Implementing Safety Culture through Onboard Ship Simulation in Maritime Education & Training

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Abstract. This paper explores the implementation of safety culture in maritime education through the introduction of life simulation aboard ships, as practiced at Politeknik Ilmu Pelayaran. The initiative addresses the significant contribution of human er-ror to maritime accidents, advocating for an innovative educational approach that incorporates real-world safety practices from the maritime industry. By simulat-ing life onboard a ship, this approach seeks to instill a safety-first mindset among maritime students from the outset of their training. The study examines the inte-gration of international standards such as SOLAS, ISM, ISPS, and STCW into the educational framework, highlighting the potential of such simulations to en-hance the competencies of future seafarers. The findings suggest that the simula-tion program not only improves students' practical skills but also fosters a deeper understanding of safety protocols, which are crucial in minimizing accidents at sea.

Keywords: Maritime Education and Training, Boarding School, STCW.

1 Introduction

Maritime Education & Training (MET) in Indonesia is overseen by the Ministry of Transportation and is recognized by the International Maritime Organization (IMO). It focuses on vocational education aimed at producing competent sailors, as life at sea differs greatly from land-based occupations. The curriculum is based on the STCW (Standard Training & Certification of Watchkeeping) and Model Courses, emphasizing the development of knowledge, understanding, and proficiency in areas like navigation and ship engineering. The goal is to ensure that graduates possess the qualifications needed to effectively handle maritime incidents or accidents, highlight-ing the importance of proper education and training to meet industry needs and en-hance safety at sea [1,2].

All Maritime Education and Training (MET) institutions in Indonesia implement onboard ship life simulations to better align with industry requirements. These simulations are conducted systematically by cadets and officers at the institution after regular learning hours, continuing into the night until the next teaching session begins. This daily practice is carried out while cadets live in dormitories, ensuring continuous engagement. The simulations aim to familiarize cadets with industry standards related to

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maritime safety and security, promoting early internalization of regulations and best practices. By adopting these industry standards, MET institutions help cadets prepare for life on commercial ships nationally and internationally, fostering a safety culture crucial for preventing maritime accidents.

2 Literature Review

According to the European Maritime and Safety Agency (EMSA), 58% of ship accidents were caused by human error in 2011-2017 [3]. This finding aligns with the Na-tional Transportation Safety Committee (KNKT) summary, which identifies human error (ship operators) as the primary cause of ship accidents. According to KNKT, human error contributed to 46.7% of all ship accidents in Indonesia between 2017 and 2023 [4]. Many studies confirm that human error is a significant factor in maritime accidents, with varying contributions ranging from 75% to 96% since 1999. These studies highlight the crucial role of human factors in ship incidents, underscoring the need for enhanced training, better procedures, and safety measures to reduce accidents caused by human mistakes [5,6,7,8,9,10,11,12] It can be concluded that there is a need for a new breakthrough program that emphasizes safety and security culture, integrating various industry standards and procedures such as SOLAS (Safety of Life at Sea), STCW (Standard of Training, Certification, and Watchkeeping), ISPS (International Ship & Port Facility Security), and MLC (Maritime Labor & Compliance). By implementing these standards from an early stage in maritime education and training (MET), it is hoped that maritime accidents caused by human error can be significantly reduced.

In the event of an accident due to a collision, one of the key human elements in-volved on board the ship is the master, along with the navigational officer of the watch. These watch officers are the first and last line of defense in preventing collisions at sea, which is why their competence and decision-making skills are critical in such situations. Their ability to respond effectively and apply their knowledge of maritime navigation and safety is essential to avoiding accidents and ensuring the safety of the vessel and crew. As explained by [14], there is a direct relationship be-tween the effectiveness, safety, and pollution prevention of a ship in the maritime industry and the competence of its sailors. This highlights the importance of continuously developing the skills and expertise of seafarers, particularly in cultivating a safety culture. Competent sailors play a crucial role in ensuring that ships operate efficiently and safely, while minimizing environmental impact. Therefore, investing in the professional growth of seafarers is essential for the long-term sustainability of the maritime industry.

Safety culture in the shipping industry has evolved significantly over the past century, particularly following major maritime disasters. The sinking of the Titanic led to the establishment of SOLAS (Safety of Life at Sea), while the sinking of the Herald of Free Enterprise ferry prompted the creation of the ISM (International Safety Management) Code. These tragic events serve as stark reminders of the critical need for rigorous safety measures. The question that arises from these incidents is: why do accidents often have to happen before we take action? This underscores the importance of proactive safety measures, emphasizing the need for continuous improvement in safety culture to prevent future disasters.

Safety culture in the maritime industry can be viewed from various perspectives [15]. However, on ships, the organizational structure tends to be hierarchical, a tradition passed down through generations. This hierarchy is reinforced by fixed procedures, such as muster lists, that outline the responsibilities of crew members during emergencies. Each crew member is assigned specific tasks that must be performed in such situations. As a result, the responsibility for safety often rests solely with the captain and officers, who must ensure that safety measures are effectively implemented and that the ship's management interacts seamlessly with the shore-based organization [16]. This emphasizes the critical role of leadership in maintaining a strong safety culture on board.

To bridge this gap, the STCW (Standards of Training, Certification, and Watch-keeping for Seafarers) and the International Safety Management (ISM) Code be-came key instruments for recognizing human factors as an essential aspect of safety culture [17,18]. However, the success or failure of these instruments is still debated [1], due to challenges like their limited application globally [17] and the absence of specific regulations addressing critical human factors [1,2]. The STCW Convention, while comprehensive in its focus on technical competence, offers only limited provisions concerning social and human competence [1,2]. The ISM Code, implemented since the 1990s, is acknowledged to have moved the industry in the right direction [19], although its effectiveness is perceived to be medium-term at best.

Despite safety culture having roots and development within the maritime industry, there are still significant obstacles in safety management [20]. One key issue is the gap between the hierarchical leadership structure and the more democratic or laissez-faire leadership styles desired by many individuals. This gap can lead to problems such as a lack of two-way communication, insufficient empathy, resistance to criticism, and a lack of motivation, social skills, and collaboration within teams. These issues hinder the effectiveness of safety culture on board ships and in the broader maritime industry.

Implementing a safety culture is akin to orchestrating a symphony, where all elements and roles in shipping must work in harmony, following the conductor's guidance [21,22,23]. This requires instilling the right mindset and behavior [17,18], which in turn will allow safety culture instruments to effectively shape and enforce safety standards. As [24] affirms, technological advancements alone do not automatically make operators more efficient; company policies and established procedures must align with these advancements to achieve meaningful results. The operation of a ship is highly complex, with numerous regulations, instructions, and guidelines. This makes it critical for officers and crew to fully understand and adhere to these provisions. When these factors are neglected, accidents become more likely, as seen in tragic incidents like the Costa Concordia disaster in Italy and the MV Sewol ferry accident in South Korea, which claimed 304 lives in 2014.

A safety culture can be effectively established through written instructions, but ultimately, it comes down to whether the organization shares a unified mindset. Management, both ashore and onboard, must ensure that formal skills are not only implemented but also foster the right attitudes to achieve safety goals. It's essential for management to inspire and encourage the behaviors necessary to maintain safety. Research on safety culture onboard ships, such as the study conducted by Hjorth in 2013 on ships in the Baltic Sea, highlights the challenges in implementing a safety culture that truly reflects the realities of shipping. The safety culture aboard a ship is influenced not only by the crew but also by the surrounding systems and structures.

This underscores the close relationship between the development of behavior and attitudes in maritime training institutions and the use of appropriate and ideal methods, content, and processes [25]. It also emphasizes the importance of continued collaboration with the maritime industry to address all aspects of human factors. Success in improving safety culture and preventing accidents will not be achieved unless it is pursued through the behavioral and psychological dimensions, which are crucial for shaping the right mindset and attitudes [24].

3 Method

The study uses a case study approach to examine the implementation of onboard ship simulation at Politeknik Ilmu Pelayaran. The simulation program is designed to replicate real-world conditions aboard a merchant vessel, integrating key industry standards such as SOLAS, ISM, ISPS, and STCW. This approach aims to ensure that cadets are adequately trained in safety, security, and operational procedures, preparing them for real-life scenarios in the maritime industry. The methodology involves the following steps:

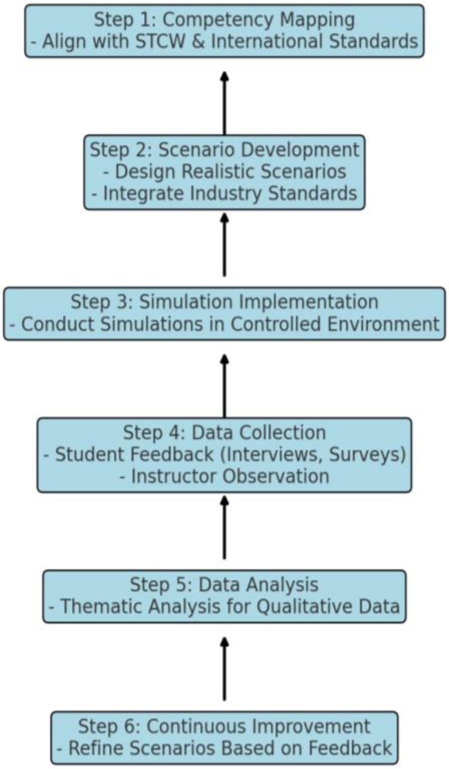

Fig. 1. Research Flow.

In the competency mapping, we analyze safety and security culture in the core curriculum based on the STCW Convention Manila Amendments, specifically Code A, Table A-II/1 for navigation expertise (Function III), and Table A-III/1 for ship engineering expertise (Function IV), both at the operational level. Key points include ensuring the correct use of appropriate safety and protective equipment, adherence to procedures and safe working practices to protect personnel and the ship, observance of environmental protection procedures, and the proper initial and follow-up actions when an emergency arises, all in accordance with established emergency response protocols. Before we develop and implement the simulation, we create a structure as follow:

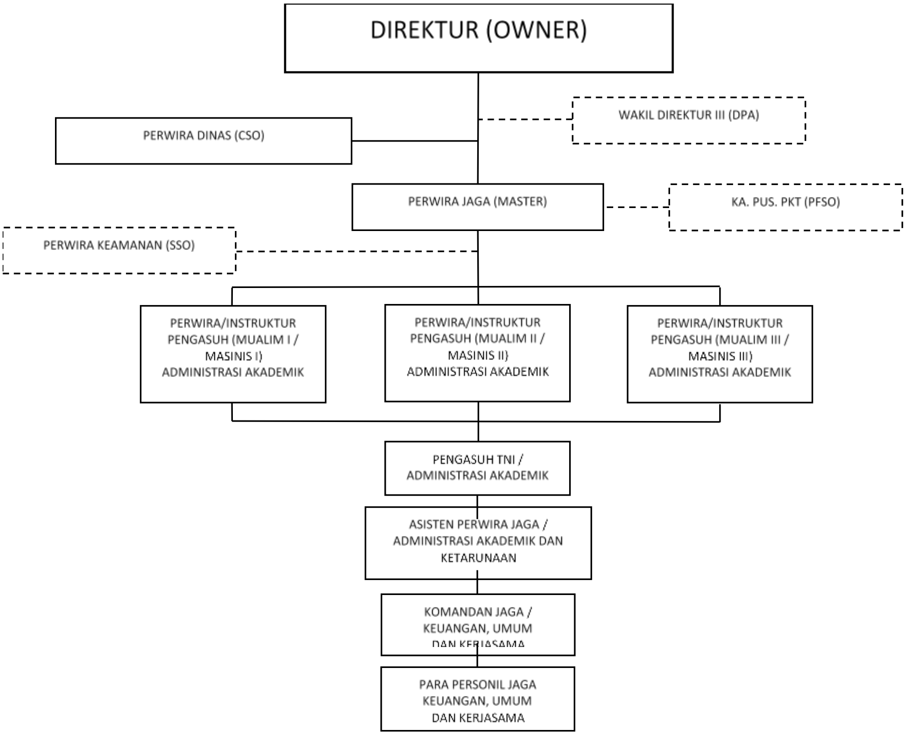

Fig. 2. Onboard simulation structure.

After that we develop scenario in this case we took an example also from the STCW where in the Chapter VIII of STCW consists of:

Fitness for Duty (Fitness in carrying out guard duty). Rest periods must be implemented according to MLC regulations. The maximum duration for guard duty is 14 hours per day or 72 hours per week, while the minimum rest period is 10 hours per day or 77 hours per week. Additionally, rest time should not be divided into more than two periods, with at least 6 hours of rest provided consecutively in one of those periods.

The master must ensure compliance with these MLC regulations by guaran-teeing that all crew members are well-rested and maintain peak fitness to perform their duties effectively.

Look-Out (Observation). In carrying out good guard duty, the onboard simulation also applies the rules in Collision Regulation (COLREG), namely Rule 5 Observation with the principles of guard duty, including:

1. An observer must be fully capable of carrying out their duties to monitor the surroundings. There should be no other side duties or distractions that could interfere with their responsibilities as an observer while on guard duty;

2. Maintain continuous vigilance with sight and hearing and also with other available tools

Watch Arrangement (watch service arrangements). Arrangements for guard duty are carried out based on the competency of the cadets carrying out guard duty and if sufficient personnel are required, these include:

1. Guard personnel are occupied by cadets majoring in Nautical and Engineering in one guard post;
2. The guard personnel on duty as Assistant Guard Officers are one of the cadet regiment staff who are assigned full day to carry out the role as assistant watch officers;
3. The officer on duty is an officer who carries out the role of captain;
4. Guard personnel with Marine Transportation Management qualifications are assigned the task of being SSB radio operators. They maintain constant communication with training ships and perform checks using checklists related to sea transportation management. This includes verifying the completeness of boarding procedures and ensuring all necessary documents for the training ships are in order;
5. Guard officers, or PAGA for short, must ensure that their guard personnel carry out fire patrols (roving patrols against the threat of fire) every hour around the guard post they occupy and then write down whatever happens in the log book, which is supervised by the instructor or caregiver;
6. The Guard Officers, during their watch, must always coordinate with the Caretaker Instructor from the PPKT (Centre for Cadet Character Development) when conducting Counter Apples (Sudden Calls) or during the implementation of drills;
7. PAGA writes the Master Night Order on each watch before transferring it to the Assistant Duty Officer;
8. Provisions or scenarios and drill schedules are carried out by Internal Service Officers;
9. The caretaker instructor on guard duty, assisting the officer on duty, must conduct mobile patrols daily, performing various roles. These include Assistant III, who inspects safety equipment and fire extinguishers; 3rd Engineer, who checks machinery such as water pumps and electrical systems; 2nd Officer, who inspects communication equipment; 2nd Engineer, who checks auxiliary machines like generators and ensures safe conditions; Chief Officer, who inspects cadets in their barracks; and 1st Engineer, who inspects infrastructure, perimeter fences, and other vital objects. If any technical issues requiring maintenance or repair are encountered, the officers, engineers, or cadets must immediately coordinate with the watch technician and document their findings in the watch report.

Taking Over the Watch (Change of Watch). Things that each guard personnel must do when changing guard include:

1. Report things that happen during the watch to the substitute on duty;

2. Report messages from the Duty Officer (Master Night Order);
3. Ensure that the campus environment is conducive and can be maintained; And
4. Ensure that the guard journal has been recorded properly and signed

After ensuring that all concerned parties understood the scenario, it was implemented over a period of 6 months. During this time, 60 cadets participated and pro-vided feedback through open-ended questions in a questionnaire. The questions were designed to evaluate the effectiveness of the program using 9 indicators. These indicators were aimed at gathering insights into the key aspects of the program's impact and identifying areas for improvement.

4 Result & Discussion

The questionnaire was designed in 9 questions representing 9 indicators. The demography and the descriptive statistical result as follow:

Table 1. Demography.

Category	Description	n
	Diploma	42
Program	Non-Diploma – DP III	5
	Non-Diploma – DP IV	13
Gender	Male	46
	Female	14

Table 2. Demography & descriptive statistic result of the respondent.

Category	Description	Mean	Median	Std Dev	Min	Max
Realism	The scenarios presented during the simulation were realistic	4.20	4	0.83	2	5
Challenge	The tasks I was required to perform during the simulation were challenging	4.14	4	0.73	3	5
Understanding Improvement	The simulation improved my understanding of maritime safety procedures	4.24	4	0.65	3	5
Decision-Making Skill	The simulation helped me develop decision-making skills in high-pressure situations	4.22	4	0.67	3	5
Teamwork Facilitation	The simulation facilitated teamwork and collaboration among participants	4.19	4	0.71	2	5
Application of Knowledge	I was able to apply theoretical knowledge to practical scenarios during the simulation	4.19	4	0.82	1	5

Usefulness of Feedback	The feedback I received during and after the simulation was useful in helping me improve my performance	4.25	4	0.73	3	5
Workplace Reflection	The simulation scenarios reflected real-world maritime operations well	4.20	4	0.71	3	5
Preparation for Work	The simulation was effective in preparing me for real-world maritime challenges	4.32	4	0.71	3	5

The data suggests that participants generally rated this aspect of the simulation positively, with most ratings being around 4 or 5. The distribution is slightly left-skewed, meaning more respondents gave higher scores. There is moderate consistency in the responses, as indicated by the standard deviation, and the confidence interval is relatively narrow, suggesting that the sample mean is a good estimate of the population mean.

The evaluation of the life simulation program revealed that participants found the scenarios highly realistic, challenging, and effective in improving their understanding of maritime safety procedures. The majority of respondents rated the simulation as "Very Realistic," indicating that the program successfully mimics real-world situations. Participants also felt that the simulation helped them significantly improve their decision-making skills, which are crucial for high-pressure situations in maritime operations. Furthermore, the simulation was effective in facilitating teamwork and applying theoretical knowledge to practical scenarios, bridging the gap between classroom learning and real-world practice.

The feedback process was also highly appreciated, with participants finding the daily evaluations by instructors to be very useful in helping them improve their performance. Overall, participants agreed that the simulation reflected the realities of the maritime workplace and was an effective tool for preparing them for future careers. However, there were slight variations in how participants rated the challenge level and teamwork facilitation, suggesting room for improvement in these areas.

5 Conclusion

To enhance the effectiveness of the simulation program, it is recommended to ad-just the challenge levels to better match participants' skill levels. Providing varying degrees of difficulty could ensure that all participants are appropriately challenged, regardless of their experience. Additionally, there is potential to further emphasize teamwork by integrating more collaborative tasks and scenarios that require participants to work together in complex situations.

Maintaining the daily feedback process is crucial, as participants found it highly beneficial. Exploring additional feedback methods, such as peer-to-peer evaluations or group debriefs, could further enrich the learning experience. Finally, continuing to develop realistic scenarios that mirror real-world maritime challenges will ensure that the simulation remains a valuable tool for preparing students for their future careers in the maritime industry.

References

1. Pekcan, C. H., Barnett, M. L., & Gatfield, D. (2005). The human element in shipping: The overlooked factor in safety management. Journal of Maritime Research.
2. Barnett, M. L., et al. (2006). Safety culture in shipping: A review of the literature. International Journal of Maritime Engineering.
3. EMSA (2018). European Maritime and Safety Agency. Annual Overview of Marine Casualties and Incidents 2018.
4. Komite Nasional Keselamatan Transportasi (KNKT). (2022). Buku Statistik Investigasi Kecelakaan Transportasi 2022. https://knkt.go.id/news/read/buku-statistik-investigasi-kecelakaan-transportasi-tahun-2022. Accessed 24 October 2023.
5. Rothblum, A. M. (2000). Human error and marine safety. National Safety Council Congress and Expo.
6. Pourzanjani, M. (2001). The role of human factors in maritime safety. Maritime Policy & Management.
7. Darbra, R. M., & Casal, J. (2004). Historical analysis of accidents in seaports. Safety Science.
8. Toffoli, A., Lefevre, J. M., Bitner-Gregersen, E., & Monbaliu, J. (2005). A comparison of wave forecasting models. Ocean Engineering.
9. Antao, P., & Soares, C. G. (2006). Causal factors in accidents involving oil tankers. Journal of Loss Prevention in the Process Industries.
10. Sydnes, A. K. (2014). The role of human factors in maritime accidents: A case study of ship collisions in Norway. Safety Science.
11. Uğurlu, Ö., Köse, E., & Yıldırım, U. (2015). Analysis of human factors in ship collisions using fault tree analysis. Journal of Marine Science and Technology.
12. Yıldırım, U., Başar, E., & Uğurlu, Ö. (2017). Human error analysis in marine accidents: A case study of ship collisions. Journal of Navigation.
13. Chan, E. S., et al. (2016). The impact of human factors on ship accidents in Hong Kong waters. Maritime Policy & Management.
14. Nikitakos, N., et al. (2017). Competence of seafarers: Key to safe and sustainable maritime transportation. WMU Journal of Maritime Affairs.
15. Berg, H. P. (2011). Safety culture in shipping: What is it and how can it be improved? Safety Science.
16. Gluch, P., & Räisänen, C. (2009). Interactional perspective on environmental communication in construction projects. Building Research & Information, 37(2), 164–175. https://doi.org/10.1080/09613210802632849
17. Veiga, J. L. (2002). Safety culture in shipping. WMU Journal of Maritime Affairs, 1, 17-31.
18. Bhattacharya, Y. (2015). Measuring safety culture on ships using safety climate: a study among Indian officers. International Journal of e-Navigation and Maritime Economy, 3, 51-70.
19. Heijari, J., & Tapanainen, U. (2010). Efficiency Of The Ism Code In Finnish Shipping Companies. http://www.merikotka.fi/julkaisut/Heijari_Tapaninen_2010_Efficiency_of_the_ISM_Code_in_Finnish_shipping_companies_high.pdf
20. Lappalainen, J. (2008). Transforming maritime safety culture. Publications from the Centre for Maritime Studies, University of Turku, A, 46, 2008.

21. Reason, J. (2016). Managing the risks of organizational accidents. Routledge.
22. Cooper, D. (2002). Safety culture. Professional safety, 47(6), 30-36.
23. Hudson, P. T. W. (2001). Safety management and safety culture: the long, hard and winding road. Occupational health and safety management systems, 2001, 3-32.
24. Schager, B. (1998). The human factor in maritime safety: Psychological and organizational aspects. In Maritime Safety: Human and Organizational Factors. Bimco Bulletin, 93, 362-365.
25. Asyali, E., Saatçioğlu, Ö., & Cerit, A. G. (2005, June). Cooperative learning and teamwork effectiveness in maritime education. In the International Association of Maritime Economists Annual Conference (IAME), Limassol, Paper (No. 8).