



Safety Performance Analysis of State and Commercial Ships in Accordance with SOLAS 1974

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Abstract

Purpose: The purpose of this study is to analyze the safety performance of state ships and commercial ships according to the requirements of Solas 1974.

Research Methodology: This study uses the Plan, Do, Check and Action (PDCA) evaluation model. Data were collected through an interview survey method and analyzed using factor analysis. Respondents consisted of 57 crew members, including 23 from state ships and 34 from commercial ships with a weight of over 500 GT at Tanjung Priok Port.

Results: The dominant factors influencing the implementation of Solas 1974 are grouped into five factors, namely Document Administration, Safety Guidelines, Guard Ship Personnel, Maritime Environmental Security, and Safety Equipment Readiness. The results can be used as reference material in terms of safety, security, and environmental protection.

Conclusions: The application of the 1974 Solas Convention and the 2018 Solas Consolidation is closely related to maritime protection in international shipping. The research output can serve as a basis for recommendations related to corrective actions to improve the marine transportation management system.

Limitations: This study is limited to data collected at Tanjung Priok Port with 57 respondents, which may affect generalizability. It also relies on survey data and self-reported questionnaires that may be subject to bias and is limited to selected safety factors.

Contributions: This study contributes to maritime transportation and safety management by providing reference material for stakeholders, including policymakers, shipping companies, and ship crews. It also supports the development of transportation management systems, including manuals, policies, procedures, and work instructions.

Keywords: *Commercial Ships, State Ships, Pioneer Ship, SOLAS 1974 Convention, International Shipping*

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1. Introduction

Indonesia, as a member of the International Maritime Organization (IMO), has ratified several rules or protocols issued by the IMO. The ratification of the 1988 Protocol relating to Solas 1974 was outlined in Presidential Regulation Number 57 of 2017 while the ratification of the 1988 Protocol relating to Loadlines 1966 was outlined in Presidential Regulation Number 84 of 2017. The 1974 Solas Convention

in the context of international shipping is related to several important aspects such as; (1) reports on the validity of ship certificates and documents to the company, (2) procedures to ensure a safe working environment, (3) procedures to ensure a safe working environment, (4) policies regarding safety and environmental protection, (5) audits of the system. on board safety management, (6) recruitment of qualified crew, (7) introduction of tools and tasks for crew, (8) documentation of crew performance, (9) safety management training, (10) crew communication skills, (11) Standard Operation Procedure for ship maintenance (12) ship maintenance planning, (13) implementation of ship equipment maintenance audit, (14) documentation of inspection and maintenance results, (15) equipment maintenance report, (16) Standard Operation Procedure for document audit, (17)) safety management guidelines, (18) storage of ship documents, (19) separation of expired documents, and (20) storage of ship safety management guidelines.

Fulfillment of all the ship's marine eligibility requirements is proven by the issuance of certificates and /or documents issued by a party authorized by the government. Broadly speaking, maritime affairs of ships in Indonesia are carried out by two bodies, namely a government agency handled by the Directorate General of Sea Transportation Organizing Unit and a non-government agency handled by the Indonesian Classification Agency (Badan Klasifikasi Indonesia). As for the problems that often arise regarding the law of ship safety enforcement, is when the certificate has been issued, but it turns out that the ship does not meet the ship's maritime requirements so that it does not meet the ship safety requirements according to the statutory regulations concerning shipping. In fact, when the certificate has been obtained, the authorized official is obliged to continue to carry out surveillance until the ship is no longer used, in order to re-confirm the truth of the facts of the ship's maritime condition. Not only officials, all crew members as well as owners and ship operators are required to support the implementation and certainty of the ship's marine condition in accordance with the regulations described above.

According to Law Number 17 of 2008, ships that will sail must meet ship safety requirements, which consist of regulations and procedures for preventing water pollution from ships, manning, loading lines, loading, crew welfare and passenger health, legal status of ships, safety management and prevention of pollution from ships, as well as ship security management for sailing in certain waters. In 1974, the new Solas 1974 convention was created, which contains several amendments in which each amendment is enforced according to a predetermined time target. This amendment is enforced as a binding rule unless there is a rejection of $\frac{1}{3}$ of the number of member countries or 50 percent of ship owners in the world (Suryani et al., 2018). Hasanov and Alsulaiman (2021) explains that the international safety management of ship facilities and international port facilities is marked by two codes that function as a center of gravity, namely the ISM Code and the ISPS Code. The purpose of these codes is to provide international standards for the management and safety of ship operations and pollution prevention (Zhang et al., 2021). In terms of research regarding onboard safety management system audits, the results of research by Nurdin (2018) show that auditors who concurrently serve as marine supervisors have never received training on the ISM Code, so they do not have the capacity as supervisors.

The commercial shipping industry, which dominates the oceans in terms of numbers, places more emphasis on safety aspects, while the navy is more focused on security aspects (Cook, 2020). Point to risk provisions, performance-based stability, and safety based on modern scientific developments. Transportation safety and security systems are key factors that must be considered and used as a basis and benchmarks for decision-makers (Paul et al., 2020). Several related studies have been conducted, for example, research by Zhang et al. (2019) related to the factors causing workplace accidents, their consequences, and efforts to reduce the risk of such accidents for ship crews. Saputra et al. (2017) concluded that ships must meet the standards set by the IMO and also comply with the conditions set by the Indonesian Classification Agency. Safety has always been a top priority in the marine transportation sub-sector (Lloyd et al., 2019).

The purpose of this study is to analyze the safety performance of state ships and commercial ships according to the requirements of Solas 1974 and to analyze significant differences in the safety of state ships and commercial ships according to the requirements of Solas 1974. The scope of activities carried out by the authors in this study are the main things that must be carried out in accordance with the professional corridor of expertise, among others, to analyze and provide recommendations for improvements, especially in relation to the implementation of Solas 1974. Modernization of Solas regulations since 1960 has replaced the 1918 Convention with Solas 1960, where since then regulations regarding design to improve ship safety have been included such as: (1) ship construction design; (2) mechanical and electrical; (3) fire prevention; (4) safety equipment; and (5) communication and navigation safety devices.

The 1974 Solas Convention applies to ships engaged in international shipping except: (1) warships and ships carrying troops; (2) merchant ships of less than 500 GT; (3) vessels not driven by mechanical equipment; (4) traditional wooden vessels; (5) cruise ships that are not related to business; and (6) fishing vessels. Meanwhile, Solas Consolidation 2018 addresses safety, security, and protection of the maritime environment, including regulations on air balance, ship engines, standards, and handling of steam pipe systems to prevent pollution from ships. Standard communication systems have also been regulated in the Solas Consolidation 2018 related to the Vessel Traffic Information System (VTIS).

State ships according to Law Number 17 of 2008 are state-owned ships used by certain government agencies that are given functions and authority in accordance with applicable laws and regulations to enforce the law and perform other government duties. The existence of different functions between merchant ships and state ships necessitates laws and regulations that specifically regulate the manning of state ships. Three ministries operate state ships, namely the Ministry of Transportation, the Directorate General of Customs and Excise at the Ministry of Finance, and the Ministry of Law and Human Rights. Some examples of state ships include: (1) pioneer ships; (2) container ships; (3) livestock ships; (4) navigation state ships; (5) training ships; and (6) state patrol ships. National navigation ships consist of the Perambuan Carrier, the Perambuan Auxiliary Ship, and the Perambuan Control Ship. Research conducted by [Irwan et al. \(2019\)](#) concluded that the number of state ships operated by the relevant ministries only fulfilled 50 percent of the total number of ships needed, which can impact the performance of state ship services. Indonesian commercial ships are sea transportation service facilities aimed at fostering economic unity across the Indonesian archipelago as well as supporting national economic growth. The provision of sea transportation services is carried out through a system of permanent and regular shipping supported by seafarers. Several studies on commercial ships have been conducted, including [Hannaford and Hassel \(2021\)](#), which explains that the use of electronic navigation equipment and ship manning requirements affects the workload of ship crews. Other research shows that commercial shipping has a strong relationship with shipping safety ([Mudiyanto, 2019](#)).

The research approach taken uses the Planning, Do, Check, and Action (PDCA) evaluation model as shown in Figure 1.

2. Literature Review & Hypothesis Development

2.1 *Maritim Safety and SOLAS Framework*

Maritime safety is a critical aspect in ensuring the sustainability of sea transportation and the protection of human life and the marine environment. The International Convention for the Safety of Life at Sea (SOLAS) 1974 is one of the most important international regulations governing ship safety standards, including ship construction, equipment, and operational procedures. According to, the SOLAS Convention and its supporting codes have significantly contributed to improving safety, environmental protection, and risk mitigation in international shipping ([Joseph & Dalaklis, 2021](#)).

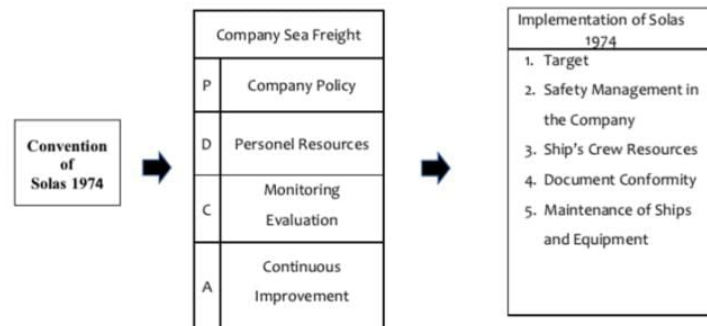


Figure 1. Research Flowchart Framework

2.2 Ship and Port Security Regulations

Maritime safety is closely linked with security regulations, particularly through the implementation of the International Ship and Port Facility Security (ISPS) Code. The legal frameworks supporting international cooperation in implementing ISPS Code provisions to address port security incidents. These regulations aim to strengthen coordination between ship operators and port authorities, ensuring a secure maritime environment (Avila-Zuniga-Nordfeld & Dalaklis, 2018).

2.3 Safety and Security in Shipping Operations

Safety and security in shipping operations require effective management practices and regulatory compliance. Modern shipping operations must balance safety requirements with operational efficiency, emphasizing the role of safety management systems and international regulations. The integration of safety and security measures is essential to minimize operational risks and ensure sustainable maritime transport (Benamara et al., 2019).

2.4 Previous Studies on Maritime Safety Factors

Several previous studies have identified key factors influencing maritime safety, including human resources, safety equipment, and operational procedures. Research indicates that compliance with international safety standards, crew competence, and effective safety management systems significantly contribute to reducing maritime accidents and improving overall safety performance (Qiao et al., 2021).

2.5 Hypothesis Development

Based on the literature reviewed above, the following hypotheses are proposed:

- H_1 : There is a significant difference in the implementation of Solas 1974 requirements between state ships and commercial ships.
- H_2 : Ship documentation, safety guidelines, and guard ship personnel have a significant positive effect on the implementation of Solas 1974 requirements.
- H_3 : Maritime environmental security and safety equipment readiness have a significant positive effect on shipping safety performance.

3. Methodology

This study employs a survey-based research design using a quantitative approach. The research is structured based on the Planning, Do, Check, and Action (PDCA) evaluation model as the main theoretical framework. The PDCA model is used as a systematic tool to evaluate the implementation of safety management systems and to support continuous improvement in accordance with ISO 9001 quality

management standards. The theoretical foundation of this study is also based on maritime safety regulations, particularly the Solas 1974 Convention and its consolidation.

The materials used in this study include structured questionnaires and interview guidelines designed to measure the implementation of safety factors on state ships and commercial ships. The questionnaire consists of several indicators grouped into five main factors, namely: (1) Ship Documentation, (2) Safety Guidelines, (3) Guard Ship Personnel, (4) Maritime Environmental Security, and (5) Safety Equipment Readiness. The measurement scale used is a Likert scale to assess respondents' perceptions.

Data were collected through direct survey methods and interviews conducted at Tanjung Priok Port by visiting ships directly. The respondents consisted of 57 crew members, including 23 crew members from state ships and 34 crew members from commercial ships with a gross tonnage of more than 500 GT. The sampling technique used is random sampling to ensure representation of respondents.

The data obtained from the questionnaires were analyzed using statistical methods, particularly factor analysis, to identify dominant factors influencing the implementation of Solas 1974. Descriptive statistical analysis was also used to describe respondent characteristics and safety performance levels. Data processing and analysis were conducted using IBM SPSS Statistics software to ensure accuracy in calculating factor loadings, variance contributions, and reliability of the research instruments.

This study assumes that all respondents provide honest and accurate answers based on their experience and knowledge. The research was conducted under normal operational conditions without experimental intervention. It is also assumed that the implementation of Solas 1974 requirements is relatively consistent across ships, although differences may arise due to organizational and operational factors. The methodology described in this study is expected to enable replication under similar research conditions.

4. Methods

4.1 Research Design

Combined with the 2018 Solas Consolidation, the research design used an interview survey method with a flexible design so that it could produce quantitative data. The research approach uses the Planning, Do, Check and Action (PDCA) evaluation model. According to [Realyvásquez-Vargas et al. \(2018\)](#), the PDCA approach is a systematic tool for evaluating the effects of new safety technologies. The application of the Plan-Do-Check-Action model is used to manage processes according to the ISO 9001 quality management standard ([Hernawan et al., 2018](#)). The findings of [Ikhsannudin and Pakpahan \(2021\)](#) through PDCA explain that quality management and empowerment can significantly help improve learning in the workplace. The application of the PDCA model has been carried out in research in the field of transportation in the mode of shipping and railways and is able to show an overview of the implementation of the internal quality assurance system [Reknati \(2019\)](#).

In the PDCA context, at the planning stage, a quality planning procedure is needed, at the implementation stage a quality assurance is required, at the evaluation stage a quality control is required, and at the continuous improvement stage quality maintenance and development are required.

4.2 Data Collection

Researchers conducted a random direct survey by visiting several pioneer shipping as state vessels and commercial shipping as commercial vessels in Tanjung Priok Port. The results of the questionnaire were conducted using the Delphi method for both state and commercial ship crew respondents.

The research survey was carried out on commercial ships with a weight of over 500 GT and pioneer ships as state ships. A total of 57 respondents from the crew of state ships and commercial ships have been asked to respond. In making an inventory of the results of the questionnaire, the researcher compiled

the characteristics of the respondents based on the age group of the crew, the number of respondents according to the type of ship, and the respondent's perception of the implementation of the Solas 1974 provisions.

4.3 Data Analysis

The data will then be tested statistically with the factor analysis method. The dominant factors that influence the implementation of Solas 1974 can be grouped into five factors, namely (1) Document Administration, (2) Safety Guidelines, (3) Guard Ship Personnel, (4) Maritime Environmental Security and (5) Safety Equipment Readiness.

5. Results and Discussion

5.1 Results

5.1.1 Respondents Characteristics

Research respondents have various characteristics. Based on their positions, respondents range from officers to captains, which allows variation in terms of age. Based on the survey results, respondents aged under 30 years were 13 people (22.8%), those aged 30–35 years were 18 people (31.6%), and those aged 35–40 years were 19 people (33.3%). The largest group of respondents was in the age range of 35–40 years, namely 19 people (33.3%). Meanwhile, respondents aged above 40 years were 7 people (12.3%). Of the 57 crew members, 23 respondents came from state ships and 34 respondents came from commercial ships. Respondents were mostly officers from pilot ships or state ships assigned to these voyages. Meanwhile, for commercial ships, respondents were at the level of commander-in-chief and captain.

The answers to the questionnaire indicate a fairly good performance on the policy variables of shipping companies, both commercial ships and state ships, with an achievement of 90.11% for commercial vessels and 98.434% for state ships. Regarding the variable of shipping personnel resources for commercial ships and state ships, the survey results show an achievement of 85.296% for commercial ships, while for state ships the achievement is 98.782%. In relation to the evaluation and monitoring variables for commercial ships and state ships, the survey shows an achievement of 81.764% for commercial ships and 98.26% for state ships. Finally, in relation to the variable of continuous improvement, commercial ships show a performance achievement of 80.82%, while for state ships the survey results show a performance achievement of 94.956%.

5.1.2 Factors Affecting the Implementation of Solas 74

Factor 1: Document Administration

Factor 1 contributed 21.69% of the variance. The document administration factor consists of eight aspects, namely: (1) ship document storage, (2) storage of ship safety management guidelines, (3) ship maintenance planning, (4) equipment maintenance report, (5) ship crew performance documentation, (6) standard operation procedure for ship maintenance, (7) separation of expired documents, and (8) documentation of the results of inspection and maintenance.

The contribution of the storage aspect of ship documents to Factor 1 was 79.74% with the highest loading factor of 0.893, while the contribution of the documentation of inspection and maintenance results was 30.47% with the lowest loading factor of 0.552.

Factor 2: Safety Guidelines

Factor 2 contributed 20.71% of the variance. The safety guidelines factor consists of a component of ship equipment maintenance audit with a contribution of 60.84% and the highest loading factor of 0.780,

while the communication ability of crew members has the lowest loading factor of 0.559.

Factor 3: Guard Ship Personnel

Factor 3 contributed 20.13% of the variance. The guard ship personnel factor consists of procedures to ensure a safe work environment with the highest loading factor of 0.940, procedures for handling and overcoming emergencies, and the recruitment of qualified crew members with the lowest loading factor of 0.752.

Factor 4: Maritime Environmental Safety

Factor 4 contributed 11.11% of the variance. The maritime environmental safety factor consists of policies regarding safety and environmental protection with the highest loading factor of 0.886, safety management system audits on board, and the validity of all certificates and documents with the lowest loading factor of 0.569.

Factor 5: Readiness of Safety Equipment

Factor 5 contributed 10.70% of the variance. The safety equipment readiness factor consists of one aspect, namely the introduction of tools and duties for crew members, with a loading factor of 0.920. The dominant factors that influence the implementation of Solas 1974 provide varying levels of contribution percentages and loading factor values, as summarized in Table 1.

Table 1 explains that all the factors and aspects in this study contributed 80% to shipping safety, consisting of Factor 1 (Ship Documentation) contributing 21.69%; Factor 2 (Safety Guidelines) contributing 20.71%; Factor 3 (Guard Ship Personnel) contributing 20.13%; Factor 4 (Maritime Environmental Security) contributing 11.11%; and Factor 5 (Safety Equipment Readiness) contributing 10.70%. It can be seen from these five factors that the completeness of documentation, safety guidelines, and guard ship personnel contributed almost equally, at around 21%. Meanwhile, the other two factors, namely Maritime Environmental Security and Safety Equipment Readiness, contributed an average of approximately 11%.

5.2 Discussion

5.2.1 Ship Documentation

The Ship Documentation factor, which consists of many important operational documents on board, contributed 21.69% of the variance. With a contribution of more than 20%, it can be seen that the importance of ship documentation must be well organized. Several previous studies regarding the importance of ship documentation are in line with this research. Storage of ship documents is very necessary, such as the process of managing ship document extensions as one of the conditions for issuing a Sailing Approval Letter (Setyawan & Aziz, 2020; Sukrisno & Piaratama, 2019). Several previous studies also support the document completeness factor, such as those conducted by Turan and Asar (2019), which indicate that in terms of ship maintenance, preventive maintenance is needed as the best approach to increase ship system reliability and overall availability.

In terms of documentation of crew performance, Mawardi (2021) explained that previous studies identified issues related to crew discipline and responsibility in carrying out watchkeeping duties. Other studies have introduced short maintenance periods for certain machine groups. Regarding Standard Operating Procedures, previous research is also in line with this study. Reports of marine accidents often mention inadequate procedures as a contributing factor to such incidents (Puisa et al., 2018). Finally, according to Pie-Ya and Chien-Chang (2019), developed standard operating procedures can be implemented by bulk carriers, ship owners, charterers, and ship safety management companies to improve navigation safety and prevent cargo damage.

Table 1. Recapitulation of Factor Analysis

Research Aspects and Factors	F1	F2	F3	F4	F5
1.Ship Documentation	.893	-.081	-.103	.236	-.022
Ship Document Storage	.819	.190	.297	-.077	.020
Storage of Ship Safety Management Guidelines	.676	.416	.501	-.005	-.080
Ship Maintenance Planning	-.655	.464	.205	.040	.301
Equipment Maintenance Result Report	.648	.554	.479	-.028	.089
Documentation of Crew Performance	.614	.404	.125	.025	.516
Standard Operation Procedure for Ship Maintenance	.590	.375	.271	.253	-.009
Expired Documents Separation	.552	.549	.116	.010	.523
Documentation of Inspection and Maintenance Results					
2. Safety Guidelines	.180	.780	.187	.114	.415
Conducting ship equipment maintenance audits	.364	.757	.138	.266	-.021
Standard Operation Procedure for Document Audit	.018	.699	.609	-.136	.131
Safety Management Guidelines	.198	.669	.517	.115	.000
Safety management training	.342	.559	.544	-.168	.120
Crew communication capabilities					
3. Guard Ship Personnel	.195	.072	.940	.153	.086
Procedures to ensure a safe working environment	.143	.239	.857	.116	.298
Procedures for dealing with emergencies	.179	.456	.752	.168	.212
Recruitment of qualified crew					
4. Maritime Environmental Security	.098	-.076	-.003	.886	.076
Policy regarding safety and environmental protection	-.037	.285	.156	.880	-.198
An Audit of safety management system on board	.324	.064	.239	.569	.510
Validity of all certificates and documents					
5. Readiness of Safety Equipment	-.093	.089	.220	-.066	.920
Introduction to tools and duties of the crew	4.338	4.143	4.026	2.224	2.141
Eigenvalue	21.691	20.715	20.130	11.119	10.703
Percent Variance (%)	21.691	42.406	62.537	73.65	84.359

5.2.2 Safety Guide

The second factor, namely Safety Guidelines, contributed 20.71%. Several studies regarding shipping safety guidelines have been carried out and are in line with this research. [Kadarisman \(2017\)](#) stated that the government is obliged to carry out law enforcement at sea, both against the threat of violations, utilization of waters, as well as maintaining and creating optimal shipping safety. An effective management system can provide clear exposure to the crew and ship managers in an effective, safe, and systematic manner. The results of the research by [Ahmad et al. \(2014\)](#) show that human error, stability factors, and external factors affect management efficiency.

According to [Joseph and Dalaklis \(2021\)](#), many SOLAS 1974 rules and related supporting codes complement each other and contribute positively to personnel safety and environmental protection. The SOLAS 1974 convention has also been ratified and implemented to accommodate both state and commercial ships in complying with applicable regulations. Safety training management is very important for the safety of ships, crew, and passengers ([Dragomir & Simona, 2016](#)). Other studies have concluded that training on the prevention of safety disturbances in every voyage is necessary ([Astuti & Muladi, 2019](#); [Lasse & Fatimah, 2016](#); [Nurhasanah et al., 2015](#)). The aspect of communication skills for crew members is also an important factor. Therefore, efforts are needed to improve the communication ability of Indonesian crews, especially in English ([Bunga, 2017](#)).

5.2.3 Guard Ship Personnel

The third factor, namely Guard Ship Personnel, consists of three aspects: (1) procedures to ensure a safe working environment, (2) procedures for dealing with emergencies, and (3) recruitment of qualified crew members. This factor contributed 20.13% of the variance. Several previous studies are in line with this research. The empowerment of employees and service quality in shipping companies, as well as the recruitment of qualified crew members by considering human resource variables, strongly support shipping safety (Berg et al., 2013; Kadarisman, 2017; Ricardianto et al., 2020; Wiweko et al., 2015).

Poor working and living conditions on board are key factors that must be avoided to increase retention among seafarers and ensure a safe working environment. This is particularly significant in relation to improving the handling of dangerous goods transportation (Lasse, 2014; Nguyen et al., 2014). Ershov et al. (2017) proposed several important procedures to address and manage emergency situations, for example by conducting maneuvers to prevent damage to the ship's hull. Other research by Astuti and Muladi (2019) on the implementation of the ISM Code to optimize ship safety shows good performance in handling ship operational safety procedures, such as dealing with bad weather, navigating narrow shipping lanes, and managing emergency steering.

5.2.4 Maritime Environmental Security

The fourth factor, namely Maritime Environmental Security, contributed 11.11%. In general, studies on the use of commercial and state ships in previous research also support this finding. In terms of policies regarding safety and environmental protection, Thamrin (2015) emphasized that re-registration and national audits of Indonesian ships that are still operating must be carried out in accordance with developments in international standardization. The use of ships must meet the requirements of SOLAS 1974 as established by the IMO (Mudiyanto2020; Akindehin et al., 2015; Francescutto & Papanikolaou, 2011; Saputra et al., 2017). These studies indicate that onboard safety measures are effective in improving maritime safety performance.

Several previous studies also support the Maritime Environmental Security factor. The International Safety Management (ISM) Code and the ISPS Code, as discussed by (Naily et al., 2019; Nikcevic Grdinic, 2015; Suganjar & Hermawati, 2019; Suhartoyo, 2018), highlight that the implementation of the ISM Code can significantly enhance ship safety. The ISM Code requires strong commitment from all levels of shipping management, both ashore and onboard. The relevance of the ISM Code to ship seaworthiness assessment indicates that its implementation must be aligned with security requirements as defined in the ISPS Code. Regarding the implementation of the Designated Person Ashore (DPA), shipping companies are expected to reduce accident rates across their fleets (Nurdin, 2018; Suganjar & Hermawati, 2019). In terms of shipping safety, this study supports previous findings (Setiono2010; Hendrawan, 2019; Kadarisman, 2017), which explain that ship safety and shipping safety indicators are closely interrelated. Furthermore, Talaie and Javidbakht (2020) emphasized that to achieve the objectives of the ISPS Code, all IMO member states must fully implement the regulations and adopt best practices from countries such as Malaysia and South Korea.

5.2.5 Safety Equipment Readiness

The fifth factor, namely Safety Equipment Readiness, contributed 10.70%. Several previous studies support these findings. In terms of improving planning and design of electronic navigation systems, as well as the availability of communication devices and safety equipment, this study aligns with previous research (An, 2016; Astuti & Muladi, 2019; Malisan, 2013; Mutholib, 2013). To prevent and mitigate safety risks, shipping companies must have procedures, facilities, and equipment in accordance with the ISM Code provisions (Asalina & Purwantini, 2018; Nurhasanah et al., 2015). Regarding navigation safety, Jensen (2016) introduced new instruments designed to improve safety and environmental sustainability,

particularly in Arctic waters.

[Grdinic \(2016\)](#) added that, in addition to international conventions, codes adopted by international organizations play a crucial role in improving navigation safety. Ships must also be equipped with essential safety equipment such as lifeboats, life jackets, fire extinguishers, and valid documentation to ensure seaworthiness ([Beattie, 2009](#); [Hendrawan, 2019](#)). Furthermore, [Hermawan et al. \(2020\)](#) highlighted the importance of the Electronic Chart Display and Information System (ECDIS) in enhancing crew understanding and operational safety.

5.2.6 Analysis of Difference in the Implementation of Commercial Ships and State Ships According to Solas 1974 Requirements

State ships that are guided by the regulations of Ministerial Regulation Number 35 of 2013 have been very strict in fulfilling the rules set by the IMO world body, where one of the instruments is Solas 1974. The principle of implementing Solas 1974 on state ships is guided by the regulations of the Minister of Transportation of the Republic of Indonesia which assigned by the state in serving pioneering routes in areas that are not covered by private shipping with consideration of the risk of costs that are not feasible for shipping operations.

Meanwhile, commercial ships guided by the provisions of Solas 1974 must pay attention to shipping safety instruments against accidents and human errors from the shipping operations. In this case the researcher limits the safety factor which is oriented to ship construction, ship operations and safety equipment available on a voyage that must be fulfilled by commercial shipping companies. The safety factor mandated by the shipping law has been clearly spelled out in fulfilling the implementation criteria which obliges state ships to carry out state duties to serve isolated areas with the condition of ships deemed sail-worthy for the safety function of shipping. The same treatment is applied to commercial ships guided by the provisions of Solas 74 where commercial ships must pay attention to shipping safety instruments in accordance with established rules, both domestic and international shipping.

6. Conclusions

From the aspect of ship documentation, the results show that state ships are better prepared with an ideal score of 97.39 percent, while commercial ships only score 87.85 percent. In respect to the aspect of crew members' resources, the survey results show that state ships are better prepared with an ideal score of 98.269 percent, while commercial ships only get a score of 83.38 percent. In respect to the document suitability aspect, the survey results show that state ships are better prepared, where the scores achieved by commercial ships are below the scores obtained by state ships. Regarding to the aspect of ship maintenance and equipment, the research results show that state ships are more prepared, because the scores obtained by commercial ships are below the scores achieved by state ships.

6.1 Research Limitations

This study has several limitations. First, the research was conducted only at Tanjung Priok Port, so the findings may not fully represent the conditions of all ports in Indonesia or other international shipping environments. Second, the number of respondents was limited to 57 crew members, consisting of state ships and commercial ships, which may affect the generalizability of the results. Third, the study relies on survey data and self-reported questionnaires, which may be subject to respondent bias and perception differences.

In addition, this study focuses only on selected safety factors, namely ship documentation, safety guidelines, guard ship personnel, maritime environmental security, and safety equipment readiness, and does not cover other potential factors such as organizational culture, leadership, and technological integration in maritime safety systems.

6.2 Suggestions and Directions for Future Research

Future research is expected to expand the scope of study by involving a larger number of respondents and covering more ports, both at the national and international levels, to improve the generalizability of the findings. Further studies can also incorporate additional variables such as organizational culture, leadership, and digital maritime technologies to provide a more comprehensive analysis of shipping safety. In addition, future research may apply different analytical methods, such as structural equation modeling (SEM) or longitudinal studies, to examine causal relationships and changes in safety performance over time. Comparative studies between countries or regions are also recommended to understand differences in the implementation of SOLAS 1974 in various regulatory and operational contexts.

Finally, future research is encouraged to explore the integration of advanced technologies, such as electronic navigation systems and real-time monitoring tools, to enhance maritime safety and environmental protection in accordance with international standards.

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Author Contributions

Conceptualization (P.R.); study design (P.R.); data collection (P.R.); formal analysis (P.R.); writing original draft (P.R.); writing, review & editing (P.R.); final approval (P.R.).

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper. The authors confirm that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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