

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH

2026, Vol. 7, No. 5, 2033 – 2060

<http://dx.doi.org/10.11594/ijmaber.07.05.15>

Research Article

Enhancing Safety of PCG Personnel Working on Vessel's Enclosed Spaces through Capacity Building Program

Denis R. Rapal*

Philippine Merchant Maritime Academy, Philippines

Article history:

Submission 25 April 2026

Revised 14 May 2026

Accepted 23 May 2026

*Corresponding author:

E-mail:

denis.rapal@gmail.com

ABSTRACT

The rising cases of shipboard enclosed space accidents and deaths has increased the significance of providing the safety of maritime personnel. This paper evaluates awareness and knowledge levels of Philippine Coast Guard (PCG) staff on enclosed space entry, in three key areas, namely, regulations, equipment, and competence. It seeks to suggest an organized capacity-building initiative to improve safety measures and operational readiness on PCG ships. The paper is designed as a mixed research with a concurrent triangulation design. It gathers both quantitative data by surveying 312 PCG personnel on board ships with the help of a structured examination tool and qualitative information by conducting in-depth interviews with five veteran seafarers of the commercial ships. The researcher analyzed the results of the examination with the help of descriptive statistics and frequency distribution and conducted thematic content analysis of the transcript of the interviews. The results indicate that despite the majority of PCG respondents expressing overall knowledge of the dangers of enclosed spaces, there are still considerable knowledge gaps. Regarding regulations, most respondents demonstrate a minimum level of knowledge and are not familiar with the applicable international regulations. The level of knowledge of equipment is generally satisfactory, but the respondents lack the skills of using and preparing special tools needed in rescue and emergency cases. Competence is considered the weakest area, and the percentage of the personnel that exhibits poor knowledge of hazard identification, electrical safety, and emergency responses is significant. These findings emphasize the importance of standardized regulatory training, practical training with equipment, and ongoing evaluation of competency. To counter this, the study recommends an all-round capacity building initiative incorporating compulsory training, simulation-based exercises, and safety drills conducted in an enclosed space to enhance the safety practice of enclosed space among PCG staff.

Keywords: *Accident prevention, Confined space entry, Maritime safety*

How to cite:

Rapal, D. R. (2026). Enhancing Safety of PCG Personnel Working on Vessel's Enclosed Spaces through Capacity Building Program. *International Journal of Multidisciplinary: Applied Business and Education Research*. 7(5), 2033 – 2060. doi: 10.11594/ijmaber.07.05.15

Introduction

Safety is still a significant issue in the maritime industry since accidents continue to pose a threat to the lives of personnel on the ships (Sha, 2020). Safety involves the control of the hazards, ensuring they do not exceed their acceptable risk level and eliminating the incidents that may lead to physical injuries, health complications, loss of money and even death (Akindehin et al., 2015). In maritime context, this entails the safety of personnel in the vessels through alleviating risks and reducing possible damages (Francisco, 2023). The problem of maritime accident prevention, in its international context, accentuates the necessity to protect seafarers and ship workers (International Maritime Organization, 2019a). The International Maritime Organization (IMO) supports safety principles of ship management across the world and puts emphasis on a safety culture based on risk evaluation, compliance with correct procedures, and sufficient training via the International Safety Management (ISM) Code (Kantharia, 2023). In spite of such efforts, maritime activities still result in severe injuries and deaths (Soner & Celik, 2020). The safeguarding of the rights of workers towards safe and secure working environments is emphasized by the United Nations Sustainable Development Goals (SDG), specifically under Goal 8. It highlights the need to ensure that safety measures are fulfilled by maritime institutions by all possible means (United Nations Development Programme, 2025).

Shipboard confinements are still one of the areas that pose the highest level of danger. They are hazardous due to factors such as poor ventilation, limited access, lack of oxygen, and human error that cause many injuries and deaths (Soner & Celik, 2020; Sakar, Buber, Koseoglu, and Toz, 2022). Despite tight training and policies, accidents still happen in ships' enclosed spaces (Marine Insight, 2021). As an illustration, in 2023, three crew members of the MV Blue Cecil died due to their alleged inhalation of toxic gas after they did not use the correct procedure of entering enclosed spaces (Port News, 2023; Ayeng, 2023; Voytenko, 2023). From 2015 to 2020, many reports documented an estimated 83 deaths related to

enclosed spaces. Most of these cases resulted from oxygen deficiency or incidents in cargo holds (Qingwei, 2022; ICHCA International, 2022). According to the ISM Code, maritime organizations, such as the PCG, are required to perform a thorough risk evaluation prior to entering enclosed spaces (International Maritime Organization, 2023). Nevertheless, deaths continue to occur and scientists have not yet come up with a comprehensive global database of enclosed space accidents. Reporting of incidents or anonymizing of incidents to safeguard commercial interests is also a failure in many organizations (International Maritime Organization, 2023). The risks that PCG personnel are exposed to are similar to those faced by seafarers in commercial ships, such as exposure to oxygen deficiency, toxic gases, extreme temperatures, entrapment, and other physical risks (Chibana, 2023; Abad et al., 2023). These risks are not dismissed despite the lack of official data from the PCG.

This paper evaluates the awareness and knowledge of the PCG personnel about the entry into an enclosed space and creates a progressive capacity-building program to improve their safety. The proposed program is defined by the study as a whole-training intervention aimed at identifying hazards, enhancing the competence and emergency response of the personnel, and setting the standard operating procedures to work in enclosed spaces on PCG vessels. At this time, such a capability-building program is not in place at PCG. The present research suggests specific measures to enhance the regularity of safety measures and minimize life-threatening events. It also documents the awareness and knowledge of PCG personnel of enclosed space operations and suggests a capacity-building initiative to enhance operational preparedness and safety on PCG vessels.

Materials and Methods

This section explains the research methods used to accomplish the objectives of the study including the research design, respondents, ethics, instrumentation, data collection, and analysis of data. It gives enough details about the procedures to enable the study to be replicated.

Research Design

The work is based on the mixed-method research design, which is a combination of quantitative and qualitative research (Schoonenboom and Johnson, 2017). It is based on concurrent triangulation design intended to cross-verify results, which increases credibility and reliability (Almeida, 2018; Warfa, 2016). This design can be used to capture both measurable trends and detailed perspectives at the same time, thus having a holistic view of the awareness, knowledge and competence of PCG personnel in enclosed space operations. The research administers a test questionnaire to PCG staff to determine their understanding of the risks of enclosed spaces and their knowledge of regulations, equipment and competence. It is also involved in structured interviews among seafarers in order to have an in-depth understanding of operational practices, gaps in policies, and possible suggested reforms.

Respondents of the Study

Two groups of respondents are involved in the study:

Philippine Coast Guard (PCG) Respondents

The research involves 312 PCG members on board different ships who participated in the quantitative analysis. The sample includes 35 vessels of eight size groups, from which the researcher selected representatives of the Deck Department, Engine Department, and Maintenance and Repair Group (MRG) are chosen. The inclusion criteria are as follows:

- Filipino natural born male or female citizens;
- Placed in tasks that involve entering enclosed areas; and a
- Minimum of two years on board experience

The population consisted of 1,650 personnel and the researcher also considered an additional 50-60 MRG personnel separately. A sample size of 312 respondents (around 18.9% of the population) would be sufficient to have a good representation of the result.

Population and Sampling

The researcher calculated the PCG sample size with the help of Raosoft sample size calculator. This study proposes a total population of 1,590 regular ship personnel of the PCG vessels. It assumes that the Maintenance and Repair Group (MRG) does not form part of the primary population count since it does not consider its own staff as regular ship crew and only deploys them on an "as needed" basis to perform specialized repair or technical support tasks. As a result, the study adds an estimated 50 to 60 MRG personnel each, bringing the total estimated population to 1,650 personnel.

The study picked a sample size of 312 PCG respondents out of this population, which is about 18.9 percent of the total population. This percentage is enough to increase the reliability of the research, and the researcher believes that a sample of 30-500 respondents is sufficient in terms of populations of up to 10 thousand people. Besides the PCG respondents, the study also involved five (5) seafarer respondents and sampled them using purposive sampling. These respondents were male or female Filipino citizens by birth and served as Training Managers or were experienced Master Mariners or Chief Engineers or served as seafarers in either capacity. They were also managerial or leaders on board commercial vessels, and with at least three (3) years of pertinent work experience. Professional background and wide experience in dealing with confined or enclosed space operations on commercial vessels allowed them to contribute valuable information especially on policy gaps, best practices and how to develop a proper capacity-building program. In general, the study obtained 317 respondents comprising 312 PCG respondents and five (5) seafarers, which guarantees the availability of enough and valid data to address the aims of the research. Table 1 shows a breakdown of the research population and sample, detailing how many personnel each type of vessel has, and how many respondents are estimated.

Table 1. Summary of the Exam Research Population and Sample

Type / Size of Vessel	Number of Vessels in Class	Number of Personnel per Unit	Total Personnel	Number of Respondents per Vessel
30-meter class	8	20 personnel (including officers)	160 personnel	31 respondents
35-meter class	4	30 personnel (including officers)	120 personnel	23 respondents
44-meter class	10	45 personnel (including officers)	450 personnel	85 respondents
50-meter class	4	60 personnel (including officers)	240 personnel	45 respondents
56-meter class	4	60 personnel (including officers)	240 personnel	45 respondents
83-meter class	1	90 personnel (including officers)	90 personnel	17 respondents
97-meter class	2	90 personnel (including officers)	180 personnel	34 respondents
Bouy tender	2	55 personnel (including officers)	110 personnel	21 respondents
Maintenance & Repair Group [MRG]	n/a	----	60 personnel	11 respondents
	35 Vessels plus MRG	----	1,650 personnel (Total Research Population)	312 personnel (Total Research Sample)

Seafarer Participants

The research subjects five (5) seafarers to structured interviews in a selective manner. All participants are Filipino nationals and are either managers or leaders in commercial vessels (e.g., Master Mariners, Chief Engineers or Training Managers) with a minimum of three years pertinent operational experience. Their experience in enclosed space operations enable them to offer detailed information on safety practices, adherence to regulations, and suggestions on capacity-building efforts.

Ethical Considerations

This study follows the principles of ethics. The researcher provides informed consent to all the participants, which includes the purpose of the study, procedure and possible risks. Participation remains voluntary and the respondents are able to pull out from the research, at any given time. The research process maintains privacy and confidentiality. The researcher does not disclose any personal data except the

demographic information required. In addition, all answers are coded and identified with a coded name, and the data are stored in a secure place in password-protected electronic files. Only aggregated data is reported in the study. The researcher upholds academic integrity by citing the work correctly and submitting the manuscript to plagiarism and Artificial Intelligence (AI) originality detector, with a Turnitin similarity index of 3%. The study follows the requirements of the Research Ethics Assessment Form.

Instrumentation

The study applies two research instruments: an exam questionnaire and a structured interview questionnaire. The exam questionnaire evaluates the demographic picture of PCG personnel, risk awareness of enclosed space, and knowledge in three areas: regulations, equipment, and competence.

Part I gathers demographic data, such as age, sex, educational qualification, job position,

roles and responsibilities, total years of service, and years of assignment in the PCG Fleet. Part II analyzes the awareness through measuring operational exposure to enclosed spaces, frequency of entry, work done, entry technique, recognizing hazards involved, previous training, use of personal protective equipment (PPE), and readiness to work in enclosed spaces. Part III is an exam of knowledge in three subdomains. The regulations subsection assesses the knowledge of safety rules, permits, risk assessment procedures, oxygen and appraises the ventilation requirements, monitoring, and emergency preparedness. The equipment sub-section evaluates knowledge of safety equipment, detection equipment, communication equipment, and rescue equipment utilized in the pre-entry, in the entry and after entry of the enclosed space. The competence subsection assesses technical expertise of atmospheric testing, hazardous gases, electrical precautions, lockout procedures and emergency evacuation measures.

The researcher designed the interview questionnaire for five participants who are seafarers and it consists of five sections. The initial part gathers background details, such as job placements, maritime experience, credentials, enclosed space work, and profession inspirations. The second part examines the awareness of accidents or injuries and experience of the participants, the third is the knowledge of the regulations, equipment, and competence. Parts four and five concentrate on the presence and possible enhancements of current training programs, and part five compiles suggestions on how the enclosed spaces can be improved to increase awareness, knowledge, and safety practices. The researcher designed both instruments to guarantee a complete data collection to evaluate the knowledge of PCG personnel on safety and to inform the creation of a successful capacity-building program.

Validity and Reliability

The researcher pre-tested and validated the research instruments before the true data collection to guarantee that the research instruments were clear, reliable and suitable to the target respondents. The researcher also pre-tested the questionnaire for the exam

among 20 PCG personnel with similar characteristics as those of the actual respondents but not included in the final sample. During the pre-test, the researcher ensured that instructions have clarity, relevance of items, and with an estimated time of completion, using the feedback of participants to clarify the ambiguous statements and enhance the overall structure of the questionnaire. Research validation guarantees the reliability and quality of a research (Elango-van and Sundararajan, 2021).

In the pre-testing stage, the researcher performed the split-half test of reliability of the exam questionnaire to evaluate the internal consistency by splitting the items into two parts and comparing the similarity of the answers to each other (Steinke and Kopp, 2020). Moreover, technical professionals with practical experience in the field of maritime safety, ship inspection, and work in the enclosed space, reviewed the parts connected with the awareness of risks in enclosed spaces among PCG personnel, which guaranteed the accuracy of the content and enhanced the effectiveness of the collected quantitative data. The researcher also designed the interview questionnaire to include qualitative information on the seafarer participants regarding PCG personnel safety in enclosed spaces and defined its face validity. Marine safety officials and seafaring professionals who have experience in enclosed-space operations reviewed the questionnaire and assessed the questions to be clear, appropriate, and capable of eliciting responses that are significant and relevant (Masuwai et al., 2024; Allen et al., 2023). This feedback led to minor adjustments, especially in perfecting the wording of the questions, streamlining the focus, and the logical progression of the interview guide, thus making it suitable to a qualitative data collection.

Data Gathering Procedure

In the case of the exam questionnaire, the researcher started by informing every respondent about the purpose of the questionnaire and sought informed consent. The researcher then sent questionnaires to 312 PCG staffs on different ships and made clarifications when necessary. The investigator verified the filled questionnaires and encoded them to

make an analysis. In case of the interviews, the researcher engaged the five seafarer participants in a schedule and also acquired consent forms. The verified interview guide provided consistency and relevance of questions and the researcher recorded the answers and gave clarification where needed. The researcher transcribed and sorted out all data of the interviews to be analyzed qualitatively.

Data Analysis

The researcher encoded and tabulated the quantitative data of the exams and analyzed them with the frequency counts, percentages and the percentage of correct answers in the three knowledge areas. The researcher also synthesized the qualitative interview data narratively to present the insights to the operations, gaps related to policy and capacity-building requirements. The study made use of triangulation to compare quantitative and qualitative results and determine what areas need to be improved. The author displayed the findings in tables and figures to visualize the trends, patterns, and knowledge gaps in an easy way that can support evidence-based suggestions on how to improve enclosed space safety,

competence, and operational preparedness in PCG vessels.

Result and Discussion

This section gives a detailed discussion of the data which is collected by the study through examination and interview questionnaires. It addresses the demographics of the respondents, their knowledge about hazards in enclosed spaces, their knowledge and competence levels and suggests the reforms to enhance the safety of the operations.

Respondents' Demographic Profile

PCG Respondents

312 PCG staff undergo an exam to evaluate their knowledge of regulations, equipment, and expertise of enclosed space operations. Among these respondents, 237 of them have a history of entering enclosed spaces, and 75 have no previous experience with entering enclosed spaces, but project future enclosed space work. The use of both past and future-assigned staff offers a complete perspective of the workforce readiness and training requirements. Table 2 provides the demographics of the respondents:

Table 2. Demographic Profile of PCG Exam Respondents

Demographics	f	%
Sex		
Male	288	92%
Female	24	8%
Total number of respondents	312	100%
Age		
20 to 29 years old	132	42%
30 to 39 years old	152	49%
40 to 49 years old	24	8%
50 to 59 years old	4	1%
Total number of respondents	312	100%
Highest Educational Attainment		
Undergraduate	95	30%
Vocational	31	10%
Bachelor's Degree	166	53%
with Master's Degree Unit	2	1%
Master's Degree	5	2%
Did not specify	13	4%
Total number of respondents	312	100%
Nature of Current Position/Designation		
Deck Officer	19	6%

Engineering Officer	13	4%
Engine Man	63	20%
Deck Hand	213	68%
Duty Officer	2	1%
Auxiliary Officer	2	1%
Total number of respondents	312	100%
Number of Years in Service		
less than a year	2	0.6%
1-5 years	142	45.5%
6-10 years	93	29.8%
11-15 years	39	12.5%
16-20 years	26	8.3%
21-25 years	7	2.2%
26-30 years	1	0.3%
31-35 years	2	0.6%
Total number of respondents	312	100%
Number of Years Assigned in PCG Fleet		
less than a year	21	6.7%
1-3 years	173	55.4%
4-6 years	92	29.5%
7-9 years	14	4.5%
10-12 years	6	1.9%
13-15 years	5	1.6%
More than 15 years	1	0.3%
Total number of respondents	312	100%

The majority of respondents are male (92%), about 30-39 years old (49%), and have a bachelor degree (53%). Deck Hands are the most numerous (68%), and the majority of respondents have 1-5 years of service (45.5%) and 1-3 years fleet assignment (55.4). These results are consistent with existing research that has shown that maritime operations include mostly male, younger, and non-officer crew (Khayat, 2023; DataSpring, 2022; Chibana, 2023; International Maritime Organization, 2022).

Interview Respondents

The research involves five seafarers on the management level with 10-26 years of

experience in maritime operations, training and safety management. The participants include senior deck officers (Chief Officer and Master Mariner), a Chief Engineer, and a QA and Training Officer. Each member is highly qualified in maritime including the Master Mariner Licenses, Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) qualifications, and the International Organization of Standardization (ISO) auditing. All of them are directly involved with enclosed space operations and are an operational lead, supervisor or compliance auditor, which qualify them to have a wealth of practical knowledge on vessel safety protocols and risk management.

Table 3. Demographic Profile of the Interviewed Seafarer Participants

Participant	Current Job Position	Years of Experience	Qualifications/Certifications	Experience in Enclosed Spaces
Seafarer 1	Chief Officer	12 years	Master Mariner License	Yes – multiple enclosed space inspections during dry dock

Participant	Current Job Position	Years of Experience	Qualifications/ Certifications	Experience in Enclosed Spaces
Seafarer 2	Master Mariner	19 years	STCW & Flag State Certificates	Yes – involved in enclosed space entries as former Chief Officer
Seafarer 3	Chief Officer	10 years	Certificate of Competency [CoC] as Officer of Navigational Watch	Yes – responsible for ensuring safety procedures in enclosed spaces
Seafarer 4	Chief Engineer	19 years	Certified Chief Engineer (STCW)	Yes – supervises engine room enclosed space entries
Seafarer 5	Quality Assurance [QA]FIS & Training Officer	26 years	ISO Lead Auditor, Marine Engineer, Maritime Investigator	Yes – technical approver and auditor for enclosed space compliance

Level of Awareness of Philippine Coast Guard Personnel Concerning Enclosed Space Risks Assignment in Enclosed Spaces

Out of 312 PCG respondents, 237 (76%) include those who had previous experience of entering or working within a confined space with 75 (24%) having no experience of doing so. It

means that most of the personnel are operationally exposed to confined spaces, which are consistent with the findings by Chibana (2023) and Abad et al. (2023), who emphasized that maritime personnel often face hazards in confined spaces.

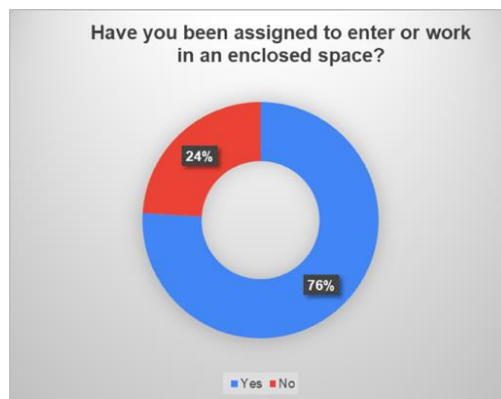


Figure 1. The Distribution of PCG Respondents Assigned to Enclosed Spaces

Frequency of Entry and Tasks Performed by PCG Respondents in Enclosed Spaces

Out of the 237 PCG respondents that had a prior experience in an enclosed space, 84 (35%) said that they had only entered once, and 76 (32%) had entered two or three times within the year. The respondents most frequently performed the following: maintenance and repairs (104 or 44%), inspections and surveys (51 or 22%), and tank cleaning (46 or 19%), in compliance with Nautilus Shipping

(2024). On entry practices, 145 respondents (61%) said they entered as a team, 80 (34 percent) said they had at least one officer with them and 12 (5%) entered alone. These data show that although the majority of entries are coordinated, there is a small percentage of those without supervision, similar to what is observed in the literature on maritime operations on the occasional occurrence of uncoordinated or unsupervised entries (Gard, 2025).

Table 4. Frequency of Entry and Tasks Performed by PCG Respondents

How many times have you entered or worked inside an enclosed space within the past year?	f	%
Once	84	35%
2 to 3 times	76	32%
4 to 5 times	37	16%
6 to 10 times	7	3%
More than 10 times	33	14%
Total number of respondents	237	100%
What type of tasks/ activities do you often perform inside ships' enclosed spaces?	f	%
Maintenance and repairs	104	44%
Inspections and surveys	51	22%
Tank cleaning	46	19%
Equipment operation	14	6%
Emergency response	13	5%
Cargo handling	9	4%
Total number of respondents	237	100%
When you enter into an enclosed space, you usually go:	f	%
Alone	12	5%
With at least one assigned officer/ ship personnel	80	34%
As a group/ as a team	145	61%
Total number of respondents	237	100%

Awareness of Risks or Hazards in Enclosed Spaces

Of the 312 PCG respondents, 227 (73%), were aware of the risks of going into enclosed spaces, 41 (13%) showed limited awareness, 37 (12%) were totally unaware, and 6 (2%), were unsure (Figure 2). These findings denote that despite the fact that a majority of the personnel is aware of the general risks, there is still a high percentage of personnel who do not have adequate knowledge on the subject matter of

enclosed space hazards; thus there is a necessity of continuous education and training on these same areas. These results are consistent with the literature indicating that enclosed space maritime accidents can be frequently explained by human error instead of the lack of procedural efficiency (International Registries, 2025). The statistics highlight the necessity to constantly strengthen the level of safety and offer appropriate training in hazard awareness and detection tools usage (Lidell, 2025).

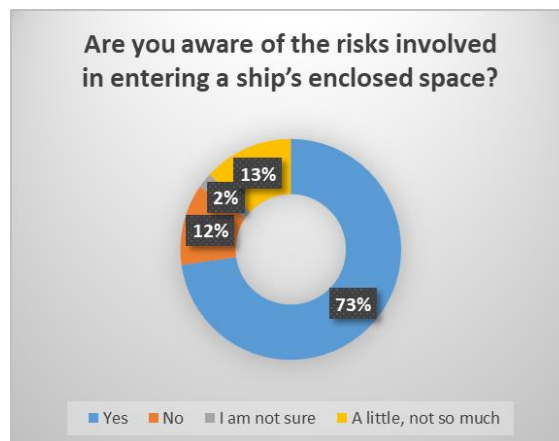


Figure 2. Awareness of Risks Involved in Entering a Ship's Enclosed Space

Risks of Entering a Ship's Enclosed Space

Figure 3 shows the risks reported by 312 PCG respondents when entering enclosed spaces. The most frequently identified risks among respondents include asphyxiation (159 or 70%); exposure to toxic gases and chemicals (121 or 53%); extreme temperatures (119 or 52%). They also mention physical hazards such as slips, trips, and falls (114 or 50%), entrapment (108 or 48%), and poor visibility (101 or 44%). Fire and explosion hazards are the least identified by respondents (79 or 35%). These findings are consistent with reports that point to oxygen deficit, toxic gases, and extreme environments among the primary risks in

shipboard enclosed spaces (Safety4Sea, 2025; Soner and Celik, 2020), and the threat of fire and explosion accidents continues to exist despite lesser acknowledgment.

The reduced awareness of fire and explosion hazards can be explained by the fact that training on the safety of enclosed spaces focuses more on the problem of oxygen deficiency and atmospheric hazards, which are more often emphasized during the training. Moreover, comparably few cases of fire and explosion might also serve to normalize the risks among the staff, which decreases the importance of these risks in the course of regular work.

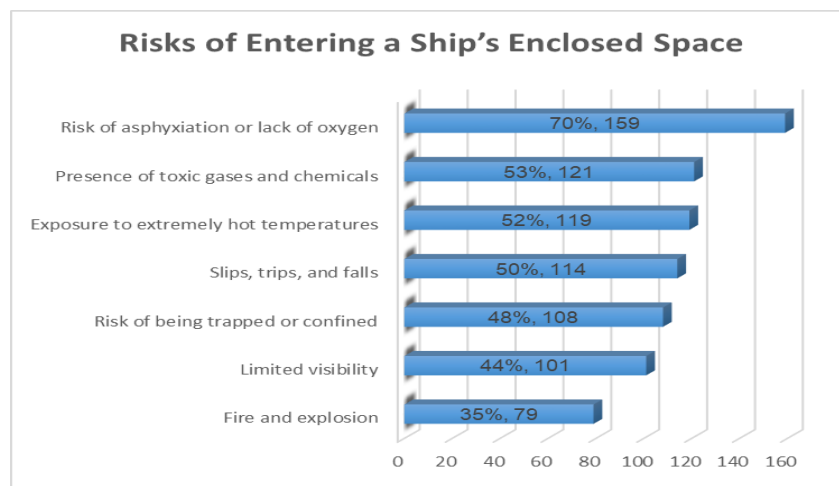


Figure 3. Risks of Entering a Ship's Enclosed Space

Insights from the five interviewed support specific findings. They highlighted risks of oxygen deficiency, toxic gases, and physical hazards. One interviewee recounted a fatal accident where oxygen concentration in a cargo compartment was at a scant 6 percent, further supporting the significance of asphyxiation hazards. The participants also mentioned exposure to toxic gases, heat stress, and structural issues like constrained layouts and limited points of entry and literature reported these risks as common in confined spaces (Safety4Sea, 2025; Soner and Celik, 2020; Baltic and International Maritime Council, 2025).

Even though the majority of the 237 interviewed respondents who had enclosed space experience did not report any personal accidents, 21 (9%) respondents did (Table 5).

The most common incidents included asphyxiation because of a lack of oxygen (11 or 52%), falls (8 or 38%), exposure to harmful or dangerous substances (6 or 29%), heat stress or heat stroke (5 or 24%), and equipment malfunctions (4 or 19%). These data prove the existence of the working hazards, and the necessity of safety training, correct protective devices and strict following the rules of entering the enclosed space.

Personal Experience of Accidents or Injuries in Enclosed Spaces

Table 5 shows the personal experience of PCG respondents about the accidents or injuries during working in an enclosed space of a ship. Out of 237 participants who had experience in enclosed space, 21 (9%) of the partici-

pants reported that they had an accident or injury and 216 (91%) of participants did not. The respondents also mentioned asphyxiation caused by oxygen deficiency (11 or 52%), falls (8 or 38%), exposure to toxic, hazardous or

flammable substances (6 or 29%), heat stress or heat stroke (5 or 24%), and equipment failure (4 or 19%) as commonly occurring injuries and accidents in confined spaces.

Table 5. Personal Experience of Accidents/Injuries While Working in a Ship's Enclosed Space

Have you personally experienced an accident/ injury while working in a ship's enclosed space?	f	%
Yes	21	9%
<i>Asphyxiation due to lack of oxygen</i>	11	52%
<i>Falls</i>	8	38%
<i>Exposure to toxic, hazardous, and flammable substances</i>	6	29%
<i>Heat stress/heat stroke</i>	5	24%
<i>Equipment malfunctioning</i>	4	19%
No	216	91%
Total	237	100%

The insights gathered from the five interviewed seafarers support these findings. In the discussions, participants pointed to oxygen shortage as a significant contributor to lethal accidents in confined places, and one of the participants recalled how a seaman died in a cargo hold. Other participants stressed that serious injuries and deaths are still possible in the absence of stringent safety measures. These observations can be consistent with reports of deaths and injuries in shipboard enclosed spaces (Safety4Sea, 2025; Steamship Insurance Management Services, 2025). Even with enhanced safety measures, these incidents keep happening, which means that preventative strategies are still inadequate or are not applied uniformly (Gard, 2015).

Preparedness and Compliance in Enclosed Space Work

Training and Preparedness

The outcomes of the exams indicate that there are considerable weaknesses in the level of readiness among PCG staff. Among the 237 respondents who had ventured into enclosed spaces, only 104 (44%) of them had undergone any kind of training before entering, with 133 (56%) having never received training (Figure 4). These results indicate that over half of the staff operated at high risks without official training, which poses significant operational and safety consequences. Practically,

insufficient training leads to more chances of procedural mistakes during enclosed space entry, specifically when it comes to the risks of identifying hazards, atmospheric testing, use of breathing apparatus, and emergency response. The direct effects that such weaknesses have are that they pose high chances of being injured or killed in the workplaces where there is lack of oxygen, poisonous gases, and no viable means of escape.

Organizationally, these gaps undermine the overall mission readiness by lowering the predictability and stability of personnel performance in critical operations. Teams can be unequal in terms of their ability to respond because units can depend on their personal experience, as opposed to standardized competence. This compromises the effectiveness of operation in the case of emergencies where a coordinated and protocol-directed response is needed. In addition, the absence of regular training sends the organization at risk of not abiding by the laid down safety systems, such as International Maritime Organization (IMO) guidelines on enclosed space entry procedures. Lack of such standards leaves the organization vulnerable to legal and regulatory risks in case of accidents or deaths. These incidences can lead to investigations, penalties or negligence discovery, especially when the personnel are deployed without proper training or certification.

The results correlate with the literature that highlights the importance of regular training and realistic exercises as the key to effective preparedness (Gard, 2019), and the

operational aspects, which also determine the level of safety in high-risk settings (Corpuz et al., 2025).

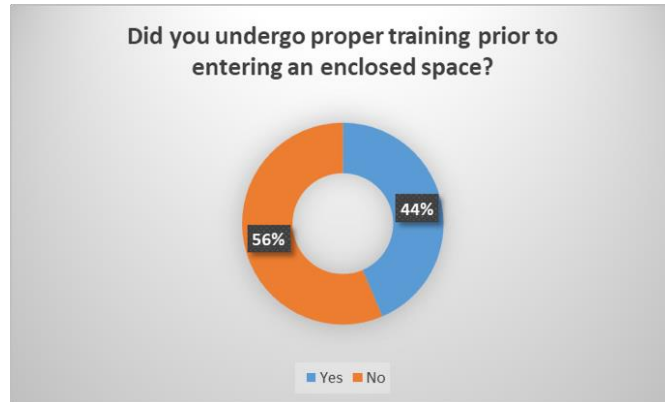


Figure 4. Training Received Before Entering a Ship's Enclosed Space

Personal Protective Equipment Compliance

The results show also the areas of noncompliance with personal protective equipment (PPE). Out of 237 respondents with an experience of the enclosed space, 178 (75%) indicate that they were always required to wear PPE prior to entering the space, whereas 59 (25%) indicated that they were never required to wear PPE before entering the space (Table 6). Protective clothing (135 or 76%), head protection (103 or 58%), and foot protection (94 or 53%) are the most frequently used types of PPE.

Nevertheless, 57 respondents (32%) indicate respiratory protection and emergency exit facilities, which are essential in combating toxic gases and oxygen deficient air. This trend is consistent with the recommendations of the

significance of full protective equipment in enclosed space missions (Ocean Technologies Group, n.d.). The partial wearing of the PPE especially respiratory protection greatly exposes the personnel to life threatening atmospheric hazards, and reduces their ability to safely complete tasks during operations. Such a discrepancy in the protective actions undermines the mission preparedness, too, since units are not able to ensure the same level of ability to endure under dangerous conditions. Moreover, lack of adherence to IMO enclosed space safety regulations predisposes the organization to increased legal liability particularly in incidents of injury or death, where a failure to protect oneself with proper gear can be attributed to negligence in operations.

Table 6. Requirement to Wear Personal Protective Equipment Before Entering a Ship's Enclosed Space

Were you required to wear personal protective equipment prior to entering an enclosed space?	f	%
Yes	178	75%
Protective clothing (e.g., work suits, coveralls, flame and chemical resistant clothing)	135	76%
Head protection (e.g., helmets, hard hats)	103	58%
Foot protection (e.g., safety shoes, steel-toed boots)	94	53%
Communication equipment (e.g., two-way radio, other communication devices)	82	46%
Eye and face protection (e.g., full-face shields, safety goggles)	78	44%
Hand protection (e.g., chemical-resistant gloves, welding gloves)	77	43%

Were you required to wear personal protective equipment prior to entering an enclosed space?	f	%
<i>Fall protection (e.g., lanyards, safety harnesses)</i>	59	33%
<i>Respiratory protection (e.g., self-contained breathing apparatus, respirators)</i>	57	32%
<i>Emergency devices/equipment (e.g., emergency escape breathing devices, lifeline and retrieval systems)</i>	57	32%
<i>Gas detection devices (e.g., portable gas detectors)</i>	45	25%
No	59	25%
Total	237	100%

Willingness to Enter Enclosed Spaces

Although the respondents were aware of the risks and had prior exposure to accidents, majority of them were still ready to work in enclosed spaces. Among the 312 PCG respondents, 265 (85%) said they would be willing to do such tasks, 137 (44%) said definitely yes and 128 (41%) said probably yes (Figure 5).

This observation is consistent with the results that staff members tend to work in dangerous conditions even after being aware of the possible risks (Gard, 2025). These findings reinforce the significance of well-organized capacity-building activities, which focus on effective training, risk minimization, and regular use of PPE.

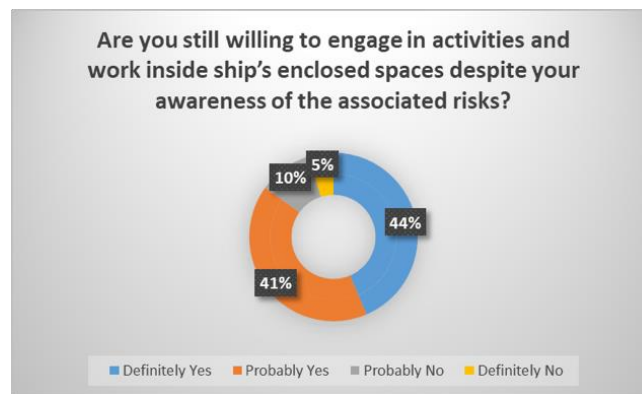


Figure 5. Willingness to Work in Ship's Enclosed Spaces Despite Awareness of Risks

Level of Knowledge of Philippine Coast Guard Personnel Assigned Aboard Ships Associated with Enclosed Spaces

The researcher evaluated the enclosed space safety knowledge of 312 PCG staff within three areas (i.e., regulations, equipment and competence). The results of the exams showed that there was a difference in the degree of proficiency, with interviews with the five participants who were seafarers giving some supporting information on industry practice.

Regulations

Table 7 results indicate that (44%) of the respondents exhibit satisfactory knowledge of regulations, 92 (29%) show very satisfactory knowledge and 15 (5%) reflect excellent knowledge. Meanwhile, 54 (17%) are rated as "fairly satisfactory", 14 (4%) are rated as "needs improvement". These findings show that the majority of the respondents are familiar with basic regulatory concepts, with some in need of additional training.

Table 7. Level of Knowledge of the Respondents in Terms of Regulations

Areas	Level of Knowledge of PCG Respondents				
	Excellent	Very Satisfactory	Satisfactory	Fairly Satisfactory	Needs Improvement
Regulations	15 (5%)	92 (29%)	137 (44%)	54 (17%)	14 (4%)

Table 8 demonstrates that the respondents excel in knowing the need to stick to regulations (85%), the intent of permits and risk assessment (87%), and the preparation of safety equipment (84%), which the study interprets as "excellent". These findings are consistent with the literature that places strong regulatory frameworks in place by the IMO to mitigate maritime hazards (International Maritime Organization, 2019b; Martek Marine, 2025). The study however records less scores in

regulatory conditions in inspections (13%) and safety precautions before entry (30%), which can be interpreted as "needs improvement" and "fairly satisfactory", respectively. These results align with literature that the Safety Management Systems of ships should clearly specify the inspection procedures and entry procedures (West of England, 2025). The general average score of regulations is 57%, which the study considers as "satisfactory".

Table 8. Respondents' Level of Knowledge on Regulations-related Questions

Regulations	% Correct	Interpretation
1. Which of the following is the most important reason for following regulations when entering enclosed spaces?	85%	Excellent
2. What is the purpose of obtaining permits and conducting risk assessments before entering enclosed spaces?	87%	Excellent
3. Which of the following statements accurately reflects regulations regarding the minimum percentage of oxygen in enclosed spaces onboard ships?	56%	Satisfactory
4. According to regulations, what condition must Coast Guard Personnel assigned to inspections of enclosed spaces meet?	13%	Needs Improvement
5. What is the purpose of preparing a safety equipment box in case of an emergency, as per regulations?	84%	Excellent
6. Based on maritime regulations, what measures must be applied during inspections of enclosed spaces?	72%	Very Satisfactory
7. Which of the following actions is a top requirement according to regulations prior to conducting an inspection of enclosed spaces aboard ships?	45%	Satisfactory
8. After the acquisition of appropriate work permits and prior to conducting an inspection of enclosed spaces aboard ships, this is considered a mandatory step:	47%	Satisfactory
9. Which action is crucial to ensure safety before entering an enclosed space according to regulations?	30%	Fairly Satisfactory
10. As per regulations, to prevent accidents during inspections of enclosed spaces, all Coast Guard personnel must do this:	54%	Satisfactory
Overall % Correct	57%	Satisfactory

Legend: 0% - 20% (Needs Improvement); 21% - 40% (Fairly Satisfactory); 41% - 60% (Satisfactory); 61% - 80% (Very Satisfactory); 81% - 100% (Excellent)

The interviews carried out with the five seafarer respondents indicated that practical training and hands-on experience in enforcing regulatory procedures are important. Although a few of them mentioned structured training programs, others had minimal formal training,

which indicated discrepancies in exposure to training. These findings are in line with the literature that focuses on training in the form of scenarios to make sure that one is familiarized with safety equipment and rescue operations (Safety4Sea, 2021).

Equipment

Table 9 indicates that respondents have satisfactory equipment knowledge with 126 (40%) scoring "satisfactory", 76 (24%) "very satisfactory", and 9 (3%) "excellent". In the

meantime, 70 (22%) have a "fair-satisfactory" rating, and 21 (10%) have a "needs-improvement" rating. This means that a significant part of the personnel is not proficient enough in equipment-related safety measures.

Table 9. Level of Knowledge of the Respondents in Terms of Equipment

Areas	Level of Knowledge of PCG Respondents				
	Excellent	Very Satisfactory	Satisfactory	Fairly Satisfactory	Needs Improvement
Equipment	9 (3%)	76 (24%)	126 (40%)	70 (22%)	31 (10%)

Literature stresses the correct use of specialized equipment and personal protective equipment (PPE) when going into enclosed spaces. Protective equipment like self-contained breathing apparatus, respirators, communication systems, and rescue equipment are necessary in averting injuries and deaths (Martek Marine, 2025; Ocean Technologies Group, n.d.).

The study, which is documented in Table 10, indicates a high accuracy in determining the

purpose of gas detectors (80%), proper response to oxygen supply failure (82%), both of which it considers to be excellent. Nevertheless, the study finds the gaps in the use of rescue equipment (25%) and preparation checks (15%), and it considers them to be "somewhat satisfactory" and to be "in need of improvement", respectively. The general mean of equipment knowledge is 53% which the research considers to be "satisfactory".

Table 10. Respondents' Level of Knowledge on Equipment-related Questions

Equipment	% Correct	Interpretation
1. Which piece of equipment is essential for ensuring adequate visibility in enclosed spaces?	51%	<i>Satisfactory</i>
2. Which type of equipment should be readily available in case of rescuing assigned personnel from enclosed spaces?	66%	<i>Very Satisfactory</i>
3. Which of these items is not typically included in the preparation for entering and rescue operations in confined spaces?	60%	<i>Satisfactory</i>
4. What is the primary purpose of a gas detector utilized in enclosed spaces?	80%	<i>Excellent</i>
5. Which device is specifically designed to detect oxygen deficiency, toxic gases, and flammable substances in an atmosphere?	76%	<i>Very Satisfactory</i>
6. In the event of a failure in the continuous supply of oxygen outside an enclosed space, what equipment should a worker immediately utilize?	82%	<i>Excellent</i>
7. Which equipment is employed to rescue a person in an enclosed space while providing oxygen from a compressed bottle?	25%	<i>Fairly Satisfactory</i>
8. What ensures the completeness of safety equipment tools before and during the inspection process?	51%	<i>Satisfactory</i>
9. What is a crucial aspect regarding safety harnesses in assigned personnel during inspections?	24%	<i>Fairly Satisfactory</i>

Equipment	% Correct	Interpretation
10. What ensures the successful checking of preparation tools, inspection, and emergency equipment?	15%	Needs Improvement
Overall % Correct	53%	Satisfactory

Legend: 0% - 20% (Needs Improvement); 21% - 40% (Fairly Satisfactory); 41% - 60% (Satisfactory); 61% - 80% (Very Satisfactory); 81% - 100% (Excellent)

Interview respondents put much stress on practical training on equipment like multi-gas detectors, self-contained breathing apparatus (SCBA), and emergency escape breathing devices (EEBD). Some of the participants cite in-service training and practice as the major ways of keeping up with the familiarity with safety equipment. These findings are in line with the recommendations in literature to encourage hands-on training and frequent exercises to enhance hazard awareness and emergency response preparedness (Marine Insight, 2021;

International Maritime Organization, 2019b; West of England, 2025).

Competence

Competence has the lowest results of the three domains. Table 11 reveals that 131 (42%) of the respondents have a "fairly satisfactory" rating and 58 (19%) have a "needs improvement" rating. 95 (30%) are "satisfactory", 24 (8%) "very satisfactory" and 4 (1%) are "excellent". These findings suggest that less than 60% of the respondents are below the preferred level of competency.

Table 11. Level of Knowledge of the Respondents in Terms of Competence

Areas	Level of Knowledge of PCG Respondents				
	Excellent	Very Satisfactory	Satisfactory	Fairly Satisfactory	Needs Improvement
Competence	4 (1%)	24 (8%)	95 (30%)	131 (42%)	58 (19%)

The Nautical Institute (2018) explains the need for high competence to provide the safety and operational efficiency of safe navigation and operations in dangerous enclosed spaces. According to Table 12, the respondents are relatively strong in their theoretical knowledge to define the competence (63%) and atmospheric

testing procedures (73%) which the study considers to be very satisfactory. Nevertheless, the study reveals significant gaps in the electrical deactivation process (15%), as well as some safety measures (29%). The general mean competence accuracy is 41%, the lowest of three domains.

Table 12. Respondents' Level of Knowledge on Competence-related Questions

Competence	% Correct	Interpretation
1. Which definition best describes a competent individual in ships' enclosed spaces?	63%	Very Satisfactory
2. The _____ should be tested periodically by an authorized ship personnel while the enclosed space is occupied by the crew.	21%	Fairly Satisfactory
3. This is the minimum acceptable oxygen level in any enclosed space:	58%	Satisfactory
4. Which of the following should a Coast Guard Personnel test first before entering a confined space?	47%	Satisfactory
5. In an enclosed space, exposure to hydrogen sulfide at extremely high concentrations can be very dangerous.	21%	Fairly Satisfactory

Competence	% Correct	Interpretation
At what concentration level will exposure to this chemical automatically result into a so-called "knock-down effect"?		
6. The act of using disconnecting switches, preferably located remotely from the equipment, to deactivate all electrical sources in an enclosed space is referred to as:	15%	<i>Needs Improvement</i>
7. The following are considered as safety precautions prior to entry into an enclosed space, except for:	29%	<i>Fairly Satisfactory</i>
8. All Coast Guard personnel should evacuate the enclosed space and the entrance should be closed or secured against entry if:	50%	<i>Satisfactory</i>
9. One of the proper procedures in testing the atmosphere of an enclosed space is:	73%	<i>Very Satisfactory</i>
10. What percentage of its Lower Explosive Limit [LEL] makes atmospheres hazardous for confined space entry due to a flammable component?	33%	<i>Fairly Satisfactory</i>
Overall % Correct	41%	<i>Satisfactory</i>
<i>Legend: 0% - 20% (Needs Improvement); 21% - 40% (Fairly Satisfactory); 41% - 60% (Satisfactory); 61% - 80% (Very Satisfactory); 81% - 100% (Excellent)</i>		

The interviews also highlighted insights concerning the procedural compliance and risk awareness of the participants. The respondents noted adherence to entry procedures, filling out permits, and situational awareness as key to enclosed space operations. They further defined competence as the procedural knowledge and also as the capacity to identify hazards and stop unsafe work when required. These findings are consistent with the recommendations that competence should be both regulatory and practical decision-making (Maritime and Coastguard Agency, 2022; Martek Marine,

2025; Ocean Technologies Group, n.d.; Marine Insight, 2021).

Summary of Knowledge Indicators

In general, 312 PCG respondents showed "satisfactory" knowledge in regulations and equipment, with competence as the least attained. Even though the three domains are in the satisfactory range, the low competence score indicates a need to strengthen the intensive training programs that emphasize practical skills, safety measures, and operational preparedness in enclosed areas. The final results of the knowledge assessment appear in Table 13:

Table 13. Summary of Overall Knowledge Indicators

Indicator	Overall % Correct / Distribution Basis	Interpretation
Regulations	57% overall accuracy	Satisfactory
Equipment	53% overall accuracy	Satisfactory
Competence	41% overall accuracy	Satisfactory

Proposed Reforms to Improve the Level of Awareness and Knowledge of Coast Guard Personnel Assigned Aboard Ships Associated with Enclosed Spaces

This section discusses the results of interviews with five seafarer participants who work on commercial ships. Their insights yield reforms which PCG vessels can also employ to

enhance personnel awareness and knowledge in enclosed space operations. The study analyzes three areas: regulations, equipment, and competence, and incorporates pertinent literature and interview responses to reveal gaps in knowledge and possible operational and policy advances.

Regulations

Responses in the interview showed that there were different degrees of awareness of the regulations of enclosed space. Certain participants referred to certain international standards, including Safety of Life at Sea [SOLAS] Regulation 7 and IMO Assembly Resolution A.1050(27), and others just showed general familiarity. Participants also varied in terms of training exposure with some having attended formal training programs and the others having limited or no formal training. These reactions indicate the inconsistency in imparting regulatory knowledge amongst staff. Respondents also highlighted that awareness is not sufficient in ensuring proper implementation. Poor enforcement and operational pressures are factors that promote unsafe practices.

One interviewee pointed out that though there are rules, they are not always apparent in practice, and another described how the pressures of operational activities can result in safety process shortcuts. These observations are an indication that more robust reinforcement mechanisms are required to make sure that regulations are adhered to in operations. According to these results, the study proposes the following reforms: (1) the introduction of standard training on international and local enclosed spaces regulations, (2) regular refresher training according to the SOLAS requirements, and (3) the enhancement of monitoring and accountability. Organizations can also use simulation-based drills that mimic operational pressures to strengthen regulatory compliance in real-life situations.

Equipment

The participants of interviews consistently identified the significance of using specialized equipment during the operations in enclosed space such as gas detectors, self-contained breathing apparatuses, and emergency escape breathing devices. However, they usually gained knowledge of these tools through procedures rather than a wide range of practical experience. Members stressed that human senses cannot easily perceive atmospheric risks, which makes competence in the use of equipment crucial.

The interviews also revealed discrepancies in exposure to training. Some of the personnel had access to structured programs and drills, whereas the other part had to depend on informal learning or on-the-job experience. This inconsistency indicates that theoretical knowledge might not be adequate in order to promote safe equipment use during high-risk operations. This study suggests implementing realistic and practical training programs that simulate critical equipment in the real conditions of operation, conducting periodic refresher training, and providing opportunities for personnel to practice their skills in an actual setting. These steps enhance operational preparedness and effective deployment of safety and rescue gear during enclosed space operations.

Competence

The interviews highlighted that the competence in enclosed space operations is not limited to procedural knowledge but also to good sound judgment, recognition of hazards, and decision-making under pressure. According to the participants, competent personnel are the ones who could respond adequately in the case of unexpected situations, as well as those who could make professional judgments in the case when the conditions were not safe. One of the main predictors of competence identified repeatedly by the participants was continuous training and realistic drills. The participants mentioned that most incidents of enclosed spaces happen because of a lack of awareness or lack of practical experience, which emphasizes the significance of practice and familiarity with operations.

The participants also pointed out that the personnel should be empowered to halt unsafe operations when the need arises. The capacity to stop working in conditions of non-safety indicates the not only professional but also organizational support of the safety-related decision-making. On the basis of these results, the suggested reforms are the introduction of compulsory scenario-based exercises that simulate emergency scenarios and conditions, the regularity of competency testings and refresher

courses, the integration of the Stop Work Authority policies that enable personnel to stop unsafe activities, and the increase of the training in terms of hazard recognition, emergency handling, and the ability to make independent decisions.

Summary of Identified Gaps and Proposed Reforms

Table 14 provides the summary of the interview results and indicates the level of knowledge observed, areas of operational gap, and the suggested reforms in the areas of regulations, equipment, and competence:

Table 14. Awareness, Knowledge Gaps, and Proposed Reforms for PCG Respondents in Enclosed Space Operations

Area	Awareness/ Knowledge Findings	Key Gaps	Proposed Reforms
Regulations	<ul style="list-style-type: none"> - Some seafarers cited specific international regulations (SOLAS Reg 7, IMO A.1050(27)) - Others had only general understanding - Training exposure varied: formal vs. none 	<ul style="list-style-type: none"> - Inconsistent delivery of regulatory knowledge - Awareness alone does not guarantee correct application - Poor implementation and weak enforcement - Operational pressures lead to shortcuts 	<ol style="list-style-type: none"> 1. Mandatory, standardized training on international and local regulations 2. Bi-monthly refresher courses aligned with SOLAS updates 3. Simulation-based drills reflecting real operational pressures 4. Monitoring compliance and accountability to prevent procedural shortcuts
Equipment	<ul style="list-style-type: none"> - All seafarers recognized importance of equipment (gas detectors, SCBAs, EEBDs) - Familiarity often procedural rather than hands-on - Practical competence emphasized: cannot rely on senses to judge safety 	<ul style="list-style-type: none"> - Reliance on personal judgment rather than strict procedures - Limited hands-on experience - Inconsistent training (structured vs. informal) 	<ol style="list-style-type: none"> 1. Practical, scenario-based training simulating real operational conditions 2. Regular refresher sessions for critical equipment 3. Repeated hands-on practice to build confidence and competence
Competence	<ul style="list-style-type: none"> - Competence involves sound judgment, critical thinking, decisive action under pressure - Stop unsafe work if necessary - Continuous hands-on training is essential - Exposure to realistic operational scenarios 	<ul style="list-style-type: none"> - Lack of operational decision-making under pressure - Weak hazard recognition or emergency response skills - Limited independent judgment 	<ol style="list-style-type: none"> 1. Mandatory scenario-based drills simulating emergency conditions 2. Structured competency assessments and refresher programs 3. Integration of Stop Work Authority 4. Expanded training on hazard recognition, emergency response, and independent judgment

In general, the discussion revealed that there were a number of regulatory knowledge and equipment familiarity as well as operational competence gaps among the participants. These results emphasize the importance of specific interventions to enhance the practices of enclosed space safety among PCG staff. The specified gaps also give the ground to the creation of the capacity-building program aimed to enhance operational readiness and safety performance on PCG ships.

Conclusion

According to the results of the investigation, the study makes the following conclusions:

1. The Philippine Coast Guard members that work on ships are usually aware of the key risks of entering the enclosed space, particularly those related to the lack of oxygen, toxic gases, and physical hazards. Nevertheless, they have less awareness of other risks like fire and explosion, which means that their understanding of the hazards of the enclosed space is not equally comprehensive. Even though staffs always require access to enclosed areas to perform operational duties that may include maintenance, repairs and inspection, a significant number of them do not have formal training on how to operate in such areas. Although the personnel commonly apply personal protective equipment, the staffs always fail to wear necessary respiratory protection and emergency escape equipment. This may put them at an extra risk when carrying out the operations in the enclosed spaces.
2. The research also finds that PCG respondents have different levels of awareness and knowledge in the three main areas studied; regulations, equipment, and competence. Respondents have a fundamental understanding of enclosed space rules, especially on permits, risk evaluations and safety preparations. They, however, exhibit inconsistency in their knowledge of certain procedural requirements before entry, and little knowledge of detailed regulatory provisions. There is also an overall reasonable level of awareness of equipment used in enclosed spaces, especially in identifying the

significance of gas detection and oxygen monitoring equipment, but many demonstrate the lack of familiarity with specific equipment needed in emergency response and rescue efforts. Interview responses from experienced seafarers back these interview responses. They stressed the need to have regular training and familiarization with practical equipment in order to achieve operational readiness.

3. Enclosed space operations competence proved the most area weak amongst the three domains. Despite the fact that some of the personnel had theoretical information, some respondents could not put safety procedures into practice especially in areas that involved hazards identification, electrical safety measures, and the identification of an explosive atmosphere or unsafe gas levels. Such disconnect between theoretical knowledge and practical skills also poses a possible safety issue because enclosed space operations need not only theoretical knowledge but also an ability to act in hazardous situations.
4. The results, therefore, suggest that the Philippine Coast Guard must reinforce safety in enclosed spaces through training, implementation of regulations, and development of practical skills. The identified gaps in the regulatory knowledge, familiarity with equipment, and operational competence require addressing to enhance the safety practices and mitigate the risk of accidents during enclosed space operations. Designing a comprehensive capacity building program is thus significant, in delivering standardized training, supporting applied competence and guaranteeing that crew members working on ships are well equipped to undertake enclosed space work safely and efficiently.

The Proposed Capacity Building Program to Enhance Personnel's Safety in Enclosed Spaces in PCG Vessels

Based on the competency, procedural and compliance gaps identified in the earlier parts of the study, this section presents the Proposed Capacity Building Program to improve the safety of the personnel of the Philippine Coast

Guard during enclosed space operations in vessels. The program works to fill the gaps in regulatory awareness, equipment competence and operational competence through organized training, simulations and standard operational procedures. The sections that follow describe the program overview, objectives, components, a phased implementation plan, the expected outcomes and the sustainability and continuous improvement mechanisms.

Program Overview

This capacity building project is an extensive, multi-stage initiative which intends to fill in the critical safety gaps in Philippine Coast Guard (PCG) personnel that operate in enclosed or confined shipboard spaces. Based on the results of the study, it demonstrates the lack of training, poor knowledge of the procedures, inadequate use of personal protective equipment (PPE), and inconsistent adherence to the regulations. The program aims at enhancing personnel competence, increasing the level of familiarity with the necessary equipment, and the knowledge and compliance of the local and international maritime safety regulations. Finally, it aims to encourage behavioral change, institutionalize safety measures, and decrease the number of accidents in confined spaces.

Program Objectives

1. To enhance the knowledge and awareness of PCG staff members on the hazards and regulatory requirements involved with enclosed spaces.
2. To make sure that every personnel is trained to the international standards in the field of maritime safety in standardized and competency-based training.
3. To foster a culture of safety and compliance by using protocols and using protective gear consistently and appropriately.
4. To establish formal safety surveillance mechanisms and emergency preparedness systems on board all PCG vessels.

Program Components

1. Identification of High-Risk Areas and Safety Weaknesses

This preliminary phase involves the auditing of PCG ships, with the aim of detecting structural, procedural, and behavioral risks in enclosed areas, as recommended by the study.

Activities

- **Hazard Mapping:** Check high-risk confined spaces (e.g. ballast tanks, cargo holds, void spaces, and sewage tanks)
- **Risk Profiling:** Evaluate historical occurrences, near miss records, and crew observations to determine typical risks that occur (e.g., oxygen deficiency, toxic gas accumulation, and lapses in procedures)
- **PPE and Equipment Inventory Audit:** Assess presence, quality, and crew knowledge of gas detectors, SCBAs, EEBDs and retrieval equipment.

Deliverables

- Risk Assessment Report
- Hazard Register and Priority Index
- Inventory Compliance Sheet

Note: Phase 1 tasks would take about 2 months (see Table 15), to give enough time to carry out solid evaluations, prior to the commencement of the training.

2. Training and Targeted Interventions

This component fills in the competence gaps and knowledge gaps identified in the previous sections through the provision of modular, simulation-based training and leadership development.

A. Competency-Based Training Modules

Each of the modules is directed to seal particular gaps in knowledge that have been marked during the research, such as low awareness of electrical risks, lack of knowledge about the pre-entry process, and low operational preparedness. The modules involve both theoretical and practical training:

Module 1: Essentials of Enclosed Space Entry

Module 2: Gas Detection and Atmospheric Hazards

Module 3: Usage of PPE and Safety Equipment
Module 4: SOPs and Entry Permits

Module 5: Rescue, Disaster Management and Emergency Response

Table 15. Training Proper Activities for Enclosed Space Safety

Module No.	Module Title	Topics / Focus Areas	Training Methods	Duration	Assessment / Deliverables
1	Fundamentals of Enclosed Space Entry	Types of enclosed spaces, hazards, regulatory frameworks (SOLAS, IMO, PCG), pre-entry procedures, roles and responsibilities	Lecture, case studies, group discussions	8 hours	Pre-test/post-test, participation record
2	Atmospheric Hazards and Gas Detection	Oxygen deficiency, toxic/flammable gases, gas detection procedures, interpretation of readings	Lecture, demonstrations, hands-on exercises	6 hours	Practical exercise with gas detection devices, skills checklist
3	PPE and Safety Equipment Usage	SCBAs, EEBDs, retrieval gear, PPE inspection and donning/doffing, common errors	Hands-on practice, simulation drills	8 hours	Skills demonstration checklist, post-test evaluation
4	Entry Permits and SOPs	Permit-to-work process, risk assessment, SOP compliance, buddy system, communication	Lecture, exercises, role-play, permit completion practice	6 hours	Mock permit completion, observation, feedback session
5	Emergency Response and Rescue Operations	Rescue drills, evacuation, casualty handling, first aid, emergency coordination	Live simulation drills, team exercises, real-time scenario enactment	12 hours	Performance evaluation, debrief report, post-test

Total number of formal training hours: 40 hours (distributed over a number of weeks as a part of the phased program, combined with simulations and drills as outlined in Table 16)

Modules and Assessment

Table 15 gives a breakdown of the content of the competency-based training modules, which are the backbone of the capacity building program. The modules are thoroughly structured to cover the knowledge and competence gaps as outlined in the previous sections, so that the personnel are fully aware of regulatory and procedural requirements and can apply such effectively in the operational environments. The specific details to each module are as follows:

Module 1: Essentials of Enclosed Space Entry. Introduces personnel to the types of enclosed spaces, common hazards, relevant inter-

national and local regulations, and roles and responsibilities. Knowledge acquisition is assessed using pre- and post-tests, whereas the involvement in lectures and group discussions is recorded in participation charts.

Module 2: Gas Detection and Atmospheric Hazards. Trains staff to recognize and quantify hazardous air conditions, such as lack of oxygen and poisonous/flammable gases. Practical work using gas detectors can strengthen proper readings and sound decision-making when performing the tasks. Evaluation is based on practice and skills check list.

Module 3: Usage of PPE and Safety Equipment. Attends to proper use, inspection and repair of important safety equipment (e.g., SCBAs, EEBDs, retrieval devices). The simulations and exercises offer practical experience, and the evaluation is conducted through skills demonstration checklists and post-test.

Module 4: SOPs and Entry Permits. Covers permit-to-work, risk assessment, compliance with SOPs, and communication procedures. Mock permit and role-playing exercises enable the personnel to train on authorization, verification, and safety checks. Evaluation involves monitoring of exercises and feedback.

Module 5: Rescue, Disaster Management and Emergency Response. Trains staff on how to act in case of an emergency in the closed area, involving live rescue, handling of casualties and coordination of the team. It entails measuring the practical competence and preparedness of personnel under simulated operational stress through performance evaluations, debriefing of reports and post-tests. All modules consist of theoretical learning, practical tasks, and evaluations to confirm the knowledge and practical skills. Pre- and post-tests, skills demonstrations, and performance observations guarantee measurable learning outcomes and the preparedness to the real-life situation.

Training Duration

The total training course duration of about nine months provides good coverage of all competency areas, but also allows enough time to practice and simulate, as well as certify personnel with a supervisor. Table 15 provides the phased schedule and Table 16 presents the operational requirements on PCG vessels with the need to:

1. Provide modules with pre- and post-tests;
2. Carry out simulation exercises to strengthen operational competence;
3. Introduce the supervisor certification program to supervise leadership;
4. Complete and issue SOPs with personnel indoctrination;
5. Acquire, examine, and distribute safety equipment;

6. Implement online tracking and reporting systems; and
7. Undertake yearly audits and ongoing improvement

Nine months might seem like a long time, but the study takes this time span as required to facilitate proper sequence training, simulations, SOP implementation, equipment issuance, and digital integration without appreciably affecting operational readiness or learning outcomes.

B. Simulation Drills and Live Exercises

- Mandates that personnel are involved in quarterly enclosed space entry and rescue training on all vessels;
- Involves simulations of realistic emergencies, use of operational stressors;
- Assesses performance and gives feedback related to promotion and readiness tests; and
- Debriefs onboard to discuss the results of the drills and what can be improved

C. Supervisor Certification Program

Mandates that officers and team leaders take an Enclosed Space Safety Supervisor course to provide higher-level skills and leadership to operate safely in confined space.

Deliverables

- Training Attendance Records Pre- and Post-Test Evaluation Scores
- Simulation Reports
- Supervisor Certification Credentials

3. Standard Operational Procedures (SOPs) Development and Enforcement

This element codifies best practices in entry to enclosed spaces, in line with study recommendations:

1. Creates an SOP manual, which includes pre-entry requirements, risk assessment, permit-to-work, PPE checklists, and post-incident reporting.
2. Adopts an online tracking system that facilitates real-time entry tracking, hazards reporting, and automatic dashboards.

3. Makes yearly safety audits to measure compliance and educate on continual improvement. lays into the overall nine-month schedule (see Table 15).

Note: These activities are done in a sequence following training modules to secure that the personnel becomes competent before the full implementation of SOP. This sequencing also

Deliverables

- SOP Manual (Printed and Digital)
- Permit to Work and Equipment Inspection Templates
- Digital Safety Audit Logs
- Annually Compliance Report per Vessel

Table 16. Phased Implementation Plan for Enclosed Space Safety Enhancement in PCG Vessels

Phase	Activity	Timeline	Responsible Unit/s	Key Output/s
Phase 1: Assessment and Baseline Profiling	Vessel hazard mapping, equipment inventory audit, and crew competence survey	Months 1-2	PCG Safety and Inspection Division + Training Branch	Risk Assessment Report, Hazard Register, Equipment Inventory Sheet
Phase 2: Training Module Development and Supervisor Certification Rollout	Finalize training materials, begin supervisor certification course, and pretest evaluation	Months 2-3	PCG Training Branch + Maritime Safety Experts	Competency-Based Training Curriculum, Certified Supervisors List
Phase 3: Training Implementation and Simulation Drills	Rollout of all training modules, conduct ship-board simulations, and monitor personnel performance	Months 3-5	PCG Training Branch + Vessel Safety Officers	Training Attendance Records, Simulation Reports, Pre/Post-Test Scores
Phase 4: SOP Finalization and Distribution	Finalize, approve, and distribute SOPs across vessels; onboard orientation for all crew	Months 5-6	PCG Safety Directorate + Legal and Standards Team	SOP Manual, SOP Orientation Logs, Onboard SOP Checklists
Phase 5: Equipment Standardization and Issuance	Procurement, inspection, and issuance of essential safety equipment to all vessels	Months 6-7	Logistics and Supply Unit + Procurement Office	Equipment Compliance Checklist, PPE Issuance Logs
Phase 6: Digital Safety Monitoring Integration	Launch digital permit systems and hazard reporting tools; train designated users	Months 7-8	ICT Unit + PCG Oversight Division	Digital Monitoring App, Compliance Dashboards, Permit-to-Work Digital Logs
Phase 7: Monitoring, Audits, and Continuous Improvement	Conduct annual safety audits, implement feedback, and review training effectiveness	Month 9 (continuous)	Oversight and Compliance Division + Third-Party Auditors	Audit Reports, Training Impact Reviews, Revised SOPs/Training Updates

Expected Outcomes

1. Improve the proportion of PCG staff who undergo formal training and have been proven to have operational competence in enclosed space procedures.
2. Minimize procedural mistakes and poor practices in ships.
3. Enhance the adherence to the use of PPE, equipment preparedness, and testing of the atmosphere.
4. Decrease reported injuries, fatalities, and near-miss incidents related to enclosed space operations.
5. Complete integration and uniform implementation of standard operating procedures (SOPs) within all PCG units of operation.

Follow-up, Sustainability and Program Evaluation

The Philippine Coast Guard has incorporated this capacity building program into its official Safety Management System (SMS) in order to have a long term effectiveness. Continuous training module, equipment guidelines and SOPs refinement are informed through regular reviews such as annual safety audit, staff responses and updating of international regulations governing maritime commerce. The program also establishes strategic alliances with commercial shipping operators and maritime training institutions to boost PCG capacities and ensure that they remain in touch with the changes in global safety standards.

Program Evaluation

The program keeps track and upholds the training outcomes with periodical re-evaluations of the staff skills, such as:

1. Pre and post training tests and monitoring of performance on simulation
2. Assessing compliance with operations via SOP compliance and incident reports
3. Offering refresher training on the basis of evaluation results
4. Revising modules and SOPs on lessons learned

This performance appraisal process guarantees the enhancement of competencies, safe

practices in PCG vessels, and program effectiveness in the long-term.

Acknowledgement

The completion of this research project is a big step forward in my entire educational accomplishment as a researcher. I am very thankful to everyone who helped, guided, and encouraged me along the way.

I would like to express profound gratitude to my Thesis Adviser, Atty. Roel Saguid, for his excellent advice, encouragement, and helpful feedback. He always made sure that my study's goals were met. I also thank Dean Ma. Nissa Espiritu, from the bottom of my heart, whose valuable support, and guidance were very helpful in making this research study better.

I am also very grateful to Mr. Marvin Tan Celamor, the statistician, for his careful analysis, expert advice, and constant help throughout the research process. I also want to thank the panel members: Capt. Neopol L. Salvador, Prof. Victoria Q. Paraggua, and CG Commo Dominador P. Senador III, for patiently reviewing my study as well as their willingness to share their knowledge, which helped make this research a huge success.

I am also thankful to CG RAMD Edgar L. Ybanez, the Commander of the Coast Guard Fleet, for allowing me to conduct the study with his staff. This research would not have been completed without the active involvement of the Philippine Coast Guard (PCG) respondents and the seafarer participants who freely and honestly shared their experiences.

Finally, I would like to thank my family from the bottom of my heart. I appreciate their valuable presence, as well as their endless support, encouragement, and inspiration while I worked on this project. I also want to thank God for giving me the strength, perseverance, and the patience I needed to get through the tough times.

References

- Abad C, Nano C, Aguilar J, Canape B, Cuevas Jr J (2023) Lived experiences of the Philippine Coast Guards personnel in performing their functions. *Mediterr J Basic Appl Sci.* 7(2):136-146.

- <https://mjbas.com/data/uploads/55646.pdf>
- Akindehin F, Ekechukwu D, Iwaye G, Oligoron M, Caiga B, Aguado C (2015) Effectiveness of seafarers' safety measures. *Asia Pac J Marit Educ.* 1(2):1-6. <https://research.lpubatangas.edu.ph/wp-content/uploads/2016/12/APJME-2015-2-001-Effectiveness-of-Safety-Measures-Onboard.pdf>
- Allen M, Robson D, Iliescu D (2023) Face validity: A critical but ignored component of scale construction in psychological assessment. *Eur J Psychol Assess.* 39(3):153-156. <https://doi.org/10.1027/1015-5759/a000777>
- Almeida F (2018) Strategies to perform a mixed methods study. *Eur J Educ Stud.* 5(1):137-151. <http://dx.doi.org/10.5281/zenodo.1406214>
- Ayeng R(2023) Three bulk carrier crew members die. <https://tribune.net.ph/2023/12/3-bulk-carrier-crew-members-die/>
- Baltic and International Maritime Council (2025) Safety in enclosed spaces: An update from the IMO CCC 10. <https://www.bimco.org/news-insights/bimco-news/2024/20241106-safety-in-enclosed-spaces/>
- Chibana I (2023) Challenges and conditions for sustainable seafarer supply: A case of the Philippines. IDE-JETRO. https://www.ide.go.jp/library/English/Publish/Re-ports/Brc/pdf/re32_00.pdf
- Corpuz A, Dirain E, Fabul I, Penilla R, Medina K (2025) The impact of conducting safety drills onboard vessels on emergency response preparedness of Filipino seafarers. *Digital J Philippines.* 2(1):32-42. <http://dx.doi.org/10.62718/vmca.ol-ijmos.2.1.SC-1024-012>
- DataSpring(2022) Filipino seafarers, the modern foundation of the maritime industry. <https://www.d8aspring.com/eye-on-asia/filipino-seafarers-the-modern-foundation-of-the-maritime-industry>
- Francisco E (2023) Introduction to maritime safety: A guide. <https://safetyculture.com/topics/maritime-safety/>
- Gard (2019) Every second counts – how long can you survive without oxygen? <https://gard.no/insights/every-second-counts-how-long-can-you-survive-without-oxygen/>
- Gard (2025) Improved safety recommendations for entering enclosed spaces onboard ships. <https://gard.no/insights/improved-safety-recommendations-for-entering-enclosed-spaces-onboard-ships/>
- ICHCA International (2022) Enclosed space incidents. <https://ichca.com/enclosed-space-incident>
- International Maritime Organization (2019a) Introduction to IMO. <https://www.imo.org/en/About/Pages/Default.aspx>
- International Maritime Organization (2019b) The International Safety Management (ISM) code. <https://www.imo.org/en/ourwork/humanelement/pages/ISMCode.aspx>
- International Maritime Organization (2023) Revision of resolution A.1050(27) to ensure the safety of personnel entering enclosed spaces on board ships. <https://www.intercargo.org/wpcontent/uploads/2023/06/CCC-9-8-2-Analysis-of-enclosed-space-accidents-2011-to-2023-and-their-impact-upon-the-revision-of-rec...-BIMCO-ICMA-IFSMA-IMarE....pdf>
- International Registries (2025) Efforts continue to raise awareness of enclosed space entry risks. <https://www.register-iri.com/blog/efforts-continue-to-raise-awareness-of-enclosed-space-entry-risks/>
- Kantharia R (2023) What is International Safety Management Code or ISM code for ships? <https://www.marineinsight.com/maritime-law/what-is-international-safety-management-code-or-ism-code-for-ships/>
- Khayat S (2023) Women, peace and maritime security in the Philippines. <https://pacforum.org/event/women-peace-and-maritime-security-in-the-philippines/>

- Lidell B (2025) Enclosed space entry: A continuing concern for seafarer safety. <https://www.iomshipregistry.com/news/2025/mar/enclosed-space-entry-a-continuing-concern-for-seafarer-safety/>
- Marine Insight (2021) Procedure for entering an enclosed space on a ship. <https://www.marineinsight.com/marine-safety/procedure-for-entering-an-enclosed-space-on-a-ship/>
- Maritime and Coastguard Agency (2022) Enclosed spaces on sea-going vessels. <https://www.gov.uk/guidance/enclosed-spaces-on-sea-going-vessels>
- Martek Marine (2025) Navigating the perils of enclosed space entry. <https://www.martek-marine.com/enclosed-space-entry/>
- Masuwai A, Zulkifli H, Hamzah M (2024) Evaluation of content validity and face validity of secondary school Islamic education teacher self-assessment instrument. *Cogent Educ.* 11(1):1-12. <https://doi.org/10.1080/2331186X.2024.2308410>
- Nautilus Shipping (2024) Enclosed space entry – what it is, permits, and how to prepare. <https://www.nautilusshipping.com/news-and-insights/enclosed-space-entry>
- Ocean Technologies Group (n.d.) Enclosed spaces at sea. <https://oceantg.com/blog/enclosed-spaces-onboard-ships/>
- Port News (2023) Three sailors dead on the Blue Cecil. <https://www.portnews.it/en/three-sailors-dead-on-the-blue-cecil/>
- Qingwei Z (2022) Who is to blame for the repeated occurrence of accidents in enclosed space? <https://safety4sea.com/who-is-to-blame-for-the-repeated-occurrence-of-accidents-in-enclosed-space/>
- Safety4Sea (2021) The importance of reviewing enclosed space procedures. <https://safety4sea.com/the-importance-of-reviewing-enclosed-space-procedures/>
- Safety4Sea (2025) Statistics show worrying trend of enclosed space related deaths. <https://safety4sea.com/statistics-show-worrying-trend-of-enclosed-space-related-deaths/>
- [worrying-trend-of-enclosed-space-related-deaths/](https://www.safety4sea.com/worrying-trend-of-enclosed-space-related-deaths/)
- Sakar C, Büber M, Koseoglu B, Toz AC (2022) Risk analysis for confined space accidents onboard ship using fuzzy bow-tie methodology. *Ocean Eng.* 263:112386. <https://doi.org/10.1016/j.oceaneng.2022.112386>
- Schoonenboom J, Johnson R (2017) How to construct a mixed methods research design. *Kolner Z Soz Sozpsychol.* 69(2):107-131. <https://doi.org/10.1007/s11577-017-0454-1>
- Sha M (2020) A study of the human factors in maritime safety. MSc thesis. World Maritime University. https://commons.wmu.se/cgi/viewcontent.cgi?article=1272&context=msem_dissertations
- Soner O, Celik M (2020) A human reliability assessment through enclosed space entry operation onboard ships. *J Eng Marit Environ.* 235(2):273-287. <https://doi.org/10.1177/1475090220979867>
- Steamship Insurance Management Services (2025) Fatality in the cargo hold (enclosed space). <https://www.steamship-mutual.com/fatality-cargo-hold-enclosed-space>
- Steinke A, Kopp B (2020) RELEX: An Excel-based software tool for sampling split-half reliability coefficients. *Methods Psychol.* 2:100023. <https://doi.org/10.1016/j.metip.2020.10.0023>
- The Nautical Institute (2018) Shiphandling competence: Learning how to get it right. <https://www.nautinst.org/resources-page/shiphandling-competence-learning-how-to-get-it-right.html>
- United Nations Development Programme (2025) The SDGs in Action. <https://www.undp.org/sustainable-development-goals>
- Voytenko M (2023) Three seamen died on board of bulk carrier BLUE CECIL, South China Sea. <https://www.fleetmon.com/maritime-news/2023/43925/three-seamen-died-board-singaporean-bulk-carrier-s/>

Warfa A (2016) Mixedmethods design in biology education research: Approach and uses. *CBE Life Sci Educ.* 15(5):1-11. <https://doi.org/10.1187/cbe.16-01-0022>

West of England (2025) Enclosed space entry. <https://www.westpandi.com/news-and-resources/loss-prevention-bulletins/enclosed-space-entry/>