Analysis of The Readiness, Challenges, and Adaptation of Marine Engineering Cadets in Performing Their Duties in The Engine Room During Sea Training

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Abstract
This study aims to analyze the level of readiness, obstacles, and adaptability of cadets of the Sorong Shipping Polytechnic Ship Ship Study Program while carrying out tasks in the engine room. The research uses a quantitative approach with a descriptive design. Data was collected through a questionnaire containing 24 statements that included three constructs, namely readiness before sea practice, obstacles during practice, and occupational adaptation and safety. A total of 16 cadets who have carried out sea practice were selected using purposive sampling techniques. The data were analyzed using descriptive statistics with the help of IBM SPSS Statistics 22. The results of the instrument test showed that all items were valid with Cronbach's Alpha values of 0.966 each; 0,926; and 0.988, which indicates very high reliability. The results of the study showed that cadets had a high level of readiness before sea practice, especially in understanding tasks in the engine room and the ship's engine system. The main obstacles faced are the lack of practical experience as well as the gap between on-campus learning and operational conditions on board. On the other hand, adaptability, working closely with the crew, and implementing safety procedures are in the high category. These findings show that marine practice plays an important role in integrating theoretical knowledge with real-world work experience and supporting the reinforcement of experiential learning through practice optimization, simulators, and collaboration with the shipping industry.

INTRODUCTION

Sea transportation is the backbone of international trade because it transports more than 80% of the world's trade volume. The development of the shipping industry marked by digitalization, automation of ship systems, improved safety standards, and demands for sustainable shipping has changed the competencies that seafarers must have. Engine officers are no longer only required to have technical skills in operating and maintaining ship engine systems, but must also be able to adapt to technological developments, work in multicultural teams, make decisions quickly, and apply a safety culture in every operational activity. The change requires the organizers to *Maritime Education and Training* (MET) to continuously adjust the curriculum, learning methods, and assessment system to be able to produce graduates in accordance with the needs of the global maritime industry (International Maritime Organization, 2017; Wiig et al., 2023).

Vocational education basically places work experience as an integral part of the learning process. One of the theories that is widely used to explain this process is *Experiential Learning Theory* developed by David A. Kolb. Kolb states that "*learning is the process whereby knowledge is created through the transformation of experience*". The statement affirms that knowledge is not only gained through the delivery of material in the classroom, but is built through a process of real experience that is then reflected, understood, and reapplied in different situations (Plumley et al., 2024; Russell & Martin, 2017; Siew et al., 2016; Watson et al., 2026). Experiential learning is therefore a very relevant approach in vocational education because it allows learners to integrate theory with professional practice (Kolb, 2015).

In line with this theory, modern vocational education developed an approach *Work-Based Learning* (WBL) which connects the learning process in higher education with the learning experience in the work environment. Through WBL, students not only acquire technical skills (*technical skills*), but also develop non-technical competencies such as communication, teamwork, leadership, problem-solving skills, and professionalism. A systematic study conducted by Jalinus et al. (2023) shows that the implementation of WBL makes a positive contribution to graduate job readiness because students get the opportunity to apply academic knowledge in a real work context. In addition to improving professional competence, WBL is also able to narrow the gap between industrial needs and learning outcomes in higher education (Jalinus et al., 2023).

In shipping education, the implementation of WBL is realized through marine practice (*Sea Practice* or *Shipboard Training*) which is one of the main requirements in the formation of seafarers' competencies. Conventions *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* (STCW) 1978 *as amended* affirms that seafarers' competencies must be acquired through a combination of education, training, competency assessment, and sailing experience (*approved seagoing service*) in accordance with international standards (International Maritime Organization, 2017). Thus, marine practice is not just about meeting the administrative requirements to obtain a certificate of competence, but is an authentic learning process that allows cadets to develop knowledge, skills, and professional attitudes in a real ship work environment (Kim & Mallam, 2020; Yoshida et al., 2020; Yurzhenko et al., 2024).

For cadets of the Ship Machinery Study Program, the learning process during sea practice mostly takes place in *engine room*, which is the center of operation of the ship engine system. This work environment has a high level of complexity because it involves the integrated operation of the main engine, auxiliary engine, fuel system, lubrication system, cooling system, compressed air system, and power generation system. In addition, *engine room* It also has the characteristics of a challenging working environment, such as high temperatures, large noise levels, limited workspaces, as well as a wide range of potential mechanical and thermal hazards (Layuk et al., 2022; Lundh & Rydstedt, 2016; Nyamekeh, 2026; Orosa et al., 2017). This condition causes cadets to not only be required to master technical aspects, but also have communication skills, situational awareness (*situational awareness*), adherence to safety procedures, and decision-making ability in dynamic operational conditions (International Maritime Organization, 2017).

Research developments regarding *Maritime Education and Training* (MET) shows that the focus of the study is no longer limited to mastering technical competencies, but also includes the development of non-technical competencies and the effectiveness of learning methods. Wiig et al. (2023), through a systematic review of maritime simulator research, showed that the use of simulators contributes significantly to improving technical competence and decision-making, but has not been able to completely replace the learning experience on board because simulators cannot replicate all operational dynamics, work culture, and social interactions that occur during sea practice. The findings indicate that learning experience in a real work environment remains an important component in the formation of the professional competence of prospective seafarers (Wiig et al., 2023).

The development of learning technology also encourages the use of simulators as a training medium in *Maritime Education and Training*. Different types of simulators, both *Full Mission*, *Virtual Reality*, or *Desktop-based simulator*, has been used to improve the technical competence of cadets before carrying out marine practice. The results of a systematic review conducted by Dewan et al. (2023) show that simulators are effective in improving operational skills, understanding of procedures, and decision-making skills in normal and emergency conditions. However, the study also confirms that simulators are not yet able to fully replicate the complexity of the onboard work environment, especially with regard to personnel interactions, organizational culture, psychological pressures, and rapidly changing operational dynamics. Thus, marine practice remains an irreplaceable learning component in shaping the professional competence of seafarers (Dewan et al., 2023).

In addition to the technical aspects, various studies have shown that the success of marine practices is influenced by the quality of the learning environment on board (*Shipboard Learning Environment*). The learning environment includes the relationship between cadets and supervisors, opportunities to engage in operational work, the safety culture implemented on the ship, as well as the support provided by the crew during the learning process. Narayanan et al. (2023) explained that the learning process on a ship is part of a *Activity System* which involves interaction between individuals, technology, work rules, communities, and task sharing. Therefore, the cadets' learning experience is not only influenced by individual abilities, but also by how the work system on board provides opportunities for cadets to learn through active participation in operational activities (Narayanan et al., 2023).

Recent studies also show that the challenges faced by cadets during sea practice do not always stem from limited technical competence. Research on learning on training vessels (*Training Ship*) showed that the success of learning was influenced by the collaboration between the cadets and the crew in completing the work in the engine room. Cadets who had the opportunity to be directly involved in operational work, receive feedback from the engine officer, and discuss technical problem solving showed better competency development than cadets who only acted as observers. The findings confirm that the quality of interaction during practice has a significant influence on the effectiveness of learning in the ship's work environment (Shimoda et al., 2025).

Although research on *Maritime Education and Training* (MET) continues to develop, the focus of research is still dominated by the development of simulators, training methods, and competency assessment systems. A systematic review conducted by Wiig et al. (2023) on 87 articles published in the period 1961–2021 showed that the MET study was largely centered on *simulator training*, *Resource Management*, *Academic Performance*, and *Assessment*, while the learning aspect that takes place during the work practice on board (*Shipboard Learning*) still receives relatively less attention (Wiig et al., 2023).

In addition, Dewan et al. (2023) explained that MET research in the last decade has focused a lot on the use of bridge simulators and engine room simulators to improve the technical competence of cadets. Although simulators have proven to be effective as learning mediums, the study also confirms that simulators have not been able to fully represent the complexities of the onboard work environment, including crew interactions, work culture, operational stresses, and learning experiences gained during sea practice (Dewan et al., 2023).

In the context of onboard learning, Narayanan et al. (2023) emphasized that seafarers' competencies develop through direct participation in operational activities and interaction with the ship's work system. This shows that learning experience during marine practice is an important component in the formation of professional competence that cannot be fully explained through simulator evaluation or academic assessment (Narayanan et al., 2023). However, the research specifically identified the obstacles experienced by cadets when carrying out operational tasks in *engine room*, especially in shipping education institutions in Indonesia, are still very limited.

In Indonesia, most research on marine practice is still oriented towards evaluating program implementation or achievement of competencies after the practice is completed, while studies that identify in detail the obstacles experienced by cadets while carrying out their duties in *engine room* It is still rarely reported in scientific publications. In fact, information about the difficulty of understanding work procedures, operating equipment, communication with machine officers, adapting to the ship's work culture, and implementing safety procedures is very much needed as a basis for curriculum improvement, practical learning, and debriefing programs before sea practice (International Maritime Organization, 2017; Narayanan et al., 2023).

Based on this analysis, a clear research gap exists. Previous research has mostly discussed simulator effectiveness, training methods, or competency achievements, while research exploring cadets' real experiences while performing operational tasks in the engine room remains limited, particularly in the Indonesian shipping education context. Therefore, this study aims to empirically analyze the obstacles faced by cadets of the Sorong Shipping Polytechnic Ship Machinery Study Program during sea practice as a basis for developing experience-based learning and improving the maritime vocational education curriculum. The findings are expected to contribute to enhancing MET quality by providing empirical evidence about the gap between campus learning and operational shipboard conditions.

METHOD

This study used a quantitative approach with a descriptive design. This approach was chosen because the research aims to systematically describe the level of readiness, constraints, and adaptability of cadets of the Ship Machinery Study Program in carrying out their duties in *engine room* during marine practice without testing cause-and-effect relationships between variables. A quantitative descriptive approach is suitable to obtain an objective picture of a phenomenon based on data collected through structured instruments and analyzed using descriptive statistics (Creswell, J.W. and Creswell, 2022).

The research was carried out at the Ship Machinery Study Program, Sorong Shipping Polytechnic. The research respondents are cadets of the Ship Machinery Study Program who are or have carried out sea *practice* and have experience in carrying out tasks in the *engine room*. Respondents were recruited using *the purposive sampling technique*, which is the selection of respondents based on the criteria that they have undergone marine practices and are willing to participate in the research. Data collection was carried out online using *Google Forms*, and 16 responses were obtained that met the criteria for analysis. The length of the respondents' sea practice varies between 1 to 12 months, thus providing an overview of the cadets' experience at various stages of implementing marine practice.

The research instrument is in the form of a closed questionnaire which is prepared based on a literature review on *Maritime Education and Training* (MET), the provisions of seafarers' competence in *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* (STCW) 1978 *as amended*, as well as previous research on learning during marine practice (International Maritime Organization, 2017). The questionnaire consisted of 24 statements grouped into three constructs, namely readiness before sea practice (8 items), obstacles during carrying out tasks in the engine room (9 items), and adaptability and application of work safety (7 items). The preparation of indicators is carried out to be able to describe the learning experience of cadets during marine practice in accordance with the basic competencies required in STCW.

Before being used as a research instrument, the questionnaire was tested for validity and reliability. The validity test was carried out using the Pearson Product Moment correlation between the score of each item and the total score in each construct. The statement item is declared valid if it has a calculated r-value greater than the r-value of the table at a significance level of 5% (Hair et al., 2019). Next, reliability tests are performed using Cronbach's Alpha coefficient to measure the internal consistency of each construct. A construct is declared reliable if it has Cronbach's Alpha value ≥ 0.70 (Hair et al., 2019). The results of the validity and reliability test of the instrument are presented in the research results section.

Each statement item is measured using a five-point Likert scale, namely 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The Likert scale was chosen because it is one of the most widely used instruments to measure respondents' perceptions, attitudes, and experiences, and has good psychometric characteristics in educational and social science research (Jebb et al., 2021).

Before filling out the questionnaire, respondents were given an explanation of the purpose of the research, data confidentiality, and the right to participate voluntarily. The respondent's consent was given before the questionnaire was filled. All data obtained are analyzed anonymously and are only used for research purposes.

Data were analyzed using IBM SPSS Statistics version 22. The analysis stages include validity tests, reliability tests, and descriptive statistical analysis in the form of frequency distributions, percentages, mean values, and *standard deviations*. Descriptive analysis was used to describe the characteristics of respondents and identify the level of readiness, obstacles, adaptability, and implementation of cadets' work safety during sea practice. The results of the analysis are then presented in the form of a table and interpreted based on the tendency of the average value in each research indicator.

RESULTS AND DISCUSSION

Instrument Validity and Reliability Test Results

Before analyzing the research data, the research instrument is first tested for validity and reliability to ensure that each statement item is able to measure the construct being researched appropriately and consistently. The validity test was carried out using the Pearson Product Moment correlation between the score of each item and the total score in each construct. The research instrument consists of three constructs, namely readiness before sea practice, obstacles while carrying out tasks in the *engine room*, and adaptation and occupational safety. Therefore, validity testing is done separately on each construct.

The number of research respondents is as many as 16 people, so that a value is obtained r table = 0.497 at a significance level of 5% (df = 14). An item is declared valid if it has a value r calculate > r table (Hair et al., 2019).

The results of the analysis show that all items in the three constructs have a correlation value above the r-value of the table so that all items are declared valid and suitable for use as research instruments.

Table 1. Instrument Validity Test Results

Construct	Code	r count	Remarks
Readiness before sea practice	KP1	0,781	Valid
	KP2	0,817	Valid
	KP3	0,896	Valid
	KP4	0,826	Valid
	FP5	0,922	Valid
	KP6	0,942	Valid
	KP7	0,892	Valid
	FP8	0,907	Valid
Obstacles during sea practice	KD1	0,738	Valid
	KD2	0,835	Valid
	KD3	0,800	Valid
	KD4	0,808	Valid
	KD5	0,622	Valid
	KD6	0,716	Valid
	KD7	0,736	Valid
	KD8	0,689	Valid
	KD9	0,673	Valid
Work adaptation and safety	AK1	0,932	Valid
	AK2	0,956	Valid
	AK3	0,984	Valid
	AK4	0,984	Valid
	AK5	0,977	Valid
	AK6	0,908	Valid
	AK7	0,949	Valid

Based on Table 1, all statements have a calculated r-value ranging from 0.622 to 0.984, which is entirely greater than the table r-value of 0.497. The results show that each item is able to represent the measured construct so that it is suitable for use in the next stage of analysis.

Next, a reliability test was carried out using the coefficient Cronbach's Alpha to find out the level of internal consistency of each construct. A construct is declared reliable if it has a minimum Cronbach's Alpha value 0,70 (Hair et al., 2019).

Table 2. Instrument Reliability Test Results

Construct	Number of Items	Cronbach's Alpha	Remarks
Readiness before sea practice	8	0,966	Highly reliable
Obstacles during sea practice	9	0,926	Highly reliable
Work adaptation and safety	7	0,988	Highly reliable

Cronbach's Alpha values in all three constructs are in the range of 0.926–0.988, far exceeding the minimum limit of 0.70. This shows that the instrument has a very high level of internal consistency so that it is able to provide stable and consistent measurement results.

Overall, the results of the validity and reliability test show that the research instrument meets the requirements as a good measuring tool. All items are declared valid and all constructs have very high reliability. Thus, the instrument is suitable to be used to describe the readiness of cadets before sea practice, the obstacles faced while serving in the *engine room*, as well as the ability to adapt and apply occupational safety during sea practice.

Respondent Characteristics

This study involved 16 cadets of the Sorong Shipping Polytechnic Ship Study Program who had completed sea *practice* as research respondents. All respondents were selected because they had direct experience carrying out tasks in the *engine room*, so that they were able to provide information based on the operational conditions they really experienced while on board. The characteristics of the respondents were analyzed based on the force, the type of ship where the sea practiced, and the duration of the implementation of the sea practice as an overview of the work experience context behind the respondents' perception.

The results showed that most of the respondents came from the 17th Batch as many as 13 people (81.25%), while three respondents (18.75%) came from the 18th Batch. Based on the type of ship, marine practices are carried out on various types of ships, namely tankers, *bulk* carriers, *Ro-Ro*, passenger ships, *general cargo*, container ships, and *offshore* ships. In addition, the majority of respondents (81.25%) had undergone marine practice for 12 months, while the rest practiced for one month. The variation in the type of vessel and the duration of the practice showed that the respondents gained operational experience in various work environments so that they were able to provide a more comprehensive picture of the implementation of tasks in the *engine room*.

The diversity of practical experience has an influence on the process of forming the competency of prospective machine officers. Each type of ship has different characteristics of machining systems, operating patterns, maintenance procedures, and workloads, thus providing a diverse learning experience for cadets. In maritime education, real-life work experience on board is an important part of the learning process because it allows learners to integrate theoretical knowledge with hands-on operational practice. The learning that takes place in the work environment contributes to the development of technical and non-technical competencies needed in the seafarer profession (Narayanan et al., 2023; Tynjälä, 2008).

The dominance of respondents who have completed marine practices for 12 months is also a strength of this study. The relatively long duration of practice provides cadets with the opportunity to engage in various operational activities, such as the operation of main and auxiliary machines, the implementation of routine maintenance, the implementation of safety procedures, and coordination with the crew. This experience allows respondents to provide a more objective assessment of the level of readiness, constraints, and adaptability while serving in the *engine room*. Thus, the characteristics of the respondents support the validity of the research findings because they are based on adequate practical experience in accordance with the competency demands regulated in the *Standards of Training, Certification and Watchkeeping for Seafarers* (STCW) (International Maritime Organization, 2017).

Cadets' Readiness Before Carrying Out Sea Practice

The readiness of cadets before carrying out sea practice is one of the factors that determine the success of the learning process on board. In this study, readiness was measured through eight indicators which included mastery of ship machinery theory, practical skills, debriefing before sea practice, understanding of tasks in the *engine room*, and understanding of the main system of ship engines. The results of the analysis showed that all indicators were in the high category with an average value between 3.75-4.13, which indicated that in general respondents felt that they had adequate provisions before undergoing sea practice.

The indicators with the highest average scores were the understanding of the cadets' duties in the *engine room* and the understanding of how the main engine works, each of which obtained a score of 4.13. These results show that the learning process carried out in the Ship Machinery Study Program has been able to build a conceptual understanding of the functions, responsibilities, and scope of work of prospective machine officers. Mastering this concept is an important foundation because engine *room* operations require an understanding of the machining system, work procedures, and good coordination with other engine personnel. Thus, the theoretical learning provided during lectures has provided the basis for the necessary competencies before cadets enter the professional work environment.

In addition to mastery of theory, the indicators of debriefing before sea practice also obtained high average values (4,00). These results show that the debriefing activities organized by the institution have helped increase the readiness of cadets before being placed on the ship. The briefing not only provides an understanding of the technical aspects, but also introduces work procedures, safety culture, and responsibilities during sea practice. According to *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* (STCW), seafarer education and training must be able to prepare students to have competencies that are in accordance with the operational demands of the ship, both in terms of knowledge, skills, and professional attitudes (International Maritime Organization, 2017)**.**

Nevertheless, the indicators of practical skills before boarding obtained the lowest average score (3,75) compared to other readiness indicators, although still in the high category. These findings show that some respondents still feel limited in practical experience when entering the world of work. This condition is a common characteristic of vocational education because learning in the laboratory is not yet fully able to represent the complexity of the operational conditions faced on board. Variations in engine types, equipment ages, shipping company procedures, and work dynamics in *engine room* Leading to hands-on experience remains an important component in the formation of professional competencies (Kolb, 2015; Tynjälä, 2008)**.**

Indicators of understanding of lubrication systems, cooling systems, and fuel systems also show relatively high average values, which range between 3,88–3,94. The results showed that respondents already had a basic understanding of the main systems that will be operated during the sea practice. However, mastery of theoretical concepts is not necessarily followed by the ability to apply them in actual operational situations. The working environment in *engine room* often presents problems that require the ability to analyze, make decisions, and coordinate quickly. Therefore, the learning experience on board is an important stage to integrate the knowledge gained in the classroom with the demands of the work in the field (Narayanan et al., 2023).

The findings of this study support the theory *Experiential Learning* which states that competence develops through hands-on experience followed by a process of reflection, conceptualization, and reapplication in different situations (Kolb, 2015). In the context of maritime education, marine practice is a stage that allows cadets to test the knowledge gained during lectures, as well as develop technical and professional skills through direct interaction with the ship's mechanical system and crew. Therefore, marine practice is not only a means of applying theory, but also a process of forming professional competencies that cannot be replaced by classroom learning.

Overall, the results of the study show that cadets of the Ship Machinery Study Program have good academic readiness before carrying out marine practice. However, these results also indicate the need to improve the quality of practical learning through laboratory optimization, utilization *Engine Room Simulator*, as well as the development of scenario-based learning (*scenario-based learning*). These efforts are expected to reduce the gap between learning on campus and the operational conditions of the ship so that cadets have better readiness when entering the professional work environment (Dewan et al., 2023; Wiig et al., 2023).

Cadets' Obstacles in Carrying Out Tasks in the *Engine Room*

Although the level of readiness of cadets before carrying out sea practice is in the high category, the results of the study show that respondents still face various obstacles while carrying out their duties in the *engine room*. The average value of all constraint indicators is in the medium category, which ranges from 2.50-3.38. These results show that the obstacles experienced by the respondents do not hinder the implementation of marine practices as a whole, but still affect the process of adaptation, learning, and competency development while on board.

The most dominant obstacle is Lack of practical experience with average values 3,38. These findings show that real work experience is still a major challenge for cadets when they first enter a professional work environment. Although respondents have gained theoretical and practicum learning on campus, operational conditions on board have much more complex characteristics than laboratory environments. Differences in machine types, operational systems, work culture, and the demands of quickly solving problems require cadets to adapt their knowledge to the actual work situation. This condition shows that practical experience is an integral part of the process of forming seafarers' professional competencies (Kolb, 2015; Narayanan et al., 2023).

Subsequent findings indicate the presence of The gap between theory and practice with average values 3,31, while the indicator Lack of on-campus practical training Obtain an average score 3,25. These results indicate that learning in educational institutions has not been able to fully represent the operational conditions faced by cadets during sea practice. During the lectures, cadets learn the mechanical system in relatively controlled conditions, while on board they are faced with variations in equipment, company operational procedures, work environment conditions, and various situations that require quick decision-making. Therefore, experiential learning in the workplace is a very important complement to academic learning because it allows learners to integrate conceptual knowledge with practical skills (Tynjälä, 2008).

In addition to the experience aspect, some respondents still had difficulty understanding the instructions from the operator, using machine tools, and understanding the work procedures on the ship. Although the three indicators are in the medium category, the results of the study show that the technical communication process and understanding of operational procedures still takes time for cadets to master. Environment *engine room* It has a work system that prioritizes discipline, coordination, and obedience to the chain of command so that the ability to understand instructions is one of the competencies that must be developed during sea practice. Learning that takes place through hands-on interaction with engine officers and crew is an important part of the process (Narayanan et al., 2023).

Interestingly, the difficulty adapting to the environment *engine room* obtained the lowest average score, namely 2,50. These findings show that the physical conditions of the engine room, such as high temperature, noise, and equipment layout, are not the main obstacles for respondents. Most cadets are able to adjust to the work environment after passing the initial adaptation stage. These results indicate that the main challenges during marine practice stem more from the process of forming work experience than from the physical conditions of the work environment itself. In other words, mental readiness, learning ability, and active involvement in operational activities have a greater influence on the success of marine practices than the characteristics of the work environment (Kolb, 2015; Narayanan et al., 2023).

The findings of this study have important implications for the development of learning in the Ship Machinery Study Program. Strengthening practical learning needs to be directed to activities that are able to simulate the operational conditions of ships more realistically through the use of *Engine Room Simulator*, scenario-based learning (*scenario-based learning*), as well as increased cooperation with shipping companies. This approach is expected to reduce the gap between on-campus learning and on-the-ground practice so that cadets are better prepared when entering the workforce. Various studies show that the use of simulators and experiential learning is able to improve technical competence, decision-making skills, and readiness of students in dealing with complex operational situations (Dewan et al., 2023; Wiig et al., 2023).

Overall, the results of the study show that the obstacles experienced by cadets during sea practice are more related to the transition process from an academic environment to a professional work environment. Therefore, the development of the maritime vocational education curriculum not only needs to strengthen the mastery of theory, but also must expand learning opportunities through authentic work experience so that the competencies of graduates are more in line with the needs of the modern shipping industry (International Maritime Organization, 2017; Tynjälä, 2008).

Adaptability and Implementation of Occupational Safety

The ability to adapt and apply occupational safety is one of the important competencies that must be possessed by cadets while carrying out marine practices. In contrast to the learning environment on campus, work in the *engine room* has complex characteristics, involving the operation of various mechanical systems, a high level of risk, and the demands for cooperation between personnel in maintaining the continuity of ship operations. Therefore, adaptability to the work environment and compliance with safety procedures are an integral part of the professional competence of a prospective machine officer. The results showed that all indicators in this aspect were in the high to very high category with average values ranging from 3.94–4.31, which shows that most respondents were able to adapt to the work environment and implement a safety culture during marine practice.

The indicators with the highest average values are Ability to work closely with the ship's crew (4,31). These results show that marine practice provides opportunities for cadets to develop communication, coordination, and collaboration skills in completing work in *engine room*. During marine practice, cadets not only learn the technical aspects of engine operation, but also learn to understand the division of duties, follow the direction of the engine officer, and participate in daily operational activities with the crew. The experience shows that learning on board takes place through social interaction and direct involvement in the work environment so that it is able to form professional competencies gradually (Narayanan et al., 2023).

The adaptability to the ship's working environment also obtained a high average score (4,25). These results show that most of the respondents are able to adjust to the work culture, the system *Watchkeeping*, the rhythm of ship operations, as well as the demands of work in *engine room*. The adaptation process is part of experiential learning because cadets learn to face conditions that cannot always be simulated during the learning process on campus. According to the theory *Experiential Learning*, real experience is a primary source of learning that allows learners to develop knowledge, skills, and professional attitudes through a process of reflection and continuous application (Kolb, 2015).

The aspect of occupational safety also shows excellent results. Indicators on implementation *Safety briefing* and pre-employment safety instructions earned average scores 4,25, while the use of *Personal protective equipment* (PPE) obtained an average score 4,19. These findings show that shipping companies have consistently implemented safety cultures during the implementation of marine practices. The introduction of safety procedures, the use of personal protective equipment, and supervision of the implementation of work are important parts in forming safety awareness for cadets from the beginning of practice. These results are in line with the provisions of the *Standards of Training, Certification and Watchkeeping for Seafarers* (STCW) which affirms that every seafarer must have competence in identifying hazards, controlling risks, and carrying out work in accordance with international safety procedures (International Maritime Organization, 2017).

However, indicators regarding the understanding of safety procedures in *engine room* Obtain an average score 3,94, slightly lower than other safety indicators. This condition shows that the understanding of safety procedures still needs to be strengthened through more applicable exercises. Learning about safety is not only provided through the delivery of materials in class, but also needs to be supported by emergency simulations, training in the use of safety equipment, and scenario-based learning that realistically depicts the ship's operational conditions. This approach has been proven to be able to increase students' readiness to deal with emergency situations while strengthening decision-making skills while working in a high-risk environment (Dewan et al., 2023; Wiig et al., 2023).

Indicators of confidence in carrying out tasks in *engine room* Obtain an average score 4,00, while the ability to follow instructions from the driver obtained an average score 4,13.

These results show that sea practice provides a learning experience that is able to increase cadets' confidence in carrying out operational tasks. The confidence that develops during practice allows cadets to more actively ask questions, receive directions, and participate in the completion of work under the supervision of a machine officer. The experience contributes to the formation of professional competencies as learners gain the opportunity to apply their knowledge in real-world work situations (Kolb, 2015; Narayanan et al., 2023).

Overall, the results of the study show that the ability to adapt and apply occupational safety is one of the main strengths possessed by respondents while carrying out marine practices. These findings indicate that marine practices not only function as a medium for the application of technical competence, but also as a means of forming a culture of safety, cooperative ability, professional communication, and work attitudes in accordance with shipping industry standards. Therefore, educational institutions need to continue to strengthen practice-based learning and expand collaboration with shipping companies so that the process of forming cadet competencies takes place more optimally and in line with international standards set in STCW (International Maritime Organization, 2017; Narayanan et al., 2023).

Synthesis of Findings and Implications for Maritime Vocational Education

The results of the study show that the success of the implementation of marine practices is not only determined by the academic readiness obtained by cadets while attending lectures, but also influenced by work experience, adaptability, and the application of safety culture on board. Although all readiness indicators are in the high category, respondents still face several obstacles, especially related to lack of work experience and the gap between the theory learned on campus and the operational conditions faced in the *engine room*. On the other hand, the ability to work together, adapt to the work environment, and implement safety procedures shows excellent results. The findings indicate that marine practice is an important stage in the process of forming professional competencies of prospective machine officers because it provides opportunities for cadets to integrate knowledge, skills, and work attitudes in real operational situations.

The findings of this study support the theory *Experiential Learning* which states that learning takes place effectively when learners gain hands-on experience, reflect on those experiences, develop conceptual understanding, and then reapply them in different situations (Kolb, 2015). In the context of marine practice, the process occurs when cadets operate equipment in *engine room*, receive direction from the engine officer, deal with various operational problems, and evaluate the experience gained during duty. Thus, marine practice is not only a medium for the application of theory, but also a learning process that shapes the ability to think critically, decision-making, and professionalism of prospective seafarers.

The results of the study also show that the work environment on board is an effective learning place in developing vocational competence. During sea practice, cadets not only learn the technical aspects of machine operation, but also understand communication patterns, work culture, division of responsibilities, and coordination between personnel in supporting ship operations. Learning that takes place through direct involvement in these work activities is in accordance with the concept *Workplace Learning*, which emphasizes that professional competence develops through the integration between formal learning and real work experience (Tynjälä, 2008). Therefore, marine practice has a strategic role in bridging the gap between learning in educational institutions and competency needs in the industrial world.

The findings regarding lack of experience as the main obstacle show that competency formation cannot be achieved only through classroom and laboratory learning. The theoretical knowledge that the cadets already have still needs to be strengthened through direct involvement in the ship's operational activities. These results are in line with research that explains that onboard learning develops through active participation in daily work, interaction with the crew, as well as involvement in solving operational problems. The higher the intensity of cadets' involvement in work activities, the greater the opportunity for developing technical and professional competencies (Narayanan et al., 2023).

In addition to technical competence, this study shows that marine practices make a significant contribution to the development of non-technical competencies. High cooperative ability, adaptability, and compliance with safety procedures indicate that marine practices play a role in shaping professional communication, work discipline, responsibility, and the ability to work in a team. This competence is increasingly important considering that ship operations are activities that involve coordination between personnel in a high-risk work environment. Therefore, the success of maritime vocational education is not only measured by mastering technical aspects, but also by the ability of graduates to work effectively and safely according to professional standards (International Maritime Organization, 2017).

The implications of this study show that improving the quality of learning in the Ship Machinery Study Program needs to be directed at strengthening a more authentic learning experience. Laboratory optimization, utilization *Engine Room Simulator*, application *scenario-based learning*, as well as increased cooperation with shipping companies can be strategies to narrow the gap between theory and practice. Studies have shown that the use of simulators can improve technical readiness, decision-making skills, and situational awareness before learners enter the actual work environment (Dewan et al., 2023; Wiig et al., 2023). Thus, the development of practical learning not only aims to improve technical skills, but also strengthens the professional readiness of prospective machine officers in dealing with the operational dynamics of ships.

This research contributes to the development of maritime vocational education, especially in understanding the factors that affect the success of marine practice in cadets of the Ship Machinery Study Program. In contrast to research that only focuses on the achievement of technical competence, this study shows that the success of marine practice is the result of an interaction between academic readiness, work experience, adaptability, and the application of safety culture. Therefore, the development of the maritime education curriculum needs to integrate experience-based learning with the strengthening of technical and non-technical competencies so that graduates have better readiness to meet the demands of the modern shipping industry as well as the international competency standards set out in STCW (International Maritime Organization, 2017; Narayanan et al., 2023).

CONCLUSION

This study shows that cadets of the Sorong Shipping Polytechnic Ship Ship Mechanical Study Program generally have a good level of readiness before carrying out sea practice. This readiness is reflected in the mastery of basic mechanical theory, understanding of tasks in the *engine room*, and debriefing provided by the institution. However, during the implementation of sea practice, cadets still face several obstacles, especially related to the lack of real work experience, limited practical training before boarding, and the gap between learning on campus and operational conditions on board. On the other hand, the results of the study show that the ability to adapt to the work environment, cooperation with the crew, and the implementation of safety procedures are in the high category. These findings indicate that marine practice plays an important role as an experiential learning medium that allows cadets to integrate theoretical knowledge with technical skills and professional competencies in a real work environment. The implications of this study emphasize the need to strengthen practical learning in maritime education institutions through laboratory optimization, the use of *engine room simulators*, the implementation of *scenario-based learning*, and increased collaboration with shipping companies. These efforts are expected to reduce the gap between theory and practice so that graduates have competencies that are more in line with the needs of the shipping industry and international competency standards. This study still has limitations because it involves a relatively small number of respondents and only comes from one educational institution. Therefore, further research is recommended to involve respondents from various shipping universities and shipping companies with a broader quantitative approach or *mixed methods* in order to obtain a more comprehensive understanding of the factors that affect the success of marine practice in ship engineering cadets.

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