



Enhancing Maritime Vocational Training in Naval Engine Operations: A Study in North Sulawesi

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Abstract

Background: In North Sulawesi, maritime vocational schools are central to producing skilled cadets for Indonesia's shipping and port industries. However, a persistent gap exists between institutional training and the technical realities of naval engine operations onboard vessels, leading to underprepared graduates. *Original Value of the Analysis:* This study provides a regionally grounded contribution by integrating the perspectives of maritime professionals and educators in North Sulawesi. Unlike prior studies with broader or policy-level focus, this research highlights localized insights into improving training effectiveness through industry-based knowledge. *Objectives:* The research aimed to explore how the integration of veteran seafarers' operational expertise and vocational lecturers' instructional experience can enhance curriculum relevance, student competency, and practical learning outcomes in naval engine education. *Methodology:* Employing a descriptive qualitative approach, the study collected data through in-depth interviews and thematic analysis involving two retired maritime professionals and ten vocational lecturers, all with substantial sea-going and teaching experience. *Results:* Findings demonstrated strong agreement on the need for curriculum reform, increased hands-on practice, mentorship programs, and competency-based assessment aligned with engine room demands. The combination of professional and pedagogical insight proved critical in identifying reform strategies. *Conclusions:* This research offers a locally relevant framework for strengthening maritime vocational training in North Sulawesi, supporting policy and institutional changes toward industry-aligned, sustainable maritime education.

1. INTRODUCTION

In the evolving landscape of global maritime operations, the engine room of a vessel remains one of the most demanding, high-pressure environments on board—a space where technical precision, safety awareness, and real-time problem-solving must converge flawlessly [1], [2]. Yet, within the walls of vocational maritime institutions, particularly in regions like North Sulawesi, a pressing concern persists: how well do our cadets, future marine engineers, understand and internalize the true nature of what awaits them beyond simulation labs and textbooks? For maritime educators, training officers, and veteran seafarers, the question of whether vocational training truly prepares cadets to navigate the complex and often unpredictable dynamics of naval engine operations is no longer theoretical—it is urgent and deeply consequential [3], [4]. The reality on the ground suggests a growing dissonance between the training provided and the expectations faced in the field, demanding a re-examination of how knowledge, skill, and experience are being transferred within the maritime education system.

In many maritime vocational schools, particularly those focused on specialized technical fields such as engine systems, curricula remain rooted in traditional frameworks that emphasize procedural and theoretical knowledge [5], [6]. However, the maritime industry itself has undergone significant technological and operational transformations. From automation and digital diagnostics to stricter environmental regulations and sustainability targets, the modern engine room now requires a multidimensional skill set that combines mechanical understanding, adaptability, leadership, and continuous learning. Despite these changes, there exists a critical lag in how educational institutions respond to industry developments. This disconnect manifests in a variety of ways—from outdated instructional materials and insufficient real-time practice, to the underutilization of expert knowledge residing in retired or veteran seafarers with decades of experience in engine room operations. In effect, maritime vocational training risks producing graduates who, while qualified on paper, are not fully prepared to assume responsibility in engine rooms that operate under intense pressure and technological complexity.

The background of this study emerges from this widening gap. In regions such as North Sulawesi—where maritime industries serve as key economic pillars and vocational education serves as a primary channel for workforce development—the alignment between training and practice is not merely a pedagogical concern, but a strategic imperative. Institutions are tasked not only with producing technically literate graduates but with cultivating a workforce that can adapt, lead, and sustain the future of maritime engineering. Unfortunately, the existing training ecosystem has yet to fully capitalize on its most valuable resource: the dual knowledge base of veteran maritime professionals and active vocational educators. Veteran professionals—those with over 20 years of sea-going experience, who now serve as auditors, advisors, or managers in maritime companies—carry a wealth of operational insight. Similarly, lecturers who have both sea-time and extensive classroom experience are uniquely positioned to reflect critically on how theory translates into practice. Yet their experiences are rarely synthesized into institutional learning or used as a foundation for reforming technical education.

This study, therefore, is grounded in a central research problem: how can the integration of industry expertise, particularly from veteran maritime professionals and experienced lecturers, contribute to reshaping the design, implementation, and effectiveness of vocational training in naval engine operations for seafarer cadets in North Sulawesi? This question not only seeks to diagnose the existing weaknesses in maritime technical education but also to uncover actionable strategies for embedding industry-based learning into vocational curricula. Specifically, the research investigates how seafarers' lived experiences and educators' reflective insights can inform competency development, training design, and learning assessment models that are more attuned to the realities of engine room work.

To achieve this, the study sets out several interrelated objectives. First, it aims to document and analyze the perspectives of veteran maritime professionals regarding current vocational education practices in engine systems. Second, it explores how vocational lecturers perceive the strengths and limitations of the existing training approach. Third, the research identifies strategic methods by which industry-based learning—particularly experiential and mentorship-based models—can be incorporated into engine room training. Finally, it seeks to develop a framework that aligns training delivery with the complex demands of modern engine operations, using qualitative insights as the foundation for curriculum enhancement.

The rationale behind this research lies in its potential to contribute practical, evidence-based solutions to a systemic challenge in maritime education. With the maritime sector facing increased pressure to adapt to environmental standards, technological innovation, and human capital development, the effectiveness of vocational training must keep pace. The study does not aim to critique institutions from a distance, but rather to engage directly with those who inhabit both ends of the educational and operational spectrum. By foregrounding the voices of veteran professionals and long-serving lecturers, the research elevates experiential knowledge to the status of strategic insight—an essential step in designing curricula that are not only pedagogically sound but professionally relevant.

Methodologically, the study adopts a qualitative descriptive approach. Through in-depth interviews and focus group discussions, the research captures nuanced, context-rich accounts from 12 participants—two maritime professionals with long-standing operational expertise and current strategic roles, and ten lecturers with experience both at sea and in the classroom. The use of qualitative methods is intentional: it prioritizes depth over breadth, allowing for a closer interrogation of how meaning is constructed around competence, training, and professional development. The narratives collected are not interpreted as isolated opinions but are thematically analyzed to identify patterns, tensions, and transformative insights that can inform institutional practice.

At its core, this research is underpinned by a conceptual framework that views maritime education as an interface between three interconnected variables: industry expertise, pedagogical structure, and technical competency development. Industry expertise refers to the tacit and explicit knowledge held by maritime professionals—particularly regarding engine room management, problem-solving, and crisis navigation. Pedagogical structure encompasses the curriculum, teaching methods, and assessment models used in vocational schools to deliver knowledge and skill. Technical competency development represents the intended outcome: a cadet who is not only trained but competent—capable of operating, managing, and leading within the engine room environment. These three variables do not operate in silos; rather, they exist in a dynamic relationship. When industry expertise is excluded from the pedagogical structure, competency development suffers. Conversely, when educators and professionals collaborate, training can be designed to reflect operational realities, thereby enhancing competency outcomes.

The integration of these variables requires deliberate effort and strategic design. This study, therefore, proposes a model in which veteran seafarers function not only as guest speakers or occasional mentors, but as co-developers of learning modules, assessors in practical evaluations, and contributors to reflective learning case studies. Likewise, lecturers are positioned not just as transmitters of knowledge, but as adaptive designers who can translate field insights into teachable, assessable content. The research highlights that the convergence of professional and pedagogical knowledge—if structured systematically—can lead to the co-creation of a new standard for vocational training in naval engine operations.

The urgency of this research lies not only in its relevance to current educational practice, but also in its implications for the future of maritime sustainability. Competent engine officers are essential not only for the mechanical functioning of vessels but for the broader goals of maritime safety, environmental compliance, and economic efficiency. In a region like North Sulawesi, where the maritime sector remains a core economic engine, the stakes are high. Producing underprepared graduates undermines not only employment prospects but also compromises the operational integrity of maritime institutions and industries. This research, therefore, contributes to a broader conversation on how vocational education must evolve—through collaboration, contextualization, and commitment—to meet the demands of a changing maritime world.

2. RESEARCH METHOD

This study is grounded in a qualitative descriptive methodology that seeks to explore how the integration of industry expertise and academic insight can enhance vocational education in naval engine systems for seafarer cadets, particularly in the North Sulawesi context. The research was constructed to engage the lived experiences, professional reflections, and pedagogical perspectives of individuals who have direct involvement in maritime engineering education and operations. By emphasizing the real-world insights of expert practitioners and seasoned educators, the study aims to understand and reimagine how vocational training can become more aligned with the dynamic needs of the shipping and port industries.

The population of this study comprises individuals who have deep and long-term engagements with the maritime sector, either through seafaring, management, technical operations, or educational development. Specifically, two veteran maritime professionals were selected as participants, each with over two decades of sea-going experience and now occupying senior positions as advisors, auditors, or managers in reputable port and shipping companies. These individuals were not chosen randomly, but purposively based on their extensive knowledge of naval engine systems and their dual familiarity with both sea operations and organizational leadership. Their insights are invaluable because they embody a synthesis of technical mastery, industry standards, and an acute understanding of the gaps between vocational training and engine room reality.

Complementing the perspectives of these maritime professionals are ten vocational lecturers who actively teach in maritime training institutions [4], [7]. These lecturers have a minimum of five years of sea experience and more than eight years of continuous involvement in teaching marine engineering, particularly focused on engine systems and operational mechanics. Their roles as educators, mentors, and curriculum implementers give them unique perspectives on how maritime cadets learn, adapt, and struggle within current training systems. These lecturers were chosen for their balanced experience between the world of industry and the classroom, as they play a critical role in shaping student outcomes while also observing first-hand the shortcomings of instructional tools, curriculum limitations, and student preparedness. This population of respondents offers an authentic and multilayered understanding of vocational education effectiveness, making their inclusion in the study both methodologically valid and contextually necessary.

To capture the complexity and depth of the participants' experiences, the research employed a semi-structured interview approach. The core instrument of data collection was a carefully developed interview guide that facilitated open-ended conversations while ensuring thematic consistency across all interviews [8], [9]. The research instrument was designed around two major variable domains: the independent variable being the integration of industry-based experiential knowledge into the vocational education system, and the dependent variable being the development of technical competency in naval engine operations among cadets. Within these domains, several indicators were identified and explored in the interview process.

For the independent variable, the indicators included the nature and depth of professional maritime experience, modes of transferring experiential knowledge, availability of mentorship structures, and opportunities for collaboration between industry and educational institutions. For the dependent variable, the indicators were centered on student skill mastery, diagnostic problem-solving capabilities in engine systems, adaptability in engine room tasks, understanding of safety protocols, and readiness for onboard engine responsibilities. Each indicator was operationalized through a set of probing questions that explored how the participants assessed the current state of technical training, where they observed gaps, and what strategies they believed could close these gaps effectively.

Supporting instruments included field notes and direct observation records taken during informal discussions and institutional visits. These were used to contextualize responses, capture non-verbal cues, and note environmental or institutional conditions that may influence teaching practices. Audio recordings of interviews were also transcribed in full to preserve accuracy and integrity during the analysis process. All instruments were tested through a brief pilot with comparable individuals to ensure clarity and relevance.

Data collection was executed in multiple phases, beginning with trust-building sessions to ensure participants felt comfortable sharing candid insights. Each participant engaged in a 60–90-minute semi-structured interview conducted in a professional yet conversational style. These interviews were guided but flexible, allowing participants to elaborate, narrate, and reflect based on their own experiences. The data collection process was deeply iterative, with new questions emerging based on early insights, which then refined the direction of subsequent interviews [10], [11]. Throughout the process, the data collection was structured to ensure that the indicators tied to both the independent and dependent variables were consistently addressed, yet without rigid control that would limit the discovery of emergent themes.

Once data collection was complete, the analysis proceeded through a structured thematic analysis framework [9], [12]. The first phase involved categorizing the data into competency development and sustainability themes. Competency development themes were those related to practical skill-building, curriculum alignment, instructional effectiveness, and assessment of student readiness. Sustainability themes focused on the long-term viability of engine training methods, the integration of environmental standards into instruction, and the retention of institutional knowledge through mentorship or alumni engagement. This categorization helped the researchers sort through the large volume of narrative data and anchor it in meaningful analytical frameworks.

Following thematic categorization, a cross-group comparison was conducted. This process involved comparing the insights, perspectives, and patterns that emerged from the maritime professionals against those from the lecturers. This comparative step revealed critical areas of consensus—such as the inadequacy of simulation-only training—and divergence, such as differing priorities between mentorship-led instruction versus curriculum-based reform. This comparison also enabled the identification of conceptual bridges between theory and practice, revealing the extent to which one group could inform and enhance the strategies of the other. It was in this phase that the unique value of integrating both groups' voices became evident, offering a multi-angled lens on maritime education reform.

The final stage of analysis involved constructing a cohesive narrative synthesis that explained the key findings within the broader context of maritime education transformation. Rather than presenting findings as isolated responses, the narrative synthesis wove together the experiences of professionals and lecturers into an interpretive storyline that captured both the urgency and the opportunity for improvement in technical competency development. This synthesis highlighted the contextual richness of maritime operations, the instructional nuances of teaching cadets, and the institutional barriers that currently impede progress. Through this approach, the data was transformed from raw experience into actionable knowledge [13]. The research methodology employed in this study allowed for a comprehensive, in-depth exploration of how industry expertise and educational practice intersect, diverge, and can be meaningfully integrated. The process of engaging directly with those who shape and experience maritime education from both sides

of the training spectrum provided a credible and critical foundation for analyzing how vocational programs can evolve to meet real-world demands in engine room operations. This method not only honored the lived experiences of maritime practitioners and educators but also generated a grounded, context-sensitive analysis capable of informing future policy, curriculum design, and instructional models in maritime vocational education.

3. RESEARCH RESULTS

This section presents a comprehensive analysis of the effectiveness and efficiency of vocational maritime training in naval engine systems based on qualitative evaluations from two groups: maritime professionals and vocational lecturers. The findings are structured according to key indicators derived from the study's conceptual framework. Each indicator was evaluated on a scale from 1 (very poor) to 10 (excellent), with averages and classifications provided to demonstrate performance and relevance.

Table 1. Summary of Evaluated Indicators and Average Scores

No.	Indicator	Maritime Professionals	Lecturers	Average Score	Classification
1	Curriculum Relevance	9	8	8.5	Very Good
2	Real-World Practice Integration	8	7	7.5	Good
3	Mentorship Opportunities	9	8	8.5	Very Good
4	Student Readiness	8	7	7.5	Good
5	Technological Adaptation	9	7	8.0	Very Good
6	Competency Assessment	8	8	8.0	Very Good
7	Instructional Effectiveness	7	8	7.5	Good
8	Industry Engagement	9	7	8.0	Very Good
9	Sustainability Understanding	8	7	7.5	Good
10	Operational Problem-Solving	9	8	8.5	Very Good

3.1 Narrative Analysis of Results

3.1.1 Curriculum Relevance

Both maritime professionals and lecturers rated this indicator highly, with an average of 8.5. Professionals emphasized that while the theoretical foundation exists, it requires closer alignment with current shipboard practices and updated technologies. Lecturers acknowledged their efforts to revise materials, although limitations in equipment and institutional support remain a barrier.

3.1.2 Real-World Practice Integration

This area received a score of 8 from professionals and 7 from lecturers. While there are simulated training efforts, cadets often lack consistent exposure to real engine room conditions. Professionals stressed the importance of learning under pressure, a context largely missing from current programs.

3.1.3 Mentorship Opportunities

Professionals saw mentorship as a critical, yet underutilized method for shaping future engine officers. Both groups noted the absence of structured mentorship frameworks, especially those that could integrate experienced seafarers into formal training programs. The high score reflects recognition of its potential, not current practice.

3.1.4 Student Readiness

Averaging 7.5, student readiness was evaluated with concern. Professionals observed that many graduates require significant onboarding and adaptation time, which reflects gaps in training. Lecturers pointed to motivational challenges and the difficulty of replicating engine room complexity in a classroom setting.

3.1.5 Technological Adaptation

Professionals rated this area as excellent (9), highlighting rapid changes in engine systems, fuel management, and emissions control. Lecturers were more cautious (7), citing constraints in accessing updated simulation tools and materials. The combined result indicates a high need for curriculum modernization.

3.1.6 Competency Assessment

This indicator received balanced high scores. Both groups agreed that current evaluation methods—focused on procedural knowledge—must evolve to include scenario-based, reflective, and performance-oriented assessments, especially for engine room crisis handling.

3.1.7 Instructional Effectiveness

With an average of 7.5, this area reflects modest satisfaction. Lecturers acknowledged strengths in module delivery but pointed to institutional challenges such as large class sizes and limited time for hands-on practice. Professionals urged for more dynamic, discussion-based sessions over rigid theoretical instruction.

3.1.8 Industry Engagement

Rated 9 by professionals, this indicator underscores their willingness to contribute more to training design. Lecturers gave a 7, recognizing the value of industry engagement but also citing bureaucratic hurdles in formalizing partnerships.

3.1.9 Sustainability Understanding

Both groups acknowledged this as a growing area of concern, especially with global green shipping standards. Scores were slightly lower due to the lack of formal integration of sustainability concepts in engine system training, despite informal discussions in the classroom.

3.1.10 Operational Problem-Solving

Rated 9 and 8 respectively, this indicator reflects the value placed on adaptive thinking, diagnostic skills, and teamwork in engine room situations. Participants emphasized the need to move beyond rote learning into applied, problem-based training.

3.2 Cross-Group Comparisons and Synthesis

Overall, the findings from maritime professionals and lecturers were largely aligned, though with distinct emphases. Professionals focused on applied knowledge, mentorship, and operational readiness, drawing from their shipboard crisis and maintenance experiences. Lecturers, on the other hand, emphasized pedagogical structure, institutional limitations, and curriculum development. Both groups agreed on the core gaps and the need for transformation but differed in how and where such changes should be initiated.

The cross-analysis confirmed that while theoretical frameworks and institutional structures exist, the depth of cadet training can only be enhanced through stronger industry-education linkages. There is a consensus that cadets are currently underprepared for the full scope of technical and leadership responsibilities in naval engine systems. This outcome validates the conceptual framework where technical competency development relies heavily on how well industry knowledge is transferred into structured pedagogical environments. The results of this research clearly demonstrate that the integration of maritime industry expertise—especially from veterans—and the pedagogical acumen of vocational lecturers produces a comprehensive and highly effective strategy for advancing technical competency in engine systems. With all key indicators averaging between **7.5 to 8.5**, and most categorized as **“Very Good”**, the effectiveness of combining field-based experience with educational innovation is evident. The study supports the urgent development of curriculum frameworks, mentorship models, and competency-based assessments that bridge theory and operational reality.

4. DISCUSSION

This study set out to explore a critical question in maritime vocational education: how can the integration of industry expertise, especially from veteran seafarers, and the structured knowledge of experienced maritime lecturers contribute to improving the effectiveness of vocational training in naval engine operations? This question was grounded in the observation that many maritime cadets, despite completing formal education, remain underprepared for the technical, adaptive, and decision-making demands of real engine room operations. The results of the qualitative analysis provide substantive and multidimensional answers to this research problem, revealing strong support for the proposed integration model, while also uncovering underlying institutional and pedagogical gaps.

The findings reveal that both groups—maritime professionals and lecturers—shared largely consistent views about the relevance of vocational curricula, the importance of real-world practice integration, and the need to modernize both content and pedagogy to meet the expectations of today’s maritime industry. This convergence strongly supports the first and second research objectives, which sought to capture how experts

and educators perceive the strengths and limitations of current practices in engine room training. The high scores and positive qualitative responses suggest that integrating real industry experiences into vocational instruction is not only beneficial but essential to building cadet competencies. Additionally, the analysis partially answers the third research question regarding the methods and models for embedding industry experience into pedagogy. While mentorship and case-based training were widely supported by participants, challenges related to institutional rigidity, lack of collaboration frameworks, and outdated instructional tools emerged as obstacles that still need to be addressed for effective implementation.

These findings are significant not merely for their descriptive accuracy but for the implications they carry. The research confirms that real-world operational experience, particularly from veteran seafarers, remains an underutilized but highly valuable asset in vocational maritime education. The data suggest that cadets benefit most when training moves beyond static simulations and procedural repetition into dynamic, scenario-driven, and reflective learning environments. Veteran professionals emphasized the limitations of simulated environments that cannot replicate the emotional, psychological, and contextual challenges of engine room decision-making. For lecturers, the data showed a growing frustration with institutional delays in curriculum updates, limited access to current engine technologies, and assessment methods that fail to capture the full range of student capabilities. Together, these insights not only validate the conceptual framework of this research but also demonstrate the urgent need to bridge theory and practice through strategic, sustained partnerships between educational institutions and maritime industries.

When comparing these findings with existing literature on maritime education and vocational training (as discussed in the background logic), several consistencies and differences emerge. Many previous studies have noted the limitations of simulation-only instruction, the stagnation of vocational curricula, and the gap between institutional teaching and onboard realities. In this study, the same patterns were identified, particularly in the areas of student readiness, mentorship, and curriculum relevance. These confirm that the issues raised are not localized to North Sulawesi but reflect broader structural challenges in maritime education systems globally.

However, this study introduces key divergences from earlier research in two important ways. First, while previous analyses often focused on broad pedagogical strategies or institutional policies, this study provides direct, qualitative insight from two distinct yet complementary groups: maritime professionals and vocational lecturers. This dual-source, narrative-driven approach allows for a deeper, experience-based analysis of how training is actually perceived and executed. Second, unlike prior literature that frequently emphasizes top-down reforms and external accreditation models, this research highlights the potential of internal reform through collaborative design, mentorship, and reflective integration of lived seafaring experiences into formal education. This bottom-up, practitioner-informed approach adds a new layer of realism and feasibility to the ongoing discourse on maritime education reform.

Where the findings differ from some assumptions in the literature, explanations can be found in the study's localized, culturally specific context. In North Sulawesi, for example, maritime education institutions often operate under strict resource constraints and rigid administrative hierarchies, which limit their flexibility to experiment with new instructional models. Additionally, veteran professionals in this region may be more accessible and willing to participate in education than in other global settings where industry-academic divides are more pronounced. These contextual factors help explain why this study uncovered a strong willingness among both professionals and lecturers to collaborate on curriculum and training reform—an opportunity that is not always acknowledged or feasible in other studies.

By documenting and analyzing these experiences, the study fills a notable gap in the existing literature, which often neglects the strategic potential of veteran seafarers as pedagogical partners. In most studies, such individuals are either seen as occasional guest speakers or as retired personnel with little role in shaping contemporary education. This research challenges that assumption, showing that their knowledge, particularly in technical diagnostics, operational leadership, and decision-making under pressure, is not only relevant but necessary to equip cadets for the current and future demands of engine room operations.

One of the primary strengths of this study lies in the rigor and richness of its qualitative data collection process. By engaging deeply with twelve participants over multiple sessions and by triangulating their responses through thematic analysis, the study provides a well-rounded, credible, and nuanced picture of current training effectiveness. Unlike more generic evaluations that rely on survey tools or institutional performance metrics, this research foregrounds personal experience and professional judgment. This is particularly important in a field like naval engineering, where competency is developed not just through instruction, but through immersion, reflection, and problem-solving under real conditions.

Another strength of the study is its conceptual framework, which views maritime education as a system of interaction among industry expertise, pedagogical design, and competency outcomes. This model allows for more targeted analysis of where interventions are needed and where collaborative leverage points exist. The framework not only helps organize the findings but provides a roadmap for future policy, training design, and research. It also acknowledges that no single actor—neither the institution, the lecturer, nor the industry—can address training challenges in isolation. Rather, it is the convergence of these roles that holds the greatest potential for reform.

The practical implications of this research are both immediate and long-term. For maritime institutions, the study provides empirical justification to review and revise their training programs with greater involvement from industry practitioners. It also offers a compelling argument for investing in mentorship systems that match cadets with veteran engineers or retired officers, whether through structured internships, hybrid teaching teams, or co-developed course modules. For policymakers, the findings suggest the need to create regulatory space and funding incentives for educational innovation that is grounded in operational relevance. This includes allowing flexibility in assessment models, accreditation pathways for professionals transitioning into education, and support for simulation facilities that reflect actual vessel conditions and technological developments.

For the maritime industry, the findings signal the need to redefine its relationship with education. Rather than viewing institutions as suppliers of entry-level workers, the industry should see them as partners in workforce development. This partnership could take many forms—from contributing to curriculum committees and offering sabbaticals for lecturers aboard ships, to creating joint training hubs where cadets, engineers, and instructors co-learn and collaborate on real-world problems. In this way, the research not only diagnoses a problem but provides a foundation for building a collaborative, responsive, and sustainable model of maritime vocational education.

Despite its strengths, the study also acknowledges certain limitations. First, the sample size, while appropriate for qualitative research, is limited to a specific region and may not reflect national or international variations. Second, while the participants represent a range of experience levels, the study does not include the perspectives of cadets themselves—an important viewpoint that could further enrich the analysis. Third, the study's reliance on narrative data means that findings are interpretive rather than generalizable, although this is consistent with its qualitative approach.

These limitations point to fruitful areas for future research. One avenue would be to expand the sample across multiple regions to examine how cultural, institutional, and industrial factors shape perceptions of training effectiveness. Another would be to include cadet narratives, capturing their lived experience of the training journey and their transition to sea life. A third area would be longitudinal research to track how specific interventions—such as mentorship programs or curriculum reforms—actually impact cadet performance over time.

This research contributes meaningful, experience-driven insights to the field of maritime vocational education, particularly in the high-stakes domain of naval engine operations. It validates the central role of both industry professionals and educators in shaping effective training, demonstrates the value of integrating real-world expertise into pedagogical design, and provides a flexible yet grounded framework for reform. As maritime industries continue to evolve in complexity, regulation, and sustainability expectations, so too must the institutions that train those who will operate at their core. This study offers one practical, contextually rooted vision of how that evolution might unfold—not through abstraction, but through collaboration, reflection, and shared commitment to excellence at sea.

5. CONCLUSION

This research critically examined the integration of industry expertise and pedagogical practice to enhance vocational training in naval engine operations for maritime cadets in North Sulawesi. Through a descriptive qualitative approach, the study uncovered strong alignment between maritime professionals and lecturers regarding the urgency of reforming curriculum content, instructional design, and assessment strategies to reflect real-world engine room conditions. The findings confirmed that while current training frameworks provide a foundation in theory, they often fail to prepare cadets for the adaptive, technical, and decision-making challenges of modern maritime operations. Key indicators such as curriculum relevance, practical integration, mentorship opportunities, and technological adaptation were rated highly by both respondent groups, demonstrating the perceived effectiveness of combining seafaring experience with structured education. The analysis also highlighted gaps in institutional responsiveness and the underutilization of experienced maritime professionals in formal training environments. This research contributes a practical

framework for reimagining maritime vocational education through collaborative, experience-informed models that center on competency development and sustainability. It not only addresses limitations found in previous studies but provides actionable insights for educational institutions, maritime companies, and policy stakeholders seeking to align training with evolving industry demands. Moving forward, the study calls for structured mentorship programs, curriculum innovation, and deeper partnerships between schools and industry to ensure graduates are both technically proficient and operationally ready.

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