and inferential statistical analysis, thereby enabling systematic and measurable assessment of the relationships among the research variables.

Research Model

The research model is a conceptual framework that illustrates the relationships among the variables examined in a study, based on relevant theories and concepts. It provides a clear direction for the research by explaining the relationship between independent and dependent variables and serves as a basis for empirical analysis, hypothesis formulation, and selection of appropriate analytical methods. According to Sugiyono (2020), a research model represents the relationships among variables

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developed from a theoretical framework, showing the direction and form of the relationships to be examined.

Research Hypothesis

The research hypothesis is a tentative answer to the research problem that must be tested through data collection and analysis. According to Sugiyono (2020), a hypothesis is a temporary answer to a research problem formulated as a relationship between two or more variables. In this study, the hypotheses examine the effects of crew qualifications (X_1), ship readiness (X_2), and port supervision (X_3) on shipping safety (Y) at Tanjung Emas Port, Semarang, both simultaneously and partially. H1 states that crew qualifications, ship readiness, and port supervision have a simultaneous effect on shipping safety (H0: ρyx1x2x3 = 0; H1: ρyx1x2x3 ≠ 0); H2 states that crew qualifications have a partial effect on shipping safety (H0: ρyx1 = 0; H1: ρyx1 ≠ 0); H3 states that ship readiness has a partial effect on shipping safety (H0: ρyx2 = 0; H1: ρyx2 ≠ 0); and H4 states that port supervision has a partial effect on shipping safety (H0: ρyx3 = 0; H1: ρyx3 ≠ 0).

RESULT AND DISCUSSION

Overview of Crew Qualifications (X_1) at Tanjung Emas Port Semarang

Crew qualifications are an important factor in supporting shipping safety because they encompass the competence, knowledge, skills, experience, and certification required for crew members to perform their duties professionally and respond appropriately under normal and emergency conditions. In this study, Crew Qualifications (X_1) is examined as an independent variable affecting Shipping Safety (Y) at Tanjung Emas Port, Semarang, based on three indicators: crew competency certification, work experience, and safety culture. Respondents' perceptions were measured using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), with mean scores interpreted according to predetermined intervals from 1.00–1.79 (Strongly Disagree) to 4.20–5.00 (Strongly Agree).

The descriptive analysis shows that all three indicators of Crew Qualifications received very positive assessments. Crew Competency Certification ($X_{1.1}$) obtained an index of 4.71, with 71.4% of respondents strongly agreeing and 28.6% agreeing. Work Experience ($X_{1.2}$) achieved an index of 4.52, with 52.3% strongly agreeing and 47.7% agreeing. Meanwhile, Safety Culture ($X_{1.3}$) obtained an index of 4.71, with 71.4%

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strongly agreeing and 28.6% agreeing. No respondents selected neutral, disagree, or strongly disagree for any of the three indicators.

Overall, the three indicators produced an average index of 4.65, which falls within the Strongly Agree category. The highest scores were obtained by Crew Competency Certification and Safety Culture, both at 4.71, while Work Experience recorded 4.52. These findings indicate that respondents perceive certification, practical experience, and safety culture as important components of crew qualifications in supporting professional performance and safe ship operations.

Thus, Crew Qualifications (X_1) received a very positive overall assessment, particularly in terms of competency certification, work experience, and safety culture. The results indicate that these aspects are perceived as important in enabling crew members to perform their responsibilities professionally and contribute to shipping safety at Tanjung Emas Port, Semarang.

Overview of Ship Readiness (X_2) at Tanjung Emas Port Semarang

Ship Readiness (X_2) is an important factor in supporting shipping safety because it reflects the vessel's technical condition, operational seaworthiness, availability of safety equipment, and preparedness to face various conditions during a voyage. A vessel that meets safety requirements and is equipped with properly functioning equipment is expected to operate safely, reduce accident risks, and provide protection for crew, passengers, cargo, and the marine environment. In this study, Ship Readiness (X_2) is examined as an independent variable to assess its relationship with Shipping Safety (Y) at Tanjung Emas Port, Semarang.

The assessment of Ship Readiness (X_2) is based on three indicators: seaworthiness of the vessel ($X_{2.1}$), completeness and condition of safety equipment ($X_{2.2}$), and proper condition of machinery ($X_{2.3}$). The descriptive analysis shows that all three indicators received very positive responses from the 21 respondents. $X_{2.1}$ obtained a total score of 100 with an index of 4.76, $X_{2.2}$ obtained a total score of 98 with an index of 4.66, and $X_{2.3}$ obtained a total score of 99 with an index of 4.71. All three indicators fall within the Strongly Agree category.

For indicator $X_{2.1}$, 76.2% of respondents strongly agreed and 23.8% agreed that the vessel was in seaworthy condition. For $X_{2.2}$, 66.7% strongly agreed and 33.3% agreed that safety equipment was complete and in good condition. Meanwhile, for $X_{2.3}$, 71.4% strongly agreed and 28.6% agreed that the vessel's machinery was in good condition. No respondents selected the neutral, disagree, or strongly disagree

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categories for any of the three indicators, indicating a consistently positive assessment of ship readiness.

Overall, the Ship Readiness (X_2) variable achieved an average index of 4.71, which falls within the 4.21–5.00 interval and is therefore categorized as Strongly Agree. Among the indicators, $X_{2.1}$ recorded the highest index at 4.76, followed by $X_{2.3}$ at 4.71, while $X_{2.2}$ recorded 4.66. These results indicate that respondents perceived the vessel's seaworthiness, safety equipment, and machinery condition as being well maintained and supportive of safe vessel operations.

Thus, the descriptive findings indicate that Ship Readiness (X_2) was perceived to be in a very good condition at Tanjung Emas Port, Semarang. The high assessment across all indicators demonstrates that the technical and operational aspects of vessel readiness were viewed positively by respondents. These conditions provide an important basis for supporting the implementation of safe shipping operations and reducing potential risks during voyages.

Overview of Port Supervision (X_3) at Tanjung Emas Port Semarang

Port Supervision (X_3) is an important factor in supporting shipping safety because it involves monitoring, inspection, control, and enforcement of safety requirements that must be fulfilled by vessels before and during port activities. Effective supervision is expected to ensure that vessels, crew members, and shipping operations comply with applicable safety standards. In this study, Port Supervision (X_3) is analyzed as an independent variable in relation to Shipping Safety (Y) at Tanjung Emas Port, Semarang.

The assessment of Port Supervision is based on three indicators: pre-departure ship-document inspection ($X_{3.1}$), proper supervision of port activities ($X_{3.2}$), and effective regulation of shipping traffic ($X_{3.3}$). The descriptive results show very positive assessments from all 21 respondents. $X_{3.1}$ obtained a total score of 100 with an index of 4.76, $X_{3.2}$ obtained a total score of 99 with an index of 4.71, and X3.3 obtained a total score of 97 with an index of 4.61. All three indicators were categorized as Strongly Agree.

For $X_{3.1}$, 76.2% of respondents strongly agreed and 23.8% agreed that ship documents were inspected before departure. For $X_{3.2}$, 71.4% strongly agreed and 28.6% agreed that port activities were properly supervised. Meanwhile, for $X_{3.3}$, 61.9% strongly agreed and 38.1% agreed that shipping traffic regulation was properly implemented. There were no responses in the neutral, disagree, or strongly disagree categories, indicating consistently positive perceptions across all indicators.

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Overall, Port Supervision (X_3) achieved an average index of 4.69, which falls within the 4.21–5.00 interval and is categorized as Strongly Agree. The highest score was recorded by $X_{3.1}$ at 4.76, followed by $X_{3.2}$ at 4.71, while $X_{3.3}$ obtained 4.61. These findings indicate that respondents perceived ship-document inspection, port activity supervision, and shipping traffic regulation as being implemented very well.

In general, the findings show that Port Supervision (X_3) at Tanjung Emas Port, Semarang, received a very positive assessment. The high scores across all indicators reflect respondents' positive perceptions of supervision in ensuring compliance with safety requirements, monitoring operational activities, and regulating shipping traffic. Therefore, port supervision represents an important aspect in supporting the implementation of safe and orderly shipping activities at Tanjung Emas Port, Semarang.

Overview of Shipping Safety (Y) at Tanjung Emas Port Semarang

Shipping Safety (Y) is a fundamental aspect of maritime transportation because it concerns the protection of vessels, crew, passengers, cargo, and the marine environment throughout shipping activities. It encompasses vessel condition, crew competence, compliance with safety procedures, use of safety equipment, and the ability to prevent and respond to potential risks. In this study, Shipping Safety (Y) is the dependent variable used to assess safety conditions and its relationship with Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3) at Tanjung Emas Port, Semarang.

The assessment of Shipping Safety is based on three indicators: consistent crew compliance with safety procedures (Y_1), smooth vessel operations (Y_2), and minimizing accident risks (Y_3). The descriptive results show very positive responses from all 21 respondents. Y_1 obtained a total score of 102 with an index of 4.85, Y_2 obtained a total score of 101 with an index of 4.80, and Y_3 obtained a total score of 99 with an index of 4.71. All three indicators were categorized as Strongly Agree.

For Y_1, 85.7% of respondents strongly agreed and 14.3% agreed that crew members consistently complied with shipping safety procedures. For Y_2, 80.9% strongly agreed and 19.1% agreed that vessel operations ran smoothly. Meanwhile, for Y_3, 71.4% strongly agreed and 28.6% agreed that accident risks were minimized. No respondents selected the neutral, disagree, or strongly disagree categories for any of the three indicators, demonstrating consistently positive perceptions of the measured aspects of shipping safety.

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Overall, Shipping Safety (Y) achieved an average index of 4.78, which falls within the 4.21–5.00 interval and is categorized as Strongly Agree. Among the indicators, Y_1 recorded the highest index at 4.85, followed by Y_2 at 4.80, while Y_3 obtained 4.71. These findings indicate that respondents perceived crew compliance with safety procedures, smooth vessel operations, and efforts to minimize accident risks as being implemented very well at Tanjung Emas Port, Semarang.

Overall, the descriptive findings demonstrate that the Shipping Safety (Y) variable received a very positive assessment, with an average index of 4.78. The high level of agreement indicates that the safety aspects measured in this study were perceived to be well implemented in supporting safe and orderly vessel operations. These findings provide a descriptive picture of shipping safety conditions at Tanjung Emas Port, Semarang, while the extent to which Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3) statistically influence Shipping Safety requires further examination through the inferential analysis.

Analysis of the Influence of Crew Qualifications, Ship Readiness and Port Supervision on Shipping Safety

The influence analysis in this study aims to determine the extent to which Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3) influence Shipping Safety (Y). This analysis provides empirical evidence regarding the relationships between the three independent variables and the dependent variable based on data collected from respondents. Multiple linear regression is employed because the study involves three independent variables and one dependent variable.

The multiple linear regression model is formulated as $Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + e$, where Y represents Shipping Safety, α is the constant, β_1–β_3 are the regression coefficients, X_1 represents Crew Qualifications, X_2 represents Ship Readiness, X_3 represents Port Supervision, and e represents the error term. The regression coefficients indicate the direction and magnitude of the relationship between each independent variable and Shipping Safety, assuming the other variables remain constant. A positive coefficient indicates a positive relationship, while a negative coefficient indicates an inverse relationship.

The significance of the relationships is examined using the t-test (partial test) and F-test (simultaneous test) at a 5% significance level ($\alpha = 0.05$). The t-test is used to determine whether Crew Qualifications, Ship Readiness, and Port Supervision individually have a significant relationship with Shipping Safety, whereas the F-test

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evaluates whether the three independent variables collectively have a significant relationship with Shipping Safety. These tests provide the statistical basis for evaluating the proposed research hypotheses.

The regression analysis results are subsequently used to address the research questions and test the hypotheses. A variable is considered to have a statistically significant relationship with Shipping Safety when its significance value is below 0.05. Thus, the analysis provides an empirical basis for understanding the role of crew competence, vessel readiness, and port supervision in supporting shipping safety at Tanjung Emas Port, Semarang.

A. Multiple Linear Regression Analysis

In this study, multiple linear regression analysis is used to examine the effects of Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3) on Shipping Safety (Y). Data processing is conducted using the Statistical Package for the Social Sciences (SPSS) to obtain information regarding the direction of the relationships, the magnitude of the effects, and the level of significance among the variables under investigation. Therefore, the results of the multiple linear regression analysis can be used to test and address the research hypotheses formulated previously.

Table 3. Multiple Linear Regression Analysis Test

Variable	B	Std. Error	Beta	T	Sig	Information
Constant	0,973	1,355	-	0,719	0,476	
X1	0,251	0,126	0,348	1,200	0,003	Positive and significant effect
X2	0,465	0,126	0,386	3.684	0,001	Positive and significant effect

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X3	0,749	0,127	0,613	5,884	0,000	Positive and significant effect

Source: Data processed by researchers 2026

The multiple linear regression results indicate a constant value of 0.973, meaning that when Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3) are assumed to be constant at zero, the predicted value of Shipping Safety (Y) is 0.973. The regression coefficient for Crew Qualifications (X_1) is -0.251, indicating that a one-unit increase in X_1 is associated with a 0.251-unit decrease in Y, assuming the other variables remain constant. Its significance value of 0.003 < 0.05 indicates a statistically significant relationship.

Meanwhile, Ship Readiness (X_2) has a regression coefficient of 0.465, indicating that a one-unit increase in X_2 is associated with a 0.465-unit increase in Shipping Safety, with a significance value of 0.001 < 0.05. Port Supervision (X_3) has the largest regression coefficient, at 0.749, indicating that a one-unit increase in X_3 is associated with a 0.749-unit increase in Shipping Safety, assuming the other variables remain constant, with a significance value of 0.000 < 0.05. Thus, based on the reported regression output, X_2 and X_3 have positive and statistically significant coefficients, while X1 has a negative coefficient but is also statistically significant.

B. Correlation Analysis

Correlation analysis is used to determine the strength of the relationship between the independent and dependent variables. In this study, the independent variables consist of Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3), while the dependent variable is Shipping Safety (Y). Correlation analysis is conducted to determine how strongly the three independent variables, collectively, are related to Shipping Safety.

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,932	0,869	0,861	1,736

Source : Processed by researchers 2026

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The results in Table 4.11 show an R value of 0.932, indicating a very strong relationship between Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3), collectively, and Shipping Safety (Y). This value falls within the 0.80–1.000 interval, which is categorized as a very strong correlation. The R value approaching 1 indicates a high degree of association between the three independent variables and Shipping Safety.

The analysis also shows an R Square value of 0.869, indicating that 86.9% of the variation in Shipping Safety (Y) is explained collectively by Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3). The remaining 13.1% is attributable to other factors not included in the research model. Overall, the findings indicate that the three independent variables have a very strong collective relationship with Shipping Safety at Tanjung Emas Port, Semarang.

C. Model Fit Analysis

Model fit analysis is conducted to determine the extent to which the independent variables—Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3)—can explain variations in Shipping Safety (Y). The model fit is assessed using the coefficient of determination (R^2), which represents the proportion or percentage of variation in the dependent variable jointly explained by the independent variables in the regression model. A higher R^2 indicates greater explanatory capability of the model, while a lower R^2 indicates that a larger proportion of the variation in Shipping Safety is explained by factors outside the research model.

Tabel 5. Model Fit Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,932	0,869	0,861	1,736

Source : Processed by researchers 2026

Based on Table 5., the Adjusted R Square value of 0.861 indicates that, after adjusting for the number of independent variables and the sample size, the regression model explains 86.1% of the variation in Shipping Safety. The Adjusted R Square value, which is close to the R Square value, indicates that the model provides a relatively stable explanation of the relationship between the independent and dependent variables.

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Based on these results, the regression model involving Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3) has a good level of fit in explaining Shipping Safety at Tanjung Emas Port, Semarang. Collectively, the three independent variables contribute 86.1% to the variation in Shipping Safety, while the remaining 13.9% (100% − 86.1%) is attributable to other factors not examined in this study. The overall significance and adequacy of the regression model are further evaluated using the ANOVA test.

Tabel 6.

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1018.135	3	339.378	112.544	.000[b]
	Residual	153.792	51	3.016		
	Total	1171.927	54			

SSumSource : Data processed by researchers 2026

From the anova table, it can be inferred that Sig is <0.05, so the model is suitable for use.

D. Hypothesis Testing

Hypothesis testing is conducted to determine whether the independent variables, consisting of Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3), have an effect on the dependent variable, Shipping Safety (Y). Hypothesis testing is used to statistically examine the validity of the provisional assumptions formulated in the study.

In this study, hypothesis testing is performed using multiple linear regression analysis. The analysis includes the t-test (partial test) to determine the effect of each independent variable on the dependent variable individually and the F-test (simultaneous test) to determine the collective effect of all independent variables on the dependent variable. The significance level used in the testing is 5% (α = 0.05).

E. Simultaneous Test

This test is used to determine the simultaneous effect of the independent variables on the dependent variable. To determine whether the combined effect of the

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independent variables on the dependent variable is statistically significant, a 5% significance level (α = 0.05) is used.

Table 7. Test F (Simultaneous)

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1018.135	3	339.378	112.544	.000[b]
	Residual	153.792	51	3.016		
	Total	1171.927	54			

Source : Data processed by researchers 2026

Based on the results of the F-test, the significance value obtained is 0.000, which is lower than the significance level of 0.05. This indicates that, simultaneously, Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3) have a statistically significant effect on Shipping Safety (Y). Therefore, the hypothesis stating that the three independent variables simultaneously affect shipping safety is accepted.

F. Partial Test

This test is used to determine the significance of the effect of each independent variable on the dependent variable individually, while assuming that the other variables remain constant. The significance of the effect can be assessed by comparing the t-table value (t-critical) with the calculated t-value (t-statistic). If the t-statistic > t-critical, the independent variable individually has a significant effect on the dependent variable. Conversely, if the t-statistic < t-critical, the independent variable individually does not have a significant effect on the dependent variable.

Table 8. T-test (Partial)

Model		**Unstandardized Coefficients B**	**Std. Error**	**Standardized Coefficients Beta**	**t**	**Sig.**
	(Constant)	0,973	1,355		0,718	0,476

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	Crew Qualifications (X_1)	0,251	0,126	0,348	1,200	0,003
	Ship Readiness (X_2)	0,465	0,126	0,386	3,684	0,001
	Port Surveillance (X_3)	0,749	0,127	0,613	5,884	0,000

Source : Data processed by 2026 researchers.

For 21 respondents at a 5% significance level, the t-table value is 2.074. Based on Table 4.12, the calculated t-value for Crew Qualifications (X_1) is 1.200, which is lower than the t-table value of 2.074; therefore, based on the stated decision rule, X_1 does not have a statistically significant effect on Shipping Safety (Y). Meanwhile, Ship Readiness (X_2) has a calculated t-value of 3.684, which is greater than 2.074, indicating a statistically significant effect on Shipping Safety (Y), while Port Supervision (X_3) has a calculated t-value of 5.884, also greater than 2.074, indicating a statistically significant effect on Shipping Safety (Y).

CONCLUSION

Based on the research findings on the Influence of Crew Qualifications, Ship Readiness, and Port Supervision on Shipping Safety at Tanjung Emas Port, Semarang, several conclusions can be drawn. Crew Qualifications (X_1) received a positive assessment from respondents, with particularly high ratings for crew competency certification and safety culture. These findings indicate that the qualifications and safety-related aspects of crew members were perceived positively in supporting shipping safety.

Ship Readiness (X_2) also received a positive assessment from the majority of respondents. The highest assessment was given to the indicator concerning the seaworthiness of the vessel, indicating that respondents perceived vessel conditions as being well prepared to support safe shipping operations. This finding reflects a positive assessment of the technical and operational readiness of vessels at Tanjung Emas Port.

Port Supervision (X_3) received a positive assessment from most respondents, with the highest rating given to the inspection of ship documents before departure. This indicates that pre-departure document inspection was perceived as an important and

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well-implemented aspect of port supervision in supporting compliance with shipping safety requirements.

Shipping Safety (Y) was also assessed positively based on the descriptive analysis. The highest-rated indicator was the consistent compliance of crew members with shipping safety procedures, indicating that respondents perceived safety procedures to be implemented well during shipping operations. This reflects a positive assessment of crew compliance and the overall implementation of shipping safety at Tanjung Emas Port.

Finally, Crew Qualifications (X_1), Ship Readiness (X_2), and Port Supervision (X_3) collectively have a statistically significant effect on Shipping Safety (Y) based on the simultaneous test. The three variables jointly explain 86.1% of the variation in Shipping Safety, as indicated by the coefficient of determination, while the remaining 13.9% is explained by other factors outside the research model. Based on the reported regression coefficients, Port Supervision (X_3) has the largest coefficient (0.749) among the three variables; however, the individual significance of each variable should be interpreted according to its corresponding t-test and significance value.

RECOMMENDATION

Based on the research findings regarding the influence of Crew Qualifications, Ship Readiness, and Port Supervision on Shipping Safety at Tanjung Emas Port, Semarang, the researcher proposes the following recommendations:

1. Referring to the analysis of Crew Qualifications (X_1), although the majority of respondents gave very positive assessments, the work experience indicator recorded the lowest index at 4.52 compared with the other indicators. Therefore, seafarers with longer work experience should continue to improve their competencies by consistently following safety guidelines and procedures on board. This is intended to support overall shipping safety, particularly in the operational area of Tanjung Emas Port, Semarang.
2. Referring to the analysis of Ship Readiness (X_2), although the majority of respondents provided very positive assessments, the indicator of safety equipment being complete and in good condition obtained the lowest index at 4.66. Therefore, companies and ship management should conduct regular and optimal internal audits, particularly to assess the readiness and condition of safety equipment. Regular drills and training should also be conducted to ensure that crew members are familiar with the proper use of such equipment.

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3. Referring to the analysis of Port Supervision (X_3), although the majority of respondents gave very positive assessments, the shipping traffic regulation indicator recorded the lowest index at 4.61. Therefore, the management and supervisory authorities at Tanjung Emas Port, Semarang, are advised to strengthen the regulation and monitoring of shipping traffic in order to reduce potential accident risks and support safer vessel movements.
4. Referring to the analysis of Shipping Safety (Y), although the majority of respondents provided very positive assessments, the accident-risk minimization indicator obtained the lowest index at 4.71. Therefore, all relevant institutions—including shipboard management, shipping companies, and port authorities—should conduct regular safety evaluations and follow-up actions to identify and address potential risks. The results of these evaluations should be communicated and implemented consistently among all relevant personnel to help prevent future accidents.
5. Regulators are encouraged to further strengthen supervision of shipping traffic, ship documentation, and activities within the port area. Consistent and integrated supervision of these aspects is expected to support compliance with applicable safety requirements and contribute to maintaining and improving shipping safety at Tanjung Emas Port, Semarang.

REFERENCES

Alzate, P., Isaza, G. A., Toro, E. M., Jaramillo-Garzón, J. A., Hernandez, S., Jurado, I., & Hernandez, D. (2024). Operational Efficiency and Sustainability in Smart Ports: A Comprehensive Review. Marine Systems & Ocean Technology, 19(June), 120–131. https://doi.org/10.1007/s40868-024-00142-z

Barasa, L., Simanjuntak, M., & Syafitra, B. W. (2025). Factors Affecting the Safety Climate of The Ship's Crew: Empirical Evidence from Shipping Companies in Indonesia. The Asian Journal of Shipping and Logistics, 41(2), 75–82. https://doi.org/10.1016/j.ajsl.2025.02.001

BPS. (2025). Sea Transportation Statistics 2024. BPS-Statistics Indonesia. https://www.bps.go.id/en/publication/2025/12/01/fdc6de7c2b34aa9b109edcad/statistik-transportasi-laut-2024

Fan, S., & Yang, Z. (2023). Analysing Seafarer Competencies in a Dynamic Human-Machine System. Ocean & Coastal Management, 240(106662), 1–9. https://doi.org/10.1016/j.ocecoaman.2023.106662

IMO. (2024). The International Safety Management (ISM) Code. International Maritime

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Organization. https://www.imo.org/en/ourwork/humanelement/pages/ismcode.aspx

IMO. (2025). Sub-Committee on Implementation of IMO Instruments (III 11), 21-25 July 2025. International Maritime Organization. https://www.imo.org/en/mediacentre/meetingsummaries/pages/iii-11th-session.aspx

Karatuğ, Ç., Ceylan, B. O., & Arslanoğlu, Y. (2025). A Hybrid Predictive Maintenance Approach for Ship Machinery Systems: A Case of Main Engine Bearings. Journal of Marine Engineering & Technology, 24(1), 12–21. https://doi.org/10.1080/20464177.2024.2393484

Kishore, L., Pai, Y. P., Ghosh, B. K., & Pakkan, S. (2024). Maritime Shipping Ports Performance: A Systematic Literature Review. Discover Sustainability, 5(108), 1–23. https://doi.org/10.1007/s43621-024-00299-y

Malik, D., Mudiyanto, & Widodo, W. (2025). Analisis Pengaruh Human Faktor Terhadap Keselamatan Pelayaran di Kapal Penumpang Perusahaan Surabaya. Jurnal Sains Dan Teknologi Maritim, 25(2), 215–228. https://doi.org/10.33556/jstm.v25i2.457

Shi, K., Fan, S., Weng, J., & Yang, Z. (2024). Seafarer Competency Analysis: Data-Driven Model in Restricted Waters Using Bayesian Networks. Ocean Engineering, 311(2), 1–14. https://doi.org/10.1016/j.oceaneng.2024.119001

Sugiyono. (2020). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Bandung: Alfabeta.

UNCTAD. (2025). Maritime Profile: Indonesia. United Nations Conference on Trade and Development. https://unctadstat.unctad.org/CountryProfile/MaritimeProfile/en-GB/360/index.html

Velasco-Gallego, C., & Lazakis, I. (2023). Mar-RUL: A Remaining Useful Life Prediction Approach for Fault Prognostics of Marine Machinery. Applied Ocean Research, 140(103735). https://doi.org/10.1016/j.apor.2023.103735

Veltsin, N., Chountalas, P. T., Koutsouki, E., Karvounidi, M. D., & Fousteris, A. E. (2025). Modeling Human Critical Success Factors for Maritime Safety: A DEMATEL Approach. Safety Science, 189(106886), 1–21. https://doi.org/10.1016/j.ssci.2025.106886

World Bank. (2026). Services Competitiveness for Growth and Jobs in Indonesia. https://documents1.worldbank.org/curated/en/099011526034524340/pdf/P506981-dd17a3b9-e242-47e9-9f9d-904833cbe12b.pdf

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