



Optimization of Communication Systems in Enhancing Navigational Safety on the Training Ship Barombong

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Abstract. This study aims to analyze how the optimization of communication systems can enhance navigational safety on board the Training Ship Barombong. Using a descriptive qualitative method, data were collected through interviews, observations, documentation, and functional testing of communication equipment on board. The results indicate that the communication equipment on the Training Ship Barombong is adequate in terms of both type and quantity. However, several significant challenges remain in its operation. These challenges include technical problems with communication devices such as VHF radios and the Global Maritime Distress and Safety System (GMDSS), lack of crew competence in operating the equipment, and inconsistent implementation of communication procedures. Training activities are still limited and are not conducted regularly, while communication documentation has not been implemented optimally. These findings suggest that the communication system has not yet been able to fully support navigational safety. Therefore, optimisation efforts are required by improving the quality of equipment, conducting regular crew training, and applying disciplined and standardised communication procedures.

Keywords: *Ship Communication Systems, Navigational Safety, Operational Optimization, Training Ship Barombong*

1. INTRODUCTION

The modes of water transport—including river, lake and ferry services, as well as maritime transport—are one of the foundations of economic equality, both domestically and internationally. The various types of vessels operated must be adapted to the requirements of the cargo being carried, including tankers, Ro-Ro vessels, passenger ships, barges, tugs, container ships, ferries, fishing vessels, and other specialized ships (Tim Penyusun Politeknik Pelayaran Barombong, 2021).

In the maritime industry, communication plays a crucial role, particularly in ship-to-ship communication, as it is closely related to navigational safety, operational coordination, and the prevention of collisions and other maritime accidents (Hickethier

& Yang, 2023; Ishak et al., 2019; Ramadhan et al., 2024). During adverse weather conditions or periods of restricted visibility, effective communication between vessel to another vessel and between vessels and Vessel Traffic Services (VTS) becomes essential to ensure safe navigation and efficient traffic management (Albrecht, 2015; Arief, 2020; Purwantomo, 2019). All vessels in operation are required to comply with applicable national and international regulations and standards concerning ship construction, navigational equipment, propulsion systems, communication systems, life-saving appliances, pollution prevention measures, collision prevention at sea, steering systems, hazardous cargo handling, and safety management systems. Compliance with these requirements is fundamental to ensuring seaworthiness and operational safety. By adhering to these regulations and standards, the maritime sector can enhance navigational safety, minimize operational risks, and reduce the incidence of maritime accidents (Hickethier & Yang, 2023; Maternová et al., 2023).

Shipboard communication systems must be properly managed to prevent communication errors and misunderstandings that may endanger navigational safety and result in maritime accidents, such as collisions and groundings (Gabedava & Hu, 2025; Misztal & Hatlas-Sowinska, 2025; Ramadhan et al., 2024). The implementation of a reliable communication system contributes significantly to maritime safety and security by fostering a shared understanding among personnel involved in vessel operations (Gabedava & Hu, 2025; Ramadhan et al., 2024). Effective communication during watchkeeping duties requires a comprehensive understanding of all regulations and procedures related to watchkeeping activities. The language used in communication should be clear, concise, and standardized to ensure that messages are delivered accurately and efficiently, thereby reducing the risk of misunderstanding (Gabedava & Hu, 2025; Misztal & Hatlas-Sowinska, 2025). In addition to being proficient in the operation of shipboard communication equipment, an Officer of the Watch (OOW) must have effective communication skills. Information and messages should be conveyed clearly and accurately so that personnel aboard other vessels can correctly interpret and respond to the communication received (Misztal & Hatlas-Sowinska, 2025; Ramadhan et al., 2024).

Communication between vessels at sea is essential for coordinating operational activities and preventing maritime incidents (Ramadhan et al., 2024). Effective ship-to-ship communication supports the exchange of navigational information, enhances situational awareness, and facilitates timely decision-making in both normal and emergencies (Gabedava & Hu, 2025; Misztal & Hatlas-Sowinska, 2025). Therefore, the ability of crew members to communicate effectively and achieve mutual understanding is a critical factor in ensuring safe, efficient, and secure maritime operations (Ishak et al., 2019; Gabedava & Hu, 2025). The information exchanged in ship-to-ship communication generally includes critical navigational data such as vessel position, course, speed, draft, and intended passing arrangements to ensure safe encounters during meeting, overtaking, and crossing situations (Purwantomo, 2019). Furthermore, under adverse weather conditions or when navigating through congested and high-traffic waterways, effective communication between vessels becomes essential to ensure navigational safety, maritime security, and the smooth conduct of vessel operations (Albrecht, 2015; Arief, 2020). Ships are generally equipped with a variety of communication systems and equipment, including Very High Frequency (VHF) radios, Single Side Band (SSB) radios, walkie-talkies, transceivers, telex and

fax systems, satellite communication systems, and computer-based digital information systems (Narang et al., 2024). In modern shipping operations, many vessels have adopted advanced communication technologies to improve the efficiency, reliability, and effectiveness of information exchange both onboard and between vessels (Narang et al., 2024). In addition to electronic communication, vessels may also communicate through visual means. Visual communication can be conducted between vessels under both normal and emergency conditions using internationally recognized signaling methods and equipment. These include the International Code of Signals (ICS) flags, Morse code signals, semaphore flags, orange smoke signals, red hand flares, rocket parachute flares, star signals, signal hoists, and other distress signals prescribed by applicable international regulations. The use of these visual communication methods provides an important alternative means of communication when electronic systems are unavailable, impaired, or insufficient to convey urgent navigational or safety-related information.

The International Maritime Organization (IMO) has established regulations requiring vessels to be equipped with appropriate radio communication equipment and manned by certified seafarers whose qualifications correspond to the vessel's operational area and onboard communication systems. In addition, vessels are required to carry Global Maritime Distress and Safety System (GMDSS) equipment in accordance with applicable international conventions and regulations to ensure effective distress, safety, and routine communications at sea. Furthermore, the IMO has developed standardized communication terminology known as the Standard Marine Communication Phrases (SMCP), which are incorporated into the requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, as amended. The implementation of SMCP aims to reduce communication barriers caused by language differences among multinational crews and vessels, thereby enhancing navigational safety and operational efficiency (Gabadava & Hu, 2025; Misztal & Hatlas-Sowinska, 2025). These measures were introduced, in part, to prevent the recurrence of maritime accidents in which communication failures played a contributing role (Hickethier & Yang, 2023; Ishak et al., 2019; Maternová et al., 2023). Notable examples include the fire aboard the passenger ferry *Scandinavian Star*, which resulted in the loss of 158 lives, and the grounding of the oil tanker *Sea Empress*, which caused significant marine pollution along the coast of Milford Haven, Wales, United Kingdom. Investigations into these incidents highlighted the importance of effective communication, adequate English language proficiency, and the use of standardized maritime communication procedures. The absence of clear and universally understood communication practices can significantly increase operational risks and adversely affect maritime safety (Grabowski et al., 2009; Gabedava & Hu, 2025; Misztal & Hatlas-Sowinska, 2025).



Figure 1. Training Ship Barombong as the Location of the Study

In recent years, Training Ship Barombong has undergone a functional transformation into a pioneer vessel (perintis vessel) in accordance with the Cooperation Agreement between the Public Service Agency (BLU) of Politeknik Pelayaran Barombong and the Directorate General of Sea Transportation, Number HK.201/1/20/DJPL/2024, concerning the utilization of the Training Ship Barombong as a public-service pioneer vessel. This initiative aims to support public maritime transportation services while optimizing the utilization and operational value of the assets owned by Politeknik Pelayaran Barombong. In 2024, the vessel was operated under the management of the Harbormaster and Port Authority Office (KSOP) Class II Ambon, serving Route R-77. Subsequently, in 2025, the vessel was assigned to the Harbormaster and Port Authority Office (KSOP) Class II Kendari to serve Route R-55, covering the voyage itinerary: Kendari – Wanci – Tomia – Binongko – Batauga – Baubau – Liana Banggai – Talaga – Sikeli – Pomalaa – Bulukumba – Pomalaa – Sikeli – Liana Banggai – Baubau – Batauga – Binongko – Tomia – Wanci – Kendari, with a total sailing distance of approximately 1,096 nautical miles. This assignment was based on the Decree of the Directorate General of Sea Transportation Number KP-DJPL.745 of 2024, dated 19 December 2024, concerning amendments to the Decree of the Directorate General of Sea Transportation Number KP-DJPL.690 of 2024 regarding the deployment of pioneer vessels for the Fiscal Year 2025. The utilization of the Training Ship Barombong as a pioneer vessel is intended to support the provision of public maritime transportation services to remote and underserved regions while enhancing the effectiveness, efficiency, and productive use of the assets belonging to Politeknik Pelayaran Barombong.

However, during the operation of Route R-55, Training Ship Barombong has encountered various challenges commonly associated with maritime operations. These include adverse weather conditions, the absence of certain meteorological detection equipment such as a weather facsimile system, the diversity in cargo types and configurations, and varying passenger characteristics. Additional operational constraints include malfunctions of several navigational instruments, limited port infrastructure—particularly the absence of adequate berthing facilities at Tomia and Binongko—and shallow navigation channels at Liana Banggai Port. Furthermore, the vessel faces challenges related to onboard communication and navigational operations.

These include incomplete communication equipment, malfunctions in MF/HF radio communication systems, and limitations in crew proficiency in operating steering systems and navigational equipment.

Field observations revealed that Training Ship Barombong experienced a grounding incident while maneuvering to berth at Pomalaa Port. The incident occurred at approximately $04^{\circ}06'890''$ S and $121^{\circ}34'856''$ E, about 300 meters from the berth, within the port approach channel. Based on the findings of the post-incident evaluation, the grounding was primarily attributed to inadequate communication between the vessel and port authorities, as well as ineffective internal communication onboard. The Master and the Officer of the Watch (OOW) failed to maintain effective coordination with the helmsman, resulting in misunderstandings and errors in decision-making during the maneuvering process. Furthermore, the lack of real-time navigational information from the port and communication breakdowns among crew members significantly contributed to the vessel's deviation from the safe navigational track, ultimately leading to the grounding in shallow waters near the port area.



Figure 2. Training Ship Barombong Grounded near Pomalaa Port, Kolaka



Figure 3. Nautical Chart Indicating the Grounding Position of Training Ship Barombong near Pomalaa Port, Kolaka

The intensity and effectiveness of communication aboard Training Ship Barombong are essential for maintaining navigational safety and operational efficiency

(Ramadhan et al., 2024; Gabedava & Hu, 2025). Optimizing communication requires the use of appropriate language skills and effective communication practices among all personnel involved in vessel operations (Gabedava & Hu, 2025; Misztal & Hatlas-Sowinska, 2025). Effective communication between vessels, as well as between vessels and coastal radio stations, is crucial to preventing incidents and maritime accidents (Hickethier & Yang, 2023; Ramadhan et al., 2024). Such communication must be supported by reliable communication equipment and by crew members who possess adequate competence in both communication techniques and the operation of communication systems (Narang et al., 2024; Ramadhan et al., 2024). On board Training Ship Barombong, communication devices such as Handy Talkies (HTs) are widely used to facilitate coordination during cargo-handling operations and during critical maneuvering activities, including berthing and unberthing operations. These devices are utilized by key shipboard personnel, including the Master, Deck Officers, Chief Engineer, Engineering Officers, Boatswain (Bosun), and Engine Foreman.

The author selected this research topic to gain a deeper understanding of communication systems and practices, particularly those implemented on board Training Ship Barombong. Through this study, it is expected that valuable insights and recommendations can be generated to support the enhancement of navigational safety, operational efficiency, and overall communication effectiveness in the operation of Training Ship Barombong.

2. LITERATURE REVIEW

2.1 Concept of Optimization

Optimization, according to various scholars, refers to the effort to achieve the best or most efficient outcome in terms of performance, benefits, or the attainment of specific objectives. In general, optimization is a process aimed at improving a system, activity, or resource utilization to achieve the highest possible level of effectiveness and efficiency.

According to Winardi (1996, p. 88), optimization is an effort to maximize activities in order to achieve the expected results or benefits effectively and efficiently. This concept emphasizes the importance of utilizing available resources in the most productive manner to attain predetermined goals while minimizing inefficiencies and operational constraints.

2.2 Concept of Communication

The meaning of communication encompasses a broad range of interpretations in everyday usage. This diversity is reflected in the various definitions proposed by communication scholars throughout history. Different experts have defined communication based on their respective academic perspectives, experiences, and areas of expertise. The term "communication" originates from the Latin word *communis*, which means common, shared, or to create togetherness. This etymological origin suggests that communication involves the process of creating mutual understanding or establishing common ground between two or more individuals. Therefore, communication cannot occur in isolation; it requires the participation of at least two

parties for the purpose of exchanging information, ideas, thoughts, or messages in order to build shared understanding and cooperation.

According to Yusuf Zainal Abidin (2013:4), in his book "Research Methods in Communication", he explains that communication is the process of transmitting information from one party to another. The communication process consists of several essential components, namely the sender, encoder, message, channel, and receiver. Similar to what was stated by Rongers and D. Lawrence Kincaid, who explained that communication is a process whereby two or more people form a community or exchange information, thereby fostering a deep understanding. From this definition, it can be understood that communication consists of the content of the message, the sender, and the receiver of the information.

Meanwhile, Edward Depari defines communication as the process of conveying ideas, expectations and messages through specific symbols that carry meaning, carried out by a sender and addressed to a receiver. From this definition, it can be understood that there are ideas, expectations and messages from the sender, intended to be understood by the receiver through a specific medium that can be used to convey the content of the message without changing its meaning.

According to Theodore Herbert, communication is a process in which knowledge is transferred from one person to another, usually with a specific purpose to deliver. This implies that communication has an even broader meaning, namely as a means of delivering knowledge possessed by one person to another, so that this knowledge can be communicated to others.

Furthermore, there is another view on communication, according to Richard L. Wiseman, who describes communication as a process involving the exchange of messages and the creation of meaning. It can be understood that communication is effective when the person receiving the message (the recipient) interprets it in precisely the same way as intended by the sender (the communicator).

There are many other definitions of communication from other experts; the author has selected those relevant to the research requirements, namely:

- a. Judy C Pearson & Paul E Melson, who state that "Communication is a process of understanding and sharing meaning."
- b. Anwar Arifin, who states that "Communication is a concept with multiple meanings. The meaning of communication can be distinguished through a social approach, in which communication generally focuses on human activities and relates to behavioural messages".
- c. Shanono and Weaver state that "Communication is a form of human interaction in which people influence each other, whether intentionally or unintentionally, and without limitation."
- d. Carl I Hovland defines communication as "a process that enables a person to convey a stimulus to change another person's behaviour."

Based on these definitions of communication provided by the experts, it can be concluded that communication has several characteristics, such as:

- a. Communication is a process of conveying information that requires a medium; it consists of a series of activities, actions, and events that occur sequentially (systematically) and are interrelated within a specific time.

- b. Communication is an intentional act with a specific purpose; that is, an activity carried out consciously with a specific purpose according to the individual's intentions.
- c. Communication requires active participation and cooperation from both the communicator (the sender of the message) and the recipient (the receiver of the message) to ensure that the information to be conveyed is received and understood.
- d. Communication is a transactional process involving two actions—giving and receiving—which must be carried out in a balanced and proportional manner.
- e. Communication is symbolical, whereby the medium of communication may take the form of specific symbols – such as Morse code, light signals or other agreed-upon forms – so that the message to be conveyed can be properly received.
- f. Communication can transcend space and time, whereby the participants need not be present at the same time and place.

2.3 Maritime Safety

Maritime safety includes accident prevention efforts and is a key factor in ensuring the smooth sailing of maritime transport, in line with Law No. 17 of 2008 on Shipping, Article 116(1): “Maritime safety and security include the safety and security of transport in waters and ports, as well as the protection of the maritime environment.”

The regulation governing maritime safety in Indonesia is Law No. 17 of 2008 on Shipping, Article 116(1), which states: “Maritime safety and security includes the safety and security of transport in waters and ports, as well as the protection of the maritime environment”, and Paragraph (2): “The implementation of maritime safety and security as referred to in Paragraph (1) shall be carried out by the Government”. The Safety Management Certificates referred to in Paragraph (1) above take the form of a Document of Compliance (DOC) for companies and a Safety Management Certificate (SMC) for ships.

Regulations in the field of safety management contain provisions that anticipate developments in the national and international strategic environment in line with advances in science and technology, whilst accommodating relevant international standards such as the International Safety Management Code (ISM Code). The system is designed to ensure effective protection against potential risks and hazards that can be predicted and anticipated as causes of accidents that should not occur in shipping operations. According to the Maritime Glossary, a shipping accident is an incident or event resulting in any of the following:

- a. The death or loss of life of a person, or serious injury to a person, caused by or related to shipping activities or the operation of a vessel; or
- b. The loss or disappearance of one or more vessels; or
- c. The grounding or incapacitation of one or more vessels, or a vessel's involvement in a collision; or
- d. Damage to property or goods caused by or related to the operation of a vessel

Ship Accidents According to Article 245 of Law No. 17 of 2008 on Shipping, “A ship accident is an incident experienced by a ship that may threaten the safety of the ship and/or human life, such as a ship sinking, a ship being on fire, a ship collision, and a ship running aground.”

There have been numerous accidents in maritime transport. Incidents typically involve sinking due to overloading, fire or explosion, or sinking due to natural factors; according to data from the Maritime Court, human error is the primary cause of maritime transport accidents. As many as 88 per cent of incidents are caused by human error on the part of those within the maritime transport system, whilst only a few are caused by natural or weather-related factors.

a. Human Error

Human error is defined as inappropriate human decisions or behaviour that reduce, or have the potential to reduce, the effectiveness, safety or performance of a system (Sanders & McCormick, 1993). Errors caused by humans have a negative impact on a company's performance. According to Meister, as cited in Eviyanti (2013), 20–50 per cent of failures occurring within a system are caused by human error. According to Meister, as cited in Soesanto (2010), human error is the probability of a person completing an activity within a specific time.

b. Natural Factors (Force Majeure)

Natural Factors (force majeure) are events or disasters arising from changes in natural conditions beyond human control, often referred to as natural disasters such as tsunamis, strong waves, earthquakes, floods, cyclones and landslides.

c. Other Factors

Accidents caused by other factors can generally be attributed to a failure to comply with the seaworthiness provisions of the International Safety Management (ISM) Code, specifically those relating to the operation of the vessel. The company or shipowner should have established procedures, plans and instructions, including key considerations for vessel operations concerning the safety of the crew, the vessel itself and maritime security.

3. METHODOLOGY

This study employs a descriptive qualitative methodology. This approach involves deep analysis of the data, drawing on the empirical data obtained. Furthermore, the study uses relevant theories as a supporting framework for understanding the phenomenon under investigation and aims to generate new theories based on the research findings (Endraswara, 2006).

The data sources for this study are:

1. Primary Data Sources

Primary data were obtained directly from the research subjects through interviews, observation, and note-taking carried out with the captain and navigation officers on the Barombong Training Ship. The author collected primary data by conducting research during the fieldwork period, observing the vessel directly, and interviewing the captain and the ship's officers involved to obtain relevant information for the subject of this study.

2. Secondary Data Sources

Secondary data was obtained from existing sources, both directly and indirectly. This included documents, journals, books, and other scientific sources relating to the research problem or capable of supporting the research findings. Secondary data was

used to enrich the understanding and analysis in this study, ensuring that the research findings are relevant and can serve as a basis for decision-making by the management of the Barombong Maritime Polytechnic.

Before conducting a more detailed analysis, the study first carried out a radio test on the VHF radio equipment onboard the Training Ship Barombong. The factors considered in this test were modulation, voice clarity, and the transmission and reception of information.

The data analysis technique employed by the researcher was the USG analysis. USG is a method for prioritising problems using a scoring technique. The USG method was implemented by examining the problems and the possibility of it getting worse.

4. DISCUSSION

This study examines how the communication system on board the Training Ship Barombong can be optimised to improve maritime safety. The Training Ship Barombong is one of the training ships owned by the Barombong Maritime Polytechnic, used to educate and train cadets in real-world maritime practice. The method employed in this study was a qualitative approach, with data collected through in-depth interviews with the captain and ship's officers who possess the authority and knowledge regarding the communication system. The analysis was conducted by examining the informants' responses, categorising the findings, and relating them to theoretical concepts and previous field studies.

Communication equipment plays a vital role in ensuring the safe and efficient operation of ships, both in terms of maritime safety and operational efficiency. Communication systems serve as the primary means of transmitting information between ships and shore-based stations, other vessels, and relevant authorities, including in emergency situations. The availability of communication equipment such as VHF radios, MF/HF radios, communication satellites, Inmarsat, and the GMDSS (Global Maritime Distress and Safety System) enables rapid and accurate coordination, particularly in reporting a vessel's position, weather conditions, and the transmission of navigational information.

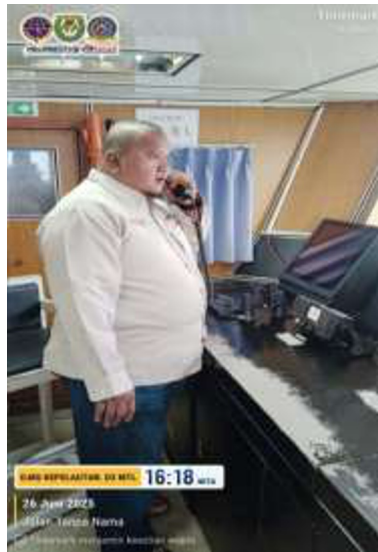


Figure 4. Testing of Communication Equipment on the Training Ship Barombong

Communication equipment also plays a vital role in the operation of navigation and safety systems, as it enables seafarers to receive early warnings and instructions from maritime authorities. Consequently, the reliability and operational readiness of a ship's communication systems are crucial aspects that not only ensure the continuity of the voyage but also guarantee the safety of the entire crew and the ship's cargo during the voyage.

"On board the Training Ship Barombong, there are currently several key communication devices available, including walkie-talkies, VHF radios, MF/HF radios, and satellite communication equipment connected via the GMDSS system. In addition, there is an AIS (Automatic Identification System), which is quite helpful in identifying other vessels in the area. Generally, these devices are available and, for the most part, in operational condition. However, I should note that some walkie-talkies are showing reduced battery life, and the VHF radio has previously experienced interference during periods of high port traffic."



Figure 5. AIS (Automatic Identification System), one of the communication devices on board the Training Ship Barombong

Based on observations carried out on board the Training Ship Barombong, it was found that the vessel is equipped with various types of communication equipment essential for maritime operations. The main equipment available includes walkie-talkies, VHF radios, MF/HF radios, and satellite communication devices integrated into the GMDSS (Global Maritime Distress and Safety System). Furthermore, the Automatic Identification System (AIS) plays a vital role in identifying other vessels in the vicinity. Although the majority of this equipment is in good working order, several technical issues have been encountered, such as reduced battery life in the walkie-talkies and signal interference on the VHF radios, particularly when operating in busy port areas with high-frequency traffic. This highlights the importance of routine maintenance and equipment upgrades to ensure smooth communication and safety. The general physical condition of the communication equipment remains in the acceptable category, particularly the GMDSS and AIS devices, which receive regular attention through regular checks. However, there are several problems with functionality that need to be considered. One of the main issues concerns the MF/HF radio, which is frequently subject to interference and high noise levels, particularly when weather conditions are poor. This affects the reliability of long-distance communication, which is the primary function of the device. Furthermore, the walkie-talkies also suffer from limited signal range, particularly when used in the lower decks of the vessel, thereby reducing the effectiveness of internal communications. Although the equipment remains operational, the captain's statement highlights the need for upgrades and technical improvements to ensure all communication devices perform optimally under various operational conditions at sea.



Figure 6. The VHF radio on board the Training Ship Barombong

Although in theory, the communication equipment on board is adequate and designed to support communication needs, including in emergency situations, the reality shows that there are limitations in practice. Experience in emergencies, such as ship groundings, shows that communication systems do not operate optimally. Coordination with port authorities is delayed due to slow responses, compounded by interference with the VHF radio, which is unable to pick up signals

Findings in the field indicate a gap between the potential of the available communication systems and actual practice on board. The ideal concept for a ship's communication system is that it should be capable of supporting all aspects of maritime operations, from navigation and safety to emergency communications. However, the reality on board the Training Ship Barombong shows that the system has not yet been optimised to its full capacity.

A study by van Westrenen and Praetorius (2020) highlighted that formal communication protocols such as closed-loop communication are used in only 15–16 per cent of ship-to-ship communication situations, even though such protocols are the ideal standard in maritime safety (Arsandi and Sitepu 2024). A similar finding was observed in research conducted on the vessel Sabuk Nusantara 78, where technical problems with equipment and a lack of proficiency in Standard Maritime Communication Phrases (SMCP) resulted in poor communication, particularly in emergency situations (Ramadhan et al. 2024). In addition to human factors, technical aspects such as the limited range of VHF-based AIS signals also become an obstacle, as explained in a study of communication systems between moving vessels and fixed stations (Narang, Pane, and Radja 2024). This research emphasises the importance of considering free-space loss, signal-to-noise ratio, and the need for alternative network models to address unreachable communication areas. Meanwhile, Alqurashi et al. (2022) emphasise that ship communication systems need to integrate various technologies—from VHF and satellite to UAVs—to ensure continuous communication under extreme conditions. Furthermore, in a controlled environment such as a training simulator, Maritime communication skills are still not optimal, indicating a significant gap between technical training and practical readiness. The situation on the Training Ship Barombong reflects a wider phenomenon: the ship's communication systems, although technically available and adequate, are not being used to their full potential due to users' limited skills, technical problems, and the poor integration of communication procedures into day-to-day shipping operations.

The grounding of the Training Ship Barombong highlights systemic weaknesses in maritime communication, which are not only caused by technical factors such as bad weather or engine failure, but also by poor communication quality and the lack of well-trained human resources. This finding is consistent with various previous studies which show that maritime accidents are often the consequence of human error and poor communication coordination. Macrae (2009), in his study *Human factors at sea: common patterns of error in groundings and collisions*, found that in many cases of ship accidents such as collisions and groundings, the primary cause of the accident was not technical but rather communication failures on the bridge, poor navigation planning, and preventable human error (Grabowski et al. 2009). Research by Misztal and Hatlas-Sowinska (2025) also emphasises that ineffective verbal communication, cross-linguistic miscommunication, and the infrequent use of Standard Maritime Communication Phrases (SMCP) often lead to misinterpretations in emergencies.

This is further proven by a study based on the Human Factors Analysis and Classification System (HFACS), which analysed ship collisions in Canada and the UK and identified decision-making errors and poor bridge management as dominant factors in maritime accidents (A F Hicketier and Yang 2023). Poor communication, crew fatigue and a lack of technical skills also contribute to the high rate of maritime accidents, with a particular focus on the relationship between fatigue, human factors and accidents in major ports (Ismila Che Ishak et al. 2019).

Furthermore, a recent 2023 study by MDPI entitled 'Human Error Analysis and Fatality Prediction in Maritime Accidents' shows that up to 70 per cent of maritime incidents are caused by human factors rather than technical faults, and emphasizes the importance of supervision, training, and the physical and mental health of ship crews (Maternová et al. 2023). Another study by Gabedava and Hu (2025) also emphasizes the vital role of linguistic analysis in improving maritime safety, finding that the use of non-standard language and miscommunication in maritime radio communications are significant causes of ship accidents.

Various relevant research findings explain that communication equipment that is not in good condition, as well as the lack of trained human resources, are crucial factors that can prevent the communication system from operating as a risk control mechanism. As in the Case Study of the Training Ship Barombong, the failure to respond to the situation properly and appropriately indicates a gap in crew coordination and response, which could in fact have been prevented if the internal communication system had functioned effectively, supported by good training and consistent management supervision. The grounding of the Barombong Training Ship cannot be seen as a simple technical incident, but as a real manifestation of a weak communication system that is not matched by the capabilities and preparation of the human operators.

Therefore, the optimisation of the communication system must be carried out comprehensively and continuously, through:

- a. The provision and replacement of equipment that is outdated.
- b. The implementation of strict communication procedures, including reporting and documentation.
- c. Ongoing training for all crew members, with an emphasis on emergency situations.
- d. Internal audits of the communication system's preparation before the ship's departure.

Furthermore, it is also aimed at developing a communication-based safety culture, in which every crew member understands that prompt, precise, and accurate communication can save lives and protect the vessel's assets. Maritime safety relies not only on the captain's expertise, but also on the collaboration and communication of the entire crew.

5. CONCLUSION

Based on the findings of the research conducted into the optimisation of the communication system to improve maritime safety on the Barombong Training Ship, it can be concluded that the communication system on board has provided appropriate equipment; however, this has not yet been fully complemented by optimal functional conditions and the maximum operational capabilities of its human resources. The

reality indicates several weaknesses and problems, whether technical, relating to human resources, or procedural. Some communication equipment suffers from issues such as signal interference, limited range, and deteriorating component quality. This results in the equipment failing to provide optimal support for maritime operations, particularly in emergency situations requiring clear and effective communication.

From a human resources perspective, not all crew members are capable of operating communication systems, particularly equipment requiring specialised skills such as GMDSS and MF/HF radios. Training in the use of such equipment has not been carried out regularly and is only incidentally provided. New crew members or cadets undertaking practical sea training have not yet acquired sufficient understanding and skills regarding emergency communication procedures, frequency allocation and the management of maritime communication traffic.

Meanwhile, from a procedural perspective, not all communication procedures are being carried out in a disciplined and consistent manner. Communication logs are not yet being completed properly and are often treated as a formality. Furthermore, there is as still no mechanism for routine evaluation or audit specifically designed to assess the effectiveness of the communication system as part of the vessel's safety management.

References

- [1] A F Hickethier, and Ching-Chiao Yang. 2023. "An Analysis of Causes Related to Human Factors in Maritime Accidents." *International Journal of Maritime Engineering* 165(A2):125–34. doi: 10.5750/ijme.v165iA2.1193.
- [2] Albrecht, G. 2015. Ship handling under adverse weather conditions. *Journal of Navigation*, 68(4), 601-617. <https://doi.org/10.1017/S037346331500070>
- [3] Arief, R. A. P. (2020). Analisis Olah Gerak Kapal ketika Cuaca Buruk saat memasuki Perairan Sungai Barito di SPB Lebam. Politeknik Ilmu Pelayaran Semarang. Arikunto, S. (2013). *Prosedur Penelitian Suatu Pendekatan Praktik*. Edisi Revisi. Jakarta: PT. Rineka Cipta.
- [4] Arikunto, Suharsimi. 2019. *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta.
- [5] Arsandi, Fauzan, and Andi Husni Sitepu. 2024. "Desain Safety and Fire Control Plan Dan Perancangan Escape Route Pada Kapal Latih Barombong." *Jurnal Riset & Teknologi Terapan Kemaritiman* 3(2):55–69. doi: 10.25042/jrt2k.122024.02.
- [6] Gabedava, George, and Yanming Hu. 2025. "Enhancing Maritime Safety through Linguistic Analysis: A Case Study of Communication Failures in Maritime Accidents." *WMU Journal of Maritime Affairs*. doi: 10.1007/s13437-025-00371-y.
- [7] Grabowski, Martha, Zhuyu You, Zhi Zhou, Huawei Song, Michael Steward, and Brittany Steward. 2009. "Human and Organizational Error Data Challenges in Complex, Large-Scale Systems." *Safety Science* 47(8):1185–94. doi: 10.1016/j.ssci.2009.01.008.
- [8] Ismila Che Ishak, Mohamad Fitri Azlan, Shaiful Bakri Ismail, and Norhayati Mohd Zainee. 2019. "A study of human error factors on maritime accident rates in maritime industry." *Asian Academy of Management Journal* 24(Supp. 2):17–32. doi: 10.21315/aamj2019.24.s2.2.

- [9] Maternová, Andrea, Matúš Materna, Andrej Dávid, Adam Török, and Lucia Švábová. 2023. "Human Error Analysis and Fatality Prediction in Maritime Accidents." *Journal of Marine Science and Engineering* 11(12):2287. doi: 10.3390/jmse11122287.
- [10] Misztal, Leszek, and Paulina Hatlas-Sowinska. 2025. "The Impact of the Human Factor on Communication During a Collision Situation in Maritime Navigation." *Applied Sciences* 15(5):2797. doi: 10.3390/app15052797.
- [11] Narang, Nur Hijriah Zubaedah, Betharia Pane, and Abdi Kurniawan Radja. 2024. "Analisis Sistem Komunikasi Antara Stasiun Tetap Dan Kapal Laut Yang Bergerak Menggunakan Automatic Identification System (AIS) Berbasis Kanal Very High Frequency (VHF)." *Jurnal SPEKTRO* 7(2).
- [12] Purwantomo, Agus Hadi. 2019. *Kumpulan Soal Jawab Teknik Pengendalian & Olah Gerak Kapal*. PIP Semarang
- [13] Ramadhan, Rizky Bahtiar, Dwi Haryanto, Lilik Yulianingsih, and I. Komang Hedi Pramana Adiputra. 2024. "Peran penting komunikasi kapal dalam keselamatan pelayaran: identifikasi kendala dan rekomendasi perbaikan." *JPB : Jurnal Patria Bahari* 4(1):36–40. doi: 10.54017/jpb.v4i1.123.
- [14] Tim Penyusun Politeknik Pelayaran Barombong (2021). *Olah Gerak dan Pengendalian Kapal*. Makassar
- [15] <https://bif.telkomuniversity.ac.id/era-baru-konektivitas-internet-apa-itu-starlink/>
- [16] <https://ilmukomunikasi.uma.ac.id/2021/12/28/media-komunikasi-modern/>

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