SOLVING MARITIME COMMUNICATION CHALLENGES WITH DIGIMAR: A PRACTICAL APPROACH

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Keywords

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Abstract

The European Maritime Safety Agency uses a systematic approach to analyse safety investigations conducted through the European Marine Casualty Information Platform. In analysing the data of accidents reported over the last ten years, nine overarching safety issues have been identified, with "working methods" being a key concern. Two of the areas identified as problematic under this safety issue are bridge resource management coordination and external communication, which are critical areas as communication between bridge team members and ship-to-ship or ship-to-shore communication issues can lead to collisions and groundings. Language barriers, misunderstandings, and ambiguities may contribute to communication failures with pilots, tugboats, and VTS. Based on qualitative analysis of selected marine accidents, this paper presents the problem of poor communication between bridge team members, with pilots, shore services, and others. In response to the challenge of communication at sea, a current Erasmus+ project DigiMar, which deals specifically with maritime communication, is also presented. The project aims to improve communication skills and safety in shipping through a freely accessible digital teaching tool for routine communication at sea. Using open-access, research-based, and ICT-supported teaching tools, the project will focus on self-directed teaching using instructional videos and chatbots that address routine communication at sea. The learner-centred approach will simulate authentic professional situations and move from simple to complex scenarios. The project also aims to develop the digital skills of different target groups, including university teachers, and thus promote lifelong learning in higher education.

1 INTRODUCTION

Understanding human error and its impact on ship management is a key factor in preventing or reducing accidents in the shipping industry. Manoeuvring through unpredictable waters requires precision, cooperation, and unwavering focus on the part of navigators. The core of cooperation is communication between all parties involved, be it between bridge team members, in communication with other vessels or with shore services. The principles of Bridge Resource Management (BRM) play an important role here. They emphasize the need to create a shared mental model among team members to ensure safe navigation. One of the key points of BRM is the constant exchange of information, which can take place through methods such as "closed-loop communication" and "thinking aloud", which allow all members to participate in the communication and share the same view of the situation. The "challenge and response" method is particularly important to encourage open communication and address safety concerns without fear of retaliation (ICS, 2022). Other important points related to communication include routine briefings and debriefings to ensure that communication and coordination within the team is improved, especially during critical operations or emergency situations. Communication between bridge and engine room teams must also be maintained for regular exchange of information about engine condition, speed settings, and so forth.

Effective communication also depends on clarity and simplicity. Using simple terminology that can be understood by all team members and other surrounding vessels is crucial. By using clear language, bridge teams – in coordination with pilots, shore services, and other vessels involved in communication – can promote mutual understanding and simplify communication channels, which increases efficiency and reduces the risk of errors due to misunderstandings. Whether dealing with routine manoeuvres or unforeseen challenges, standardized procedures provide all stakeholders with the necessary protocols for effective communication and quick, informed decision making. This is especially important for seafarers where English is often the lingua franca. Here, the Standard Marine Communication Phrases (SMCP) serve as standardized phrases used in maritime communication to ensure clarity and efficiency. These phrases, defined in 2001 by the International Maritime Organization (IMO), cover various aspects of maritime communication, including navigation, safety, distress calls, and manoeuvring.

The literature surrounding maritime communication and language proficiency skills for seafarers reveals various factors impacting communication effectiveness and safety outcomes. Ahmmed (2020) underscores the significance of communicative competence, emphasizing the importance of radio communication over VHF and with Vessel Traffic Services (VTS) for on-board jobs. This aligns with findings by Hatlas-Sowinska (2022), who highlights the repercussions of ineffective VHF voice communication in collision situations at sea. They propose an ontology-based approach to enhance communication clarity and avoid misunderstandings. Moreover, Costa et al. (2018) discuss the role of non-technical communication factors in VTS. They stress the importance of closed-loop feedback communication models and the use of SMCP to ensure accuracy and reliability of information exchange. The study also reveals the impact of language proficiency on judgments made by VTS operators regarding vessels' navigational behaviour. Øvergård et al. (2015) highlight the link between communication, situational awareness, and team performance in navigational teamwork. They identify communication errors as a leading cause of marine accidents, stressing the need for effective information exchange to maintain situational awareness and enhance decision-making abilities. In addition, John et al. (2013) and Nævestad et al. (2023) explore the safety implications of communication difficulties in mixed nationality crews and the importance of standardized communication protocols outlined by the IMO. Language and cultural differences were identified as another potential source of misunderstandings, emphasizing the need for improved language skills and adherence to communication standards to enhance maritime safety. Boström (2020) further investigates the gap between ship-to-ship communication and intended communication protocols in icebreaker operations, emphasizing the necessity for precise and unambiguous language use. The study underscores the role of closed-loop communication in mitigating communication errors and maintaining situational awareness in this highly specific shipping context. Last but not least, Jurkovič (2022) analyses routine ship-shore communication in the Northern Adriatic Sea area, focusing on adherence to international communication standards. The study suggests that communication efficiency relies more heavily on topic predictability rather than on strict adherence to communication protocols.

1.1 DigiMar project

In order to meet the challenges of communication in the maritime sector, the EU project DigiMar (https://digimar.si/; 2023–2026) aims to improve communication through education and training in maritime communication processes. The main objective of the Erasmus+ DigiMar initiative, which will run for three years under the code 2023-1-SI01-KA220-HED-000151704, is to increase the safety of maritime navigation. This objective is based on an anticipated improvement in the communication skills of shore-based personnel and higher education students after the implementation of a digital education pilot study. Overall, the project aims to refine maritime communication skills and thus increase the safety of navigation. This objective is pursued by providing a digital teaching tool that combines research findings and information-communication technology (ICT). This tool will be designed for the self-directed education and training of students at maritime universities as well as for the continuous professional development of shore-based service providers, seafarers, and other stakeholders in the maritime sector.

The project consists of a consortium of 10 partners and is a collaboration between five higher education institutions (HEIs) and five maritime safety authorities (MSAs). These partners are spread across two different geographical regions – the Adriatic Sea and Scandinavia – each characterized by unique maritime dynamics. This diversity promotes the scalability of the project and allows the results to be extrapolated to a global level. In addition, the partnership between HEIs and MSAs serves as a conduit for the direct application of research results in education, training, and operations. The collaborative approach ensures that the project results are tailored to the specific needs of the identified target groups, ensuring their relevance and quality.

The project is divided into five different work packages (WPs), namely Project Management (WP1), Development of Maritime Communication Standards and Data-based Content (WP2), Development, Deployment and Evaluation of Digital Teaching Tools (WP3), Maritime Communication Standards and Data-based Benchmarking (WP4), and Exploitation and Dissemination (WP5). In order to understand the extent and manner in which inadequate communication may play a role in the occurrence of marine accidents, a detailed analysis of selected marine accidents was produced as part of WP2, and is presented in the following section.

The main objective of this paper is to examine whether maritime communication may play a direct or an indirect role in marine casualties or incidents at sea. It is divided into five sections, which include an introduction to the topic, the methodology adopted for the analysis, and the results of the analysed investigation reports. The paper ends with the concluding remarks with special focus placed on the benefits of the DigiMar's digital educational tools, and a list of references.

2 METHODOLOGY

The methodology used in this study comprises two main approaches:

- A systematic literature review was conducted to collect relevant sources on maritime communication, navigational safety, and related factors. Academic databases, journals, and other scientific sources were searched to fully understand the topic.
- The survey of cases in marine accident reports was conducted in two steps as part of WP2.2. of the Erasmus+ DigiMar project:
    - Step 1: The HEIs analysed marine casualties and incidents by examining published reports in available databases to identify cases where maritime communication played a direct or an indirect role in casualties or incidents at sea.
    - Step 2: The MSAs checked the consistency of the findings and conclusions of the reports using checklists to ensure 100% accuracy.

Furthermore, a comprehensive examination of specific cases was conducted to categorise communication errors and disorders using the Human Factors Analysis and Classification System (HFACS). This system is used extensively to study and understand human errors in complicated systems, such as aviation, healthcare, and transport. Human factors are divided into four categories, namely unsafe acts, preconditions for unsafe acts, unsafe supervision, and organisational influences. This categorization helps to identify the underlying causes and systemic problems that contribute to causalities or incidents (Wiegmann et al., 2003).

The accident data were extracted from various databases available on the investigators' websites:

- Australian Transport Safety Bureau (www.atsb.gov.au)
- Japan Transport Safety Board (www.mlit.go.jp/jtsb/shipmenu_en.html)
- Marine Accident Investigation Branch UK (www.gov.uk/government/organisations/marine-accident-investigation-branch)
- The Bahamas Maritime Authority (www.bahamasmaritime.com/published-investigation-reports)
- National Transportation Safety Board US (www.ntsb.gov/Pages/home.aspx)
- Norwegian Safety Investigation Authority (www.nsia.no/Marine/Published-reports)
- Safety Investigation Authority Finland (www.turvallisuustutkinta.fi/en/index.html)
- Swedish Accident Investigation Authority (www.havkom.se)
- Transportation Safety Board of Canada (www.tsb.gc.ca)
- Dutch Safety Board (www.onderzoeksraad.nl/en/)
- Transport Accident and Incident Investigation Bureau of the Republic of Latvia (www.taiib.gov.lv/en)

The selection was primarily based on freely accessible databases containing accident reports in English. The analysis was limited to reports of accidents that occurred between 2013 and 2023, but was not restricted to the type of accident, as communication problems can occur in all areas of maritime transport. A two-step process was used to analyse the data. First, databases of investigation reports were searched for indications of the type of communication problem, such as misunderstanding, mispronunciation, lack of information, lack of communication, poor English, noncompliance with SMCP, etc. In a second step, the selected accidents were analysed in more detail with regard to communication deficits and errors. Based on HFACS, the reports were searched for active and latent human factor errors in maritime communication which generally belong to the causal category "preconditions for unsafe acts – personnel factors" (Chauvin, 2013; Yildiz, 2021; Youssef, 2023). An important aspect here is poor communication, both within the ship's bridge as well as in their communication with pilots and other shore personnel. This category also includes situations where there is a lack of cooperation between crew members or where those directly supervising operations do not sufficiently coordinate crew member activities.

3 RESULTS AND DISCUSSION

The overall aim of the DigiMar Erasmus+ project is to measure statistically significant differences in the communication skills of shore service operators and higher education students before and after conducting a digital pilot study through the use of digital educational tools developed by the project consortium. WP2 of the project focuses specifically on defining regulatory frameworks, building databases of authentic maritime communication, and developing educational content. Through a partnership of various HEIs and MSAs, WP2 aims to create standard protocols, analyse communication standards and inventory communication incompliances, and create simulation tasks. One of the outcomes of WP2 is to analyse cases in maritime accident databases where inadequate maritime communication has contributed to casualties and incidents at sea.

A total of 1034 accidents were considered, of which 44 were identified as having communication problems as a primary or secondary cause. The majority of these accidents were collisions between vessels or contacts between vessels and piers, the other most common accident types or navigation situations were groundings, while near misses[1] and other marine accident types accounted for a smaller proportion (Fig. 1). A quarter of the

[1] Near-miss cases were also analyzed, as a near-miss is defined as a sequence of events and/or conditions that could lead to a loss. Source: MSC-MEPC.7/Circular.7 – Guidance on Near-Miss Reporting – (10 October 2008).

accidents investigated were caused by communication errors, while in the remaining accidents communication deficiencies contributed to the severity of the accident's consequences.

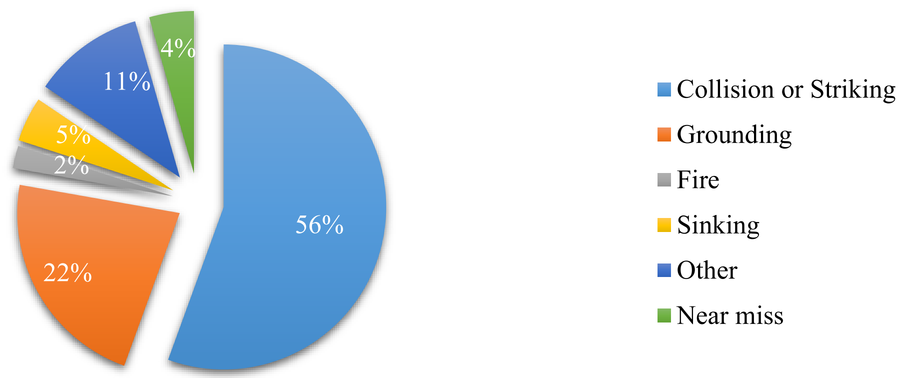

Fig. 1 Type of accident/navigational situation

As far as the consequences of the analysed accidents are concerned, damage to the ship's structure was found in the majority of cases (38 cases), while human loss was found to be a consequence of five accidents. One accident resulted in marine pollution and in two cases no consequences were identified as they were near-misses (Fig. 2).

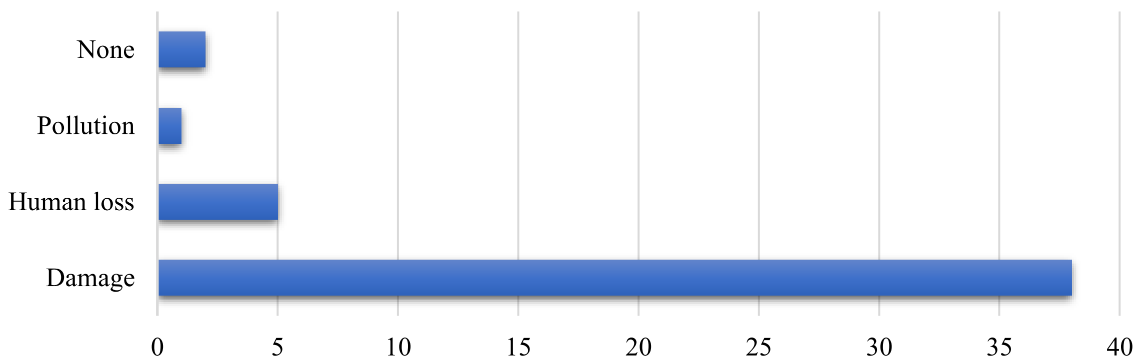

Fig. 2 Consequences of accidents

70 ships were involved in the analysed accidents, 60% of which were cargo ships such as bulk carriers and car carriers, 14% were tankers, 6% passenger ships, and the rest fishing vessels, tugboats, and other service vessels (Fig. 3).

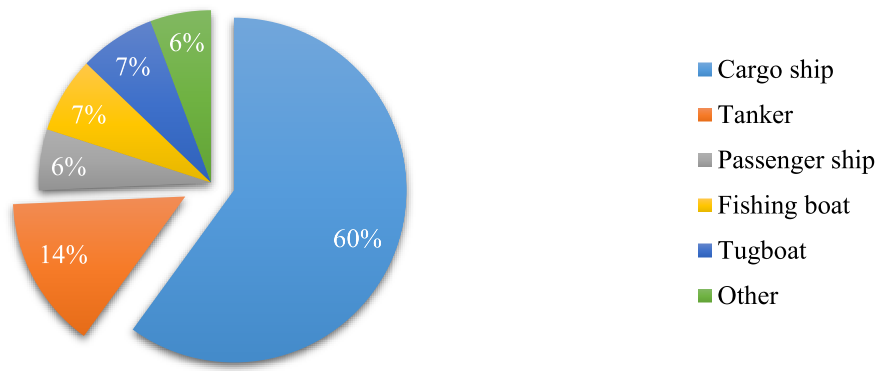

Fig. 3 Type of vessels involved in the analysed accidents

Unsafe acts were found in 88% of all cases investigated, primarily due to errors by frontline operators such as pilots, masters, or officers of the watch (OOWs). A more thorough investigation revealed deficiencies in the implementation of BRM. It is crucial to maintain situational awareness through effective cooperation and communication between bridge team members, especially in narrow waters or dense traffic. Insufficient situational awareness was identified in 31 cases, mainly due to inadequate communication on the bridge, while insufficient monitoring of the performance of other crew members is another significant factor, as shown in Fig. 4. It illustrates that in most cases insufficient communication between the two main actors during navigation (master and pilot) contributed to the lack of situational awareness and, consequently, to the events that influenced the course of the accident.

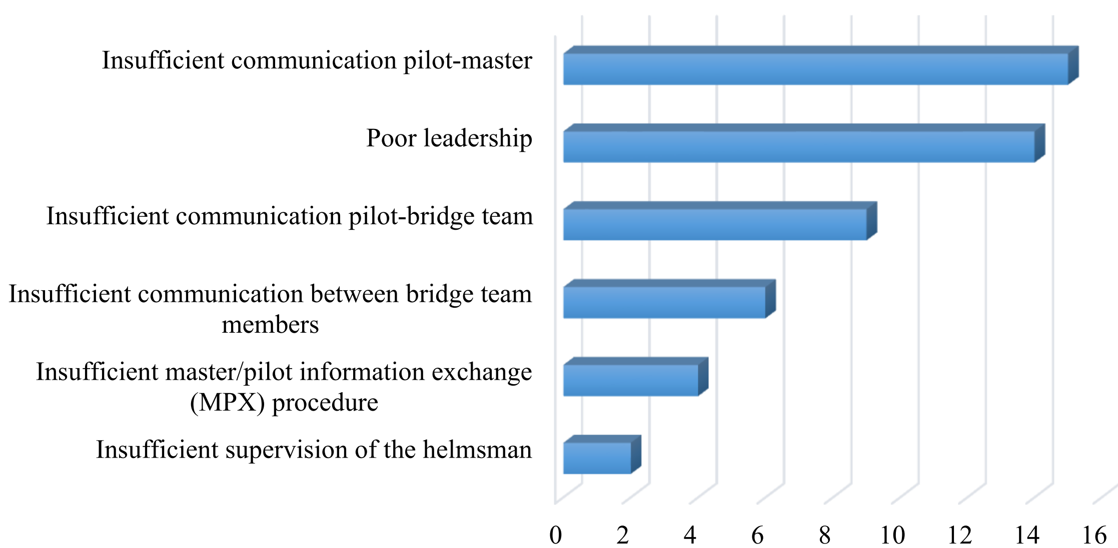

Fig. 4 Observed BRM errors in the analysed cases

During navigation with a pilot, it is essential to maintain full situational awareness through regular information exchange. This ensures that all members of the bridge team are aware of the pilot's actions and can provide assistance or timely advice. BRM involves managing and utilizing all available resources, both human and technical, to ensure the safe completion of the voyage. Central to BRM is effective communication on the bridge, facilitating the development of a common understanding, or shared mental model, among bridge team members regarding the execution of individual tasks and the progression of the voyage as a whole (ICS, 2022).

In almost 40% of accident cases, a lack of a shared mental model was detected. For BRM to work effectively, the continuous exchange and updating of information and intentions between bridge team members is essential throughout the voyage. Critical to this process is seamless communication during the master-pilot exchange (MPX), where the master and pilot work together to establish procedures, plans, manoeuvres, and contingencies prior to departure. This exchange should continue among the bridge team throughout the voyage to ensure the continuous exchange of navigational information. Instances where communication breakdowns occurred resulted in team members not properly understanding the developing situations, as was evident in four specific cases.

Using a common language on board is of paramount importance, as misinterpretation or misunderstanding of information can lead to wrong decisions. In 2014, the Transportation Safety Board (TSB) of Canada conducted an online survey of pilots that reflected pilots' ongoing concerns about language barriers on foreign-registered vessels. The results showed that 49% of pilots experienced occasional communication difficulties with helmsmen due to language barriers, while 15% reported frequent difficulties. Similarly, 54% of pilots noted occasional barriers to effective communication with masters and officers on watch (OOW), while 17% encountered frequent barriers. These findings underline the ongoing impact of language barriers on maritime communication and highlight the need for continued efforts to address language-related challenges in the industry (TSB, 2017).

In the current analysis, the use of English as the working language was observed among bridge team members or among ships communicating with each other (or with VTS) via VHF. The results indicate that language barriers were found in more than 60% of all analysed cases. The most frequently observed problems related to the use of English were (Fig. 5):

- In 34% of the accidents investigated, inadequate English language skills or inadequate understanding of English were cited as a contributory factor. The main problem was a language barrier between the bridge crew and pilot, which led to communication breakdowns and consequently ineffective use of bridge resources at critical moments during the voyage. The situation was exacerbated by the crew's poor command of English, which inevitably hindered effective communication on board.
- The use of the local language, which was not understood by the master or the bridge team, was another common reason that influenced the development of the accident (34%). Communication between the pilot and the tugboat or other pilots often takes place in the local language, which is usually not understood by the crew of the foreign vessel. If the pilot does not exchange information with the master or the OOW in the relevant language, there may be a lack of a shared mental model between the team members.
- Two other common occurrences, albeit in smaller numbers, were the use of a language on the bridge that the pilot did not understand and which impaired his situational awareness, and the use of a working language on board that another crew member did not understand (a common occurrence on ships with a crew of different nationalities).

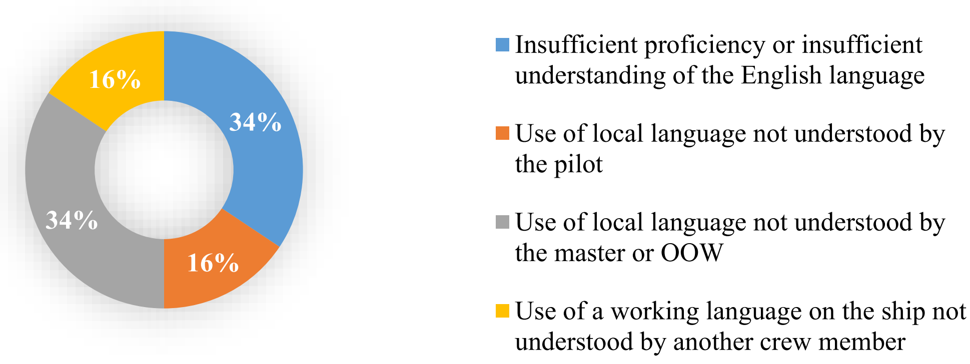

Fig. 5 Language-related problems

The communication between ships and shore stations was also observed. In 11 cases, VTS was involved in the communication, in three cases the communication between the vessel and the VTS was considered inadequate, which influenced the course of the accident, and in eight cases the VTS did not intervene in the communication although it could or should have done so.

It was also observed that in a few cases the VTS was not involved because the communication did not occur on the channels monitored by the VTS as the pilots discussed their manoeuvres via cell phones or other VHF channels.

The role of VTS in maritime communication is both important and limited. According to Costa (2018), once vessels have agreed on a manoeuvre, the influence of VTS is limited. VTS operators are careful when giving advice so that it is not misunderstood as an instruction as they may be held responsible in the event of casualty or incident. However, they can intervene to regulate the traffic situation if necessary to ensure compliance with safety regulations.

All in all, there are many factors that influence the course of events, and in the end, it is not one person who made the mistake, even if it may seem so at first glance. Instead, each mistake is the result of an activity where one wrong decision leads to another, which in turn leads to consequences of greater magnitude.

4 CONCLUSIONS

The main objective of this paper was to examine whether maritime communication may play a direct or indirect role in casualties or incidents at sea. It was clearly shown that communication plays an important role in maritime accidents, be it in the lack of a common language or the lack of communication in general between the parties involved. These communication problems can be addressed through further training and professional development of shore service operators and higher education students through self-directed digital education.

Therefore, WP3 of the Erasmus+ DigiMar project titled Digital Educational Tool Development, Deployment, and Evaluation (August 2024 – May 2025) in the context of maritime routine communication is intended to make an important contribution to the overarching goal of improving navigational safety. This is to be achieved by comprehensively improving the maritime communication skills of both shore-based personnel and higher education students.

The objectives of this WP include in particular the development, use, testing, and evaluation of instructional videos and communication chatbots for routine maritime communication. Through the involvement of stakeholders such as shore service operators, students, and the wider maritime community, the effectiveness of these tools will be evaluated. The key outcomes of this WP are:

1. The creation of freely accessible instructional videos focused on routine maritime communication protocols.
2. The development of freely accessible speech recognition chatbots for routine maritime communication scenarios.
3. Implementation and evaluation of a pilot study on digital education using the educational videos and chatbots.

Both qualitative and quantitative indicators will be used to measure the achievement of these goals and the quality of the results. These include metrics such as the number of educational videos developed, the level of satisfaction of those involved in the study, and scale of participation in the pilot study. Overall, the results of this WP are expected to have broad-reaching benefits for the maritime industry and beyond by enabling improved communication practices and consequently navigation safety.

In conclusion, effective communication is the cornerstone of successful crew resource management. Through clear and concise language, standardized procedures, cohesive communication, pre- and post-sailing briefings, checklists, effective listening, clear role allocation, cultural awareness, use of technology, and continuous training, bridge teams can optimize their communication practices and improve operational efficiency. In the dynamic and demanding maritime environment, effective communication is not just a skill but a strategic imperative that underpins safety, efficiency, and success at sea.

Continuous training and professional development are essential to improve the communication skills not only of bridge teams, but of all those involved in maritime transportation. Ongoing training programs provide the opportunity to refine communication techniques, learn new protocols and keep up to date with industry best practices. By investing in ongoing training, one can cultivate a culture of excellence and continuous improvement. Training fosters confidence, competence, and cohesion within teams, enabling them to tackle challenges with agility and competence, which is also the main goal of the DigiMar Erasmus+ project.

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