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Cadet's Proficiency in Engine Watchkeeping Course Using Engine Simulator

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ABSTRACT

The engine simulator is the state-of-the-art learning tool that replicates the actual engine system and machinery operations onboard the ship and is considered the best alternative to train and assess the competence of maritime cadets in maritime higher education institutions. This descriptive study aimed to evaluate the cadet's proficiency in the engine watchkeeping course using an engine simulator. The respondents of the study were 208 third-year cadets taking up the Bachelor of Science in Marine Engineering program at the University of Antique for the academic year 2023-2024. The researcher-made instrument was adopted based on the engine watchkeeping course syllabus approved by the Maritime Industry Authority (MARINA), a single maritime administration in the Philippines aligned with the Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) Convention. The statistical tools were mean, frequency, and percentage for descriptive analysis; Kruskal-Wallis H test for the independent samples. The study found that the majority of the cadets can handle familiar ship conditions and seek assistance on difficult ship conditions using an engine simulator as an evaluation tool in the engine watchkeeping course, from cold ship operation to their own supply, harbor condition operation to ready for departure, and constant speed operation, respectively. Recommendations are made to improve the cadets' proficiency on engine-related operations using an engine simulator.

1. Introduction.

Human factor is widely recognized as a key element of the safety of life onboard ships and a contributing factor to most of the casualties in the shipping sectors. Over 80% of the world's trade depends on the professionalism and competence of seafarers. Human errors, on the other hand, are believed to be the cause of around 80% of maritime accidents. Some of such accidents occur in the engine room where over 20% of accidents take place. The erroneous actions of the crew account for 65.8% of the 4104 accidents. It is vital that cadets have acquired adequate knowledge and skills before they start working onboard (International Maritime Organization, 2019; European Maritime Safety Agency, 2019; Wrobel, 2021; Krystosik-Gromadzinska, 2020).

The maritime industry demands a knowledgeable and skillful maritime professional, especially on the safe operation and maintenance of various machinery and equipment onboard the ship. Maritime cadets, as aspiring maritime professionals, are poised to possess practical skills and knowledge to prepare themselves for a more challenging ship-related operation. To bridge the gap between the theory and practical application, the engine simulator (ES) is the best learning and training tool for maritime cadets (STCW Convention, 1978, as amended; Joint CHED-MARINA Memorandum Circular No. 1, 2023).

The engine simulator is a state-of-the-art learning and training tool that is considered the best alternative for the real-life scenarios onboard that replicate the complexities of a ship's engine room, allowing cadets to hone their skills, practice emer-

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gency procedures, and familiarize themselves with the operations of various propulsion systems. This tool provides a necessary knowledge and skills for cadets to gain hands-on experience without accident that can be experienced in the real-life scenario onboard. The use of an engine simulator as a learning tool for cadets can prepare them for more challenging shipping activities in the 21st century.

Many studies have been conducted using the engine room simulator as a learning and assessment tool. Zincir et al. (2017) studied and confirmed that the scenario-based assessment method can be a good tool to evaluate the cadets in various scenarios using the engine room simulator. Similar studies revealed that the engine room simulator is an integral part of maritime education, providing cadets with a practical and realistic learning environment that prepares them for real-world scenarios. It also helps enhance the digital literacy of the cadets, which prepares them to adapt better to the rapid-evolving technologies (Zaini, 2023a). Picpican's (2024) study recommended the need for intervention on students' operational skills on handling a simulator.

Thus, this study sets the stage for evaluating the cadet's proficiency in engine watchkeeping course of using engine room simulator highlighting its role in shaping competent and skilled professionals in the maritime industry.

1.1. Theoretical Framework of the Study.

This research is anchored on constructivism learning theory by Piaget & Elkind (1967), which says that knowledge cannot be transferred but should be built by the learners. It is a potent tool in knowledge retention to develop the skills essential for ship-related operations. The applications of this theory allow the learners to be more engaged with the content and actively learn, e.g., flipped classrooms, debate, role-play, simulation, and interactive classrooms (Zaini, 2023b).

1.2. Conceptual Framework of the Study.

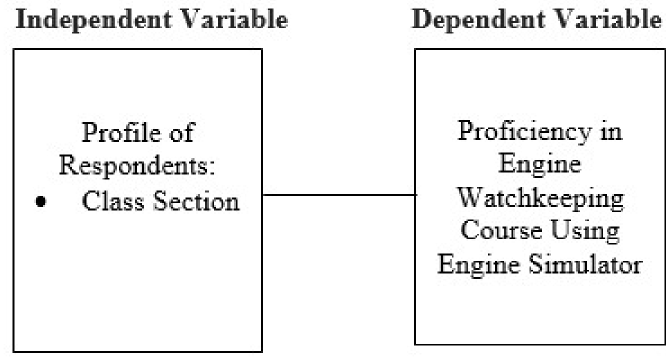
Scrutiny of the aforementioned figure reveals that the independent variable of the study is the class sections of the third-year marine engineering cadets. They are grouped as Polaris, Alpha, Bravo, Charlie, Delta, and Echo, respectively.

Proficiency in the engine watchkeeping course, however, was the dependent variable in this study. Cadet's proficiency was categorized into the following levels of proficiency: basic, foundational, intermediate, advanced, and expert. Figure 1 illustrates in graphic form the paradigm of this study.

1.3. Objectives.

This study aimed to evaluate the cadet's proficiency in the engine watchkeeping course using an engine simulator on ship scenarios from cold ship operation to own supply and harbor condition operation to ready for departure condition, respectively, when they are taken as a whole and when they are classified according to class section. Also, to determine the significant difference in the cadet's proficiency in the engine watchkeeping course using the engine simulator when classified according to their class section.

Figure 1: Paradigm of the study.



Source: Authors.

1.4. Hypothesis.

Based on the preceding problems, the following hypothesis was tested: there is no significant difference in the level of cadet's proficiency in the engine watchkeeping course using the engine simulator when they are classified according to their class section.

2. Review of Related Literature.

Few studies were conducted on engine room simulator. One of these studies was conducted by Zaini (2020a) about the effectiveness of engine room simulator (ERS) as a learning tool in maritime education and training (MET). It is proven that having training in ERS is useful as it provides a realistic training platform and extensive practical training to develop excellent operators in a highly automated environment. Furthermore, the ERS has a high potential to facilitate the acquisition of digital skills and other seafaring-related skills in preparing the seafarers to embrace digitalization and technological advancement. However, there is a lack of pedagogical understanding and approach necessary for ERS trainers due to inadequate research on ERS compared to bridge-navigation simulators.

A similar study was conducted by Zincir et al. (2017), which states that education of engine crews is important due to the reduced number of persons on the ship. Especially, the importance of education shows up in the engine room emergencies. The engine room simulator is an effective tool for the education of engine room officers, which provides a close-to-real engine room atmosphere with real failures in the engine room. In addition to the education, engine room simulators can be an effective evaluation tool. Students can be evaluated while doing the scenario, and their strong and weak sides can be determined. In this study, a scenario-based assessment method was formed and used for the evaluation of the students at the engine room simulator course. Behavior, leadership, communication skills, and operational capability criteria with their sub-criteria were evaluated at the cold ship scenario. The assessment method showed the strong and weak sides of the students. This study confirms that the scenario-based assessment method can be a good tool to evaluate the students in various scenarios.

According to the study of Mangga et al. (2021), ship engine room simulator is a tool used by maritime academies that offer the Marine Engineering Program. According to the Standards of Training Certification and Watchkeeping for Seafarers (STCW), to provide physical realism in training and assessment, simulators are employed. Assessment programs have the intent of providing results that educators will utilize to improve their teaching strategies and improve learner performance (Klinger et al. 2008). This study aimed to (1) determine the level of competencies of the Bachelor of Science in Marine Engineering cadets in Engine Watchkeeping with Resource Management before and after their exposure to the training on the use of the simulator as a tool for learning, and (2) find out if there is a significant difference in the level of competencies of the cadets in Engine Watchkeeping before and after the training on the use of the simulator as a tool for learning. Mean and Wilcoxon tests were utilized to analyze the data. It was found that a significant difference in the level of competencies of the cadets in Engine Watchkeeping before and after the training, which implies that the Engine Room Simulator is a tool for learning and assessing the competencies of students in Engine Watchkeeping is effective. The study recommends that instructors should maximize the use of the available simulators in teaching the course. Students shall have a hands-on experience as supplementary to the theories that they learn.

3. Methodology.

3.1. Research Design.

This descriptive study aimed to evaluate the level of cadet's proficiency in the engine watchkeeping course using an engine simulator. The descriptive method of research was employed in this investigation since the data were collected to answer questions concerning the level of the cadet's proficiency in the engine watchkeeping course using an engine simulator.

According to Fraenkel et al. (2012), descriptive research focuses on present conditions and interprets the conditions that are happening at the moment. A descriptive study is a process involving collections of data to test a hypothesis, answer questions concerning the status of the subject of the investigation, and document the way things and conditions are (Mills & Gay, 2019). In other words, it is something more than, and beyond, just data gathering. The true meaning of the data collected was reported from the point of view of the objectives of the basic assumption of the study.

The study also used quantitative methods of inquiry. This is the most appropriate method when the study seeks to identify the factors that might affect a specific outcome. Furthermore, this method emphasizes objective measurements and the statistical, mathematical, or numerical analysis of data collected through questionnaires and surveys (Mills & Gay, 2019).

The quantitative data was gathered using the research-made questionnaire adopted based on the engine watchkeeping course syllabus approved by the Maritime Industry Authority (MARINA), a single maritime administration in the Philippines aligned with the Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) Convention.

Means, frequency, and percentage for descriptive analysis; and the Kruskal-Wallis H Test for independent samples were used as statistical tools. The alpha level was set at 0.05.

3.2. Respondents of the study.

The respondents of the present study were 208 third-year cadets who officially enrolled in the Bachelor of Science in Marine Engineering (BSMarE) program at the University of Antique for academic year 2023-2024. The University of Antique is recognized as the only state university in Region VI to offer the Bachelor of Science in Marine Engineering and the Bachelor of Science in Marine Transportation programs (Commission on Higher Education, 2018).

The respondents were categorized according to their class section, namely, Polaris, Alpha, Bravo, Charlie, Delta, and Echo, respectively.

A total population sampling method was used in determining the number of respondents, where all third-year cadets who officially enrolled in the Bachelor of Science in Marine Engineering program taking up the engine watchkeeping course for the academic year 2023-2024 were selected. Total population sampling technique is a type of purposive sampling technique that involves examining the entire population that has a particular set of characteristics, such as specific attributes/traits, experience, knowledge, skills, exposure to an event, etc. Those who meet the purpose or objective of the study are being deliberately included by the researchers in their sample. One hundred percent (100%) of the total population of the third-year cadets were involved as respondents of the study. Table 1 shows the distribution of the respondents per variable.

Table 1: Distribution of the respondents.

Variables	*f*	%
A. As a Whole	208	100%
B. Section		
Polaris	35	17%
Alpha	34	16%
Bravo	35	17%
Charlie	30	14%
Delta	38	19%
Echo	36	17%

Source: Authors.

3.3. Data gathering instrument.

The data needed for the present research was adopted based on the engine watchkeeping course syllabus approved by the Maritime Industry Authority (MARINA), a single maritime administration in the Philippines aligned on the Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) Convention.

The instrument was constructed to evaluate the level of a cadet's proficiency in the engine watchkeeping course on various scenarios from cold ship operation to own supply, harbor condition operation to ready for departure, and constant speed operation, respectively, using an engine simulator.

Table 2: Presents the numerical scale with assigned description and interpretation.

Scale of Means	Description	Interpretation
95	Expert	Cadet can handle all assigned tasks and may serve as coach to others.
94 – 90	Advanced	Cadet can handle many tasks that need expert assistance on difficult scenarios.
89 – 85	Intermediate	Cadet can handle many tasks but may seek assistance on difficult scenarios.
84 – 80	Foundational	Cadet can handle some task/s but need assistance beyond assigned scenarios.
75 – 79	Basic	Cadet can handle simple task/s but need assistance.

Source: Authors.

The researchers obtained permission to conduct the study from the office of the university president and the office of the dean of the College of Maritime Studies from the University of Antique.

The researchers personally administered the research instrument to the respondents covering the three (3) ship scenarios, namely: from cold ship to own supply, from own supply to harbor condition, and from harbor condition to ready for departure condition, respectively. Further, the researchers informed the respondents about the nature of the study and assured them that all the results of the proficiency test would be treated with utmost confidentiality. Furthermore, the respondents were also informed that they are given the opportunity to withdraw as respondents anytime they are not comfortable participating.

After retrieving the questionnaire, the researchers tallied, processed, analyzed, and interpreted the data.

4. Results.

4.1. Level of Cadet's Proficiency in Engine Watchkeeping Course Using Engine Simulator.

When taken as a whole, cadets in this investigation had an intermediate level of proficiency in the engine watchkeeping course using an engine simulator in terms of three (3) scenarios, namely: from cold ship to own supply, own supply to harbor condition, and harbor to ready for departure condition, respectively, with an overall mean score of 88.72. The result reveals that cadets obtained the highest mean score on the first scenario, from cold ship to own supply condition (M = 91.85), described as advanced.

However, cadets got a lowest mean score on third scenario, from harbor condition to ready for departure condition (M = 84.91), described as foundational.

Table 3 presents the level of cadet's proficiency in engine watchkeeping course using engine simulator operating the three (3) ship scenarios when classified according to variables.

Table 3: Level of cadet's proficiency in watchkeeping course using engine simulator operating the three (3) ship scenarios when taken as a whole.

Category	Mean	Description
Cold ship to own supply condition.	91.85	Advanced
Own supply to harbor condition.	89.41	Intermediate
Harbor condition to ready for departure condition.	84.91	Foundational
Overall Mean	**88.72**	**Intermediate**

Scale of Means: 95-100 Expert; 94 – 90 Advanced; 89 – 85 Intermediate; 84 – 80 Foundational; 75 – 79 Basic

Source: Authors.

The level of a cadet's proficiency in the engine watchkeeping course using the engine simulator from cold ship to own supply is "advanced" when classified according to class section.

Cadets in class section Alpha are considered experts in handling scenarios from cold ship to their own supply using an engine simulator (M = 97.53). However, cadets who belonged in class section Charlie (M = 87.23) and Delta (M = 88.37) have an intermediate level of proficiency in handling the same scenario.

Table 4 presents the level of cadet's proficiency in engine watchkeeping course using engine simulator when classified according to variables.

Table 4: Level of cadet's proficiency in engine watchkeeping using engine simulator from cold ship to own supply condition when classified as to variables.

Variable	Mean	SD	Description
Class Section			
Polaris	93.45	6.45	Advanced
Alpha	97.53	3.43	Expert
Bravo	91.46	6.14	Advanced
Charlie	87.23	5.06	Intermediate
Delta	88.37	6.75	Intermediate
Echo	92.81	8.19	Advanced
Overall Mean	**91.81**		**Advanced**

Scale of Means: 95-100 Expert; 94 – 90 Advanced; 89 – 85 Intermediate; 84 – 80 Foundational; 75 – 79 Basic

Source: Authors.

The level of a cadet's proficiency in the engine watchkeeping course using the engine simulator from their own supply to harbor condition is "intermediate" when classified according to class section.

Cadets in class section Polaris, Alpha, and Echo are considered advanced in handling scenario from own supply to harbor condition using engine simulator (M = 94.14, M = 94.47, and M = 90.44, respectively). However, cadets belonged in class section Bravo (M = 86.89), Charlie (M = 85.47 and Delta (M = 85.89) have intermediate level of proficiency on handling the same scenario.

Table 5 presents the level of cadet's proficiency in engine watchkeeping course using engine simulator when classified according to variables.

Table 5: Level of cadet's proficiency in engine watchkeeping using engine simulator from own supply to harbor condition when classified as to variables.

Variable	Mean	SD	Description
Class Section			
Polaris	94.14	7.20	Advanced
Alpha	94.47	7.71	Advanced
Bravo	86.89	5.82	Intermediate
Charlie	85.47	4.04	Intermediate
Delta	85.89	6.11	Intermediate
Echo	90.44	8.74	Advanced
Overall Mean	**89.55**		**Intermediate**

Scale of Means: 95-100 Expert; 94 – 90 Advanced; 89 – 85 Intermediate; 84 – 80 Foundational; 75 – 79 Basic

Source: Authors.

The level of a cadet's proficiency in the engine watchkeeping course using the engine simulator from harbor condition to ready-for-departure condition is "foundational" when classified according to class section.

Cadets in class section Alpha are considered advanced in handling scenarios from harbor condition to ready for departure condition using an engine simulator (M = 90.91). However, cadets in class sections Polaris, Bravo, Charlie, and Delta have a foundational level of proficiency in handling the same scenario (M = 83.43, M = 83.57, and M = 82.11, respectively).

Table 5 presents the level of cadet's proficiency in engine watchkeeping course using engine simulator when classified according to variables.

Table 6: Level of cadet's proficiency in engine watchkeeping using engine simulator from harbor to ready for departure condition when classified as to variables.

Variable	Mean	SD	Description
Class Section			
Polaris	83.43	2.65	Foundational
Alpha	90.91	8.99	Advanced
Bravo	83.57	7.72	Foundational
Charlie	83.17	5.17	Foundational
Delta	82.11	6.22	Foundational
Echo	86.39	7.23	Intermediate
Overall Mean	**84.93**		**Foundational**

Scale of Means: 95-100 Expert; 94 – 90 Advanced; 89 – 85 Intermediate; 84 – 80 Foundational; 75 – 79 Basic

Source: Authors.

4.2. *Difference in the Level of Cadet's Proficiency in Watchkeeping Course Using Engine Simulator.*

The Kruskal-Wallis H test result in Table 7 shows that a significant difference was found to exist in the level of the cadet's proficiency in the engine watchkeeping course on performing three (3) ship scenarios using an engine simulator when classified according to class section, h = .000, $p < 0.05$. This suggests that the class section does influence the level of a cadet's proficiency in the engine watchkeeping course using the engine simulator.

Table 7: Significant difference in the level of cadet's proficiency in watchkeeping course using engine simulator when classified according to class section.

Variable	Mean Rank	H-value	p-value	Remarks
Class Section				
Polaris	128.70			
Alpha	156.31			
Bravo	89.56	60.287	.000	Significant
Charlie	67.17			
Delta	68.08			
Echo	116.13			

$p < 0.05$, Significant, $p > 0.05$, Not Significant

Source: Authors.

5. Discussions.

The cadets in this study demonstrated an "intermediate" level of proficiency in the engine watchkeeping course on three (3) ship scenarios: from cold ship to own supply, from own supply to harbor condition, and from harbor condition to ready for departure condition using the engine simulator when they are taken as a whole. It was further revealed that cadets had an "advanced" level of proficiency in performing the ship scenario, focusing on the cold ship to their own supply condition. On the other hand, they had an "intermediate" level of proficiency in performing tasks when the ship started from its own supply to harbor condition. Further, they have shown a "foundational" level of proficiency in preparing the ship from its own supply to a ready-for-departure condition.

Furthermore, a significant difference existed in the cadet's level of proficiency in the engine watchkeeping course on performing ship scenarios from cold ship to own supply, own supply to harbor condition, and from harbor condition to ready for departure condition when classified according to class section.

Conclusions and Recommendations.

The cadets can easily handle and operate familiar ship scenarios from cold ship to own supply, own supply to harbor condition, and from harbor condition to ready for departure condition using engine simulator. However, they seek assistance from the expert when encountering difficult scenarios.

Further, cadets can engage effortlessly in performing the ship from cold ship to own supply condition using the engine simulator. However, as the tasks are advancing to more difficult scenarios, especially on performing the ship scenario from own supply to harbor condition and from harbor condition to ready for departure condition using an engine simulator, they tend to seek assistance from the expert.

Furthermore, cadets in this study have dissimilar levels of proficiency in the engine watchkeeping course on ship scenarios from cold ship to own supply, own supply to harbor condition, and from harbor condition to ready for departure condition using the engine simulator with regard to their class section.

Concerned Maritime Higher Education Institutions (MHEIs) may provide a study plan that focuses on the enhancement of cadet's proficiency in all major courses, particularly the engine watchkeeping course, and provide enough time to navigate the use of the engine simulator, which is considered the best alternative for the real-life scenarios onboard. Further, the concerned MHEI may procure an up-to-date engine simulator to address the demand of shipping in the 21st century. They should ensure that assigned instructors possess the simulator-based training or IMO Model Course 6.10. They may also extend their all-out support on the needs of maritime programs to meet the standard set by regulatory bodies.

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