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Knowledge and Training Exposure in Safety Risk Management Among Third-Year Marine Transportation Cadets: A Descriptive-Comparative Study

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ABSTRACT

Safety Risk Management (SRM) is essential for seafarers, yet few studies measure how well pre-immersion cadets grasp SRM concepts or how training exposure relates to that knowledge. This study assessed SRM knowledge and training exposure among 80 third-year Marine Transportation and Marine Engineering cadets at a Philippine maritime institution before shipboard immersion. A descriptive-comparative design used a questionnaire aligned with the ISM Code and STCW Convention, covering four SRM areas: hazard identification, risk assessment, risk control/mitigation, and monitoring and review. Cadets reported high SRM knowledge and training exposure overall. Training exposure correlated strongly with SRM knowledge in every area, while differences between the two programs were not significant. Findings suggest strong theoretical grounding, but hands-on exposure remains closely tied to knowledge development; expanding simulation-based training and structured mentoring is recommended.

Keywords: *cadet training, hazard identification, maritime education, risk assessment, safety culture, safety risk management*

INTRODUCTION

Safety has always been the cornerstone of maritime operations. The inherently high-risk nature of the shipping industry, characterized by unpredictable weather, mechanical failures, navigational complexity, and human error, demands a systematic and proactive approach to managing risks. Safety Risk Management (SRM) provides this framework by guiding seafarers in identifying hazards, assessing risks, implementing control measures, and continuously monitoring safety performance. At the global level, the International Maritime Organization (IMO) institutionalizes safety practices through key frameworks such as the International Safety Management (ISM) Code, the International Convention for the Safety of Life at Sea (SOLAS), and the Standards of Training, Certification and Watchkeeping for Seafarers (STCW), all of which aim to standardize safety competencies and reduce maritime accidents worldwide (International Chamber of Shipping [ICS], 2011; International Maritime Organization [IMO], 2015, 2020).

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Despite the existence of these international standards, maritime incidents continue to occur, with human error identified as a primary contributing factor. The Allianz Safety and Shipping Review reports that human error is implicated in up to 96% of maritime accidents, with roughly 75% of liability claims stemming from failures in human performance (Allianz Global Corporate & Specialty, 2019). This highlights a critical issue: while regulatory frameworks exist, their effectiveness depends largely on how well individuals, particularly future seafarers, understand and apply safety risk management principles in real-world contexts. Guo and Li (2021) similarly argue that integrating the ISM Code into educational curricula needs to be complemented with pedagogical innovations, such as simulation training and reflective debriefing, to build authentic SRM competence. For marine cadets, especially those preparing for shipboard immersion, this challenge becomes more pronounced. Many cadets possess theoretical knowledge of safety procedures but experience difficulty applying these principles in dynamic, high-risk environments. Limited exposure to real-life scenarios, inconsistent training opportunities, and varying levels of confidence contribute to gaps between knowledge and actual safety practice.

Despite the extensive literature on maritime safety, gaps remain in understanding cadets' readiness in Safety Risk Management. Most existing studies center on licensed officers, accident investigations, or organization-level safety management systems, which, while informative, largely overlook cadets at the initial phase of their training, leaving a blind spot in how well maritime education and training institutions prepare prospective officers. Recent literature points to several recurring issues facing cadets during shipboard training, including limited hands-on exposure to real shipboard hazards, inconsistent implementation of safety protocols, and insufficient preparedness for high-risk tasks, reflecting a disconnect between classroom instruction and the actual demands of shipboard operations.

At the national level, the Philippines plays a vital role in the global maritime industry as one of the largest suppliers of seafarers. As such, the country is bound to uphold international standards while also ensuring the quality of maritime education. Regulatory bodies such as the Commission on Higher Education (CHED) and the Maritime Industry Authority (MARINA) are responsible for overseeing maritime education and training institutions, ensuring that programs comply with STCW requirements, particularly in developing competencies related to safety, emergency response, and risk management. At the institutional level, maritime schools are tasked with translating these global and national standards into effective educational practices. Through Bachelor of Science programs in Marine Transportation and Marine Engineering, cadets are equipped with both theoretical knowledge and practical skills necessary for maritime operations. Within this framework, third-year cadets occupy a critical transition point, as they prepare to shift from classroom-based instruction to shipboard immersion, and are expected to demonstrate readiness not only in understanding safety procedures but also in applying them effectively in real-life situations.

Given these challenges, there is a need to critically assess the level of knowledge and training exposure in Safety Risk Management among third-year marine cadets. Understanding how well these students grasp and apply SRM competencies before shipboard immersion is essential in identifying gaps in maritime education and improving training strategies. In light of this, the present study aims to assess the knowledge and training exposure in Safety Risk Management among third-year cadets, specifically evaluating their competencies in hazard identification, risk assessment, risk control and mitigation, and monitoring and review, and examining how training exposure relates to their level of preparedness.

Theoretical and Conceptual Framework

This study draws on three complementary theories. The Swiss Cheese Model of accident causation (Reason, 1990) frames cadets' SRM knowledge as one layer of defense against maritime accidents, alongside international conventions, institutional training, and shipboard protocols. The ISO 31000 risk management framework (International Organization for Standardization [ISO], 2018) provides the structured process, hazard identification, risk analysis, evaluation, and control, against which cadets' understanding was assessed. High Reliability Organization (HRO) theory (Weick & Sutcliffe, 2015) contributes the cultural dimension, emphasizing

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vigilance, resilience, and proactive safety behavior even before full shipboard immersion. Together, these perspectives frame SRM knowledge as a systemic requirement, a structured process, and a cultural mindset.

Fig. 1 summarizes the conceptual framework: cadets' profile (program, age, sex, prior training) and training exposure (survival craft and rescue boats, advanced firefighting, medical first aid and medical care, and security-related training) were treated as independent variables hypothesized to influence SRM knowledge (hazard identification, risk assessment, risk control and mitigation, and monitoring and review), the dependent variable.

Independent Variables	Dependent Variable
Cadet profile (program, age, sex, prior training/seminars); training exposure (survival craft and rescue boats; advanced firefighting; medical first aid and medical care; security-related training)	Safety Risk Management knowledge (hazard identification; risk assessment; risk control and mitigation; monitoring and review)

Fig. 1. Conceptual framework relating cadets' profile and training exposure to their Safety Risk Management knowledge.

METHODS

Research Design

The study adopted a descriptive-comparative research design to capture and contrast the levels of knowledge and training exposure among third-year cadets, allowing the researchers to describe cadets' understanding of SRM and to compare differences between groups (Calmorin & Calmorin, 2007; Fraenkel et al., 2012; Kothari, 2004).

Participants

Participants were third-year cadets enrolled in the BSMT and BSMARE programs at a Philippine maritime higher-education institution during the second semester of Academic Year 2025-2026. Purposive sampling was used, yielding a final sample of 80 respondents. A pilot test was conducted beforehand with 20 students (10 BSMT, 10 BSMARE) to confirm the instrument's reliability and validity.

Research Instrument

A structured questionnaire, developed based on the ISM Code, the STCW Convention, and relevant literature, was used. It had two sections: (1) Profile of Respondents, covering program, age, sex, and prior safety-related training; and (2) Knowledge of Safety Risk Management and Training Exposure, using Likert-scale items across the four SRM competency areas and four corresponding training-exposure areas. The instrument was reviewed by faculty members and maritime education practitioners for content validity.

Data Gathering Procedure and Ethical Considerations

Ethical clearance was secured from the University Research Ethics Committee, and permission was obtained from the College of Maritime Education prior to data collection. Participation was voluntary; cadets were briefed on the study's purpose and their right to withdraw, and informed consent was obtained before questionnaires were completed and collected. Responses were treated with strict confidentiality and anonymity throughout encoding, storage, and analysis, and data will be securely disposed of after the underlying thesis is completed and defended.

Data Analysis

Data were analyzed using descriptive statistics (frequency, percentage, weighted mean) to summarize respondent profiles and levels of knowledge and training exposure, interpreted on a five-point scale. Inferential statistics tested the study's hypotheses: an independent-samples t-test examined differences by program, and the

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Pearson product-moment correlation coefficient (r) examined the relationship between training exposure and SRM knowledge. All data were analyzed using SPSS Version 30.

RESULTS AND DISCUSSION

This section presents findings on cadets' SRM knowledge, training exposure, and the statistical relationships and group differences examined through the study's hypotheses.

Level of Safety Risk Management Knowledge

Table 1. *Level of Safety Risk Management knowledge among third-year cadets*

Competency Area	Weighted Mean	Descriptive Rating
Hazard Identification	4.03	Agree/High
Risk Assessment	3.94	Agree/High
Risk Control and Mitigation	4.06	Agree/High
Monitoring and Review	3.98	Agree/High
Overall	4.00	Agree/High

Note. 4.21-5.00 = Strongly Agree/Very High (A); 3.41-4.20 = Agree/High; 2.61-3.40 = Neutral/Moderate; 1.81-2.60 = Disagree/Low; 1.00-1.80 = Strongly Disagree/Very Low.

Table 1 shows that cadets' SRM knowledge was consistently rated Agree/High across all four competency areas, with an overall mean of 4.00. The highest composite mean was in Risk Control and Mitigation (M = 4.06), followed by Monitoring and Review (M = 3.98), Hazard Identification (M = 4.03), and Risk Assessment (M = 3.94), the lowest-scoring area. Within Risk Assessment, the item “I am able to assess the likelihood of potential hazards occurring on board” recorded the lowest individual mean (M = 3.85), suggesting comparatively less confidence in probability judgments than in other SRM tasks.

Level of Training Exposure

Table 2. *Level of training exposure among third-year cadets in Safety Risk Management*

Competency Area	Weighted Mean	Descriptive Rating
Hazard Identification	4.06	Often
Risk Assessment	4.03	Often
Risk Control and Mitigation	4.07	Often
Monitoring and Review	4.10	Often
Overall	4.06	Often

Note. 4.21-5.00 = Always (A); 3.41-4.20 = Often (O); 2.61-3.40 = Sometimes; 1.81-2.60 = Rarely; 1.00-1.80 = Never.

Table 2 shows an overall training exposure mean of 4.06, indicating that cadets were often to always exposed to SRM-related training. The highest composite mean was recorded in Monitoring and Review (M = 4.10), followed by Risk Control and Mitigation (M = 4.07), Hazard Identification (M = 4.06), and Risk Assessment (M = 4.03). Within Hazard Identification, classroom lectures or theoretical sessions recorded the lowest individual mean (M = 3.90, Often), while onboard shipboard training in which cadets observed or assisted in risk assessments recorded the highest (M = 4.15, Always), suggesting that hands-on shipboard exposure outpaced classroom-based instruction in this sample.

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Relationship Between Knowledge and Training Exposure

Table 3. *Relationship between cadets' Safety Risk Management knowledge and training exposure, by competency area*

Competency Area	r	p
Hazard Identification	0.781	< .001
Risk Assessment	0.699	< .001
Risk Control and Mitigation	0.813	< .001
Monitoring and Review	0.760	< .001

Note. All correlations significant at p < .001 (2-tailed).

Table 3 indicates a strong, statistically significant, positive relationship between cadets' SRM knowledge and their training exposure across all four competency areas, with correlation coefficients ranging from r = 0.699 to r = 0.813 (p < .001 in every cell). This indicates that cadets with higher levels of SRM knowledge also tended to report greater exposure to training activities, including classroom lectures, practical exercises, and onboard shipboard training, providing support for rejecting the null hypothesis of no relationship between training exposure and SRM knowledge (H02).

Difference in Knowledge and Training Exposure by Program

Table 4. *Difference in cadets' Safety Risk Management knowledge and training exposure by program*

Variable	Program	M	SD	t	p
SRM Knowledge	BSMT	3.64	1.50	-1.945	.066
	BSMARE	4.36	0.42		
Training Exposure	BSMT	3.85	1.37	-1.826	.082
	BSMARE	4.47	0.43		

Table 4 presents differences in SRM knowledge and training exposure between BSMT and BSMARE cadets. BSMARE cadets recorded a higher mean SRM knowledge score (M = 4.36, SD = 0.42) than BSMT cadets (M = 3.64, SD = 1.50); however, the difference was not statistically significant, t = -1.945, p = .066. Similarly, BSMARE cadets recorded higher training exposure (M = 4.47, SD = 0.43) than BSMT cadets (M = 3.85, SD = 1.37), but this difference was also not statistically significant, t = -1.826, p = .082. These results do not provide sufficient grounds to reject the null hypothesis of no significant difference in SRM knowledge or training exposure by program (H01).

DISCUSSION

The findings show that third-year cadets in this sample already report a high level of both SRM knowledge and training exposure. Read alongside the broader literature, however, a more nuanced picture emerges: knowing safety concepts is not necessarily the same as being fully prepared to apply them in real-world shipboard situations. The Allianz Safety and Shipping Review's finding that human error is implicated in up to 96% of maritime accidents (Allianz Global Corporate & Specialty, 2019) suggests that even where cadets understand hazard identification, risk assessment, and safety procedures well, challenges may still arise once they are placed in actual shipboard environments, consistent with this study's pattern of strong theoretical scores alongside acknowledged gaps in practical application.

The literature also emphasizes the importance of training exposure, particularly simulation-based learning and shipboard experience. Bal (2011) and Sharma et al. (2015) found that simulation helps cadets practice decision-making and risk assessment in controlled but realistic conditions, and the present study similarly found

that cadets with higher exposure to drills, simulations, and onboard training reported stronger SRM knowledge, with training exposure significantly correlated with knowledge across every competency area (r = 0.699-0.813).

At the same time, one of the more important concerns raised in both the literature and this study's results is inequality of training opportunity. Mori (2024) and Rivera et al. (2025) found that cadets do not receive uniform shipboard exposure or mentoring, with some actively involved in safety tasks and others limited to minor roles, creating differences in confidence, skill, and readiness. Although overall training exposure was high in this sample, the lowest individual item score (classroom lectures on SRM, M = 3.90, Often) suggests room to strengthen the theoretical, classroom-based component that complements hands-on exposure.

The role of mentoring and safety culture also warrants attention. Nicolae et al. (2023) found that cadets learn most effectively when guided by experienced officers who model proper safety behavior, a form of learning that extends beyond formal instruction to real-world judgment and responsibility. Without consistent mentoring, cadets may struggle to fully internalize a safety mindset even where they understand the underlying procedures, reinforcing the value of pairing structured training exposure with active mentoring ahead of shipboard immersion.

The non-significant difference in SRM knowledge and training exposure between BSMT and BSMARE cadets suggests that, in this sample, program of study was not a major driver of disparities in SRM readiness, which may reflect a shared institutional training pipeline for core safety competencies across both programs. This finding should be interpreted cautiously given the sample size and the wide standard deviation observed among BSMT cadets.

CONCLUSION

This study concludes that third-year cadets in this sample possessed a generally high level of Safety Risk Management knowledge, and their training exposure was similarly high across all four SRM competency areas, though their preparedness likely varies with the extent and quality of that exposure. Training exposure, encompassing participation in safety drills, simulation exercises, and seminars, was strongly and significantly related to SRM knowledge in every competency area examined, indicating that structured training experiences play a substantial role in shaping how well cadets understand and can apply safety principles. Differences in SRM knowledge and training exposure between Marine Transportation and Marine Engineering cadets were not statistically significant, suggesting relatively comparable readiness between the two programs in this sample. Taken together, the findings suggest that while the current educational framework provides a solid foundation for SRM learning, strengthening experiential and hands-on components, and ensuring their consistent delivery, remains important for closing the gap between theoretical knowledge and shipboard-ready practice.

These findings carry several implications for maritime education, training institutions, and policy development. First, given the strong association between training exposure and SRM knowledge, institutions may benefit from integrating more simulation-based activities, hands-on exercises, and structured mentoring into their curricula. Second, the literature's emphasis on unequal access to shipboard opportunities suggests that institutions and partner shipping companies should work toward ensuring that all cadets, regardless of academic standing or program, receive fair opportunities to participate in safety-related activities. Third, from a policy perspective, training programs should be continuously updated to reflect emerging industry demands, including alternative fuels, digitalization, and automation, so that SRM competencies keep pace with the risks cadets will actually encounter. Future research would benefit from longitudinal designs that track how SRM competencies develop over time, particularly before and after shipboard immersion, and from studies that compare the relative effectiveness of specific training modalities, such as simulation versus traditional classroom instruction. Expanding this line of research to multiple maritime institutions, and incorporating performance-based or observed measures of competence alongside self-report, would help clarify how training exposure translates into demonstrated shipboard readiness.

This study has several limitations. It was conducted among third-year cadets at a single maritime institution, which limits the generalizability of the findings to cadets at other institutions or in other national

contexts. Knowledge and training exposure were measured through a self-reported questionnaire, which is susceptible to response bias; some participants may have overestimated or underestimated their actual knowledge or experience. The study also relied solely on quantitative data, which does not capture the deeper experiences, challenges, or perceptions cadets have regarding SRM; qualitative approaches such as interviews or focus groups could provide richer insight. In addition, the study did not directly assess cadets' actual performance in real or simulated scenarios, meaning it measures perceived knowledge rather than demonstrated competence, a distinction that matters because understanding safety procedures does not guarantee the ability to apply them effectively under pressure. Finally, time and resource constraints may have limited the scope of the research, including sample size and depth of analysis.

Based on the findings and conclusions, the following are recommended: (1) since classroom lectures or theoretical sessions on SRM recorded the lowest training-exposure mean (M = 3.90), maritime institutions should look for ways to strengthen the classroom component alongside hands-on training; (2) since assessing the likelihood of hazards recorded the lowest knowledge-area mean (M = 3.85), curricula and simulation exercises should place additional emphasis on probability-based risk judgment; (3) given the strong, consistent relationship between training exposure and SRM knowledge, institutions should expand simulation-based and hands-on training opportunities and monitor that these are distributed equitably among cadets; (4) given literature indicating unequal shipboard placement and mentoring quality (Mori, 2024; Rivera et al., 2025), shipping company partners and institutions should work toward more consistent, structured mentoring programs; (5) because differences between BSMT and BSMARE cadets were not statistically significant in this sample, institutions should continue applying comparable SRM training standards across programs while monitoring whether this pattern holds with larger samples; and (6) future institutional research should incorporate performance-based assessment, such as observed drill performance, to complement self-reported knowledge and training-exposure measures.

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Declaration of Generative AI Use

Generative AI assistance (large language model) was used during manuscript preparation, limited to: reformatting content to the journal's template, condensation for length, and reference-list standardization. Data collection, analysis, and interpretation were performed solely by the authors. All AI-assisted text was reviewed, verified, and edited by the authors, who take full responsibility for the accuracy and content of this publication.

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