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Competency and Sustainability Integration in Enhancing Maritime Vocational Training for Deck Officers (Systematic Literature Review and Qualitative Analysis of Perspectives)

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Abstract. *The growing complexity of maritime operations demands deck officers with advanced competencies and a strong understanding of sustainability principles. This study addresses critical gaps in maritime vocational education by exploring the effectiveness of current training programs, the integration of sustainability, and the role of technology-driven approaches. While previous research has focused on technical skills aligned with STCW standards, limited attention has been paid to leadership, communication, and environmental education. The research sought to answer how maritime training can be enhanced to address these gaps. Using a systematic literature review and qualitative analysis of insights from maritime professionals, educators, and graduates, the study synthesized theoretical frameworks with real-world experiences. Data were collected through semi-structured interviews and questionnaires, analyzed using thematic coding, and triangulated with findings from the literature review. The results demonstrate strong technical training aligned with STCW standards but reveal fragmented sustainability integration and inadequate leadership preparation. Simulation-based training was identified as highly effective, though it requires support from mentorship and real-world experiences. The findings provide actionable recommendations for enhancing curricula, fostering industry-academic partnerships, and refining policies to better prepare deck officers for modern maritime challenges. This research offers a practical roadmap for transforming maritime education, ensuring safety, operational efficiency, and sustainability in global maritime operations.*

Keywords: *Maritime Education, Deck Officer Training, Sustainability, STCW Competencies, Simulation-Based Training*

1. INTRODUCTION

The global maritime industry is a cornerstone of international trade, facilitating the transportation of goods across vast oceans and linking economies worldwide. As the complexity of maritime operations grows, the demand for skilled and competent deck officers capable of navigating these challenges has become more pressing. This urgency is further heightened by the industry's increasing focus on sustainability, where environmental concerns and regulatory pressures demand innovative and adaptive approaches. These developments underscore the critical importance of maritime vocational education, particularly in preparing deck officers to meet both traditional operational standards and emerging sustainability imperatives. This research delves into the intersection of these domains, exploring how training programs can be enhanced to align with evolving industry demands and sustainability goals.

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The preparation of deck officers, particularly in alignment with Standards of Training, Certification, and Watchkeeping (STCW), lies at the heart of maritime vocational education (Christodoulou-Varotsi & Pentsov, 2008; Sharma et al., 2019). These standards set the foundation for ensuring safety, competence, and professionalism within the maritime sector. However, existing training frameworks often fail to address the nuanced challenges that modern deck officers face, including advanced navigation, environmental management, and the integration of cutting-edge technologies. Moreover, while the role of sustainability in maritime operations is widely recognized, its incorporation into training curricula remains fragmented (House & Saeed, 2016). This gap highlights a pressing need for comprehensive educational frameworks that not only enhance core competencies but also integrate sustainability principles into the fabric of deck officer training.

Against this backdrop, this research seeks to address the following central question: How can maritime vocational education for deck officers be enhanced to meet the dual demands of industry competency and sustainability? This question is further refined into specific objectives: (1) to analyze the effectiveness of current training programs in preparing deck officers for professional challenges; (2) to evaluate the incorporation of sustainability practices into vocational education; and (3) to propose innovative strategies for bridging identified gaps in training and competency development. These objectives are pursued through a dual approach: a Systematic Literature Review (SLR) and a qualitative analysis of perspectives from maritime professionals, educators, and graduates.

The motivation for this research stems from the critical role that deck officers play in ensuring maritime safety, operational efficiency, and environmental stewardship. Deck officers are not merely navigators; they are key decision-makers responsible for cargo operations, emergency response, and adherence to international regulations. Yet, the rapid evolution of the maritime industry, driven by technological advancements and environmental imperatives, necessitates a reevaluation of their training. By focusing on the perspectives of industry experts, educators, and graduates, this research aims to provide a holistic understanding of the challenges and opportunities in deck officer training.

The methodological framework of this study combines the rigor of a Systematic Literature Review with the richness of qualitative data derived from interviews and questionnaires (Linnenluecke et al., 2020; Macke & Genari, 2019). The SLR provides a

comprehensive overview of existing knowledge, identifying trends, gaps, and best practices in maritime education and sustainability. Complementing this, the qualitative analysis captures the lived experiences and insights of ten individuals deeply embedded in the maritime sector: two seasoned professionals, six educators specializing in maritime training, and two recent graduates. Together, these methodologies enable a nuanced exploration of the research problem, ensuring that the findings are both theoretically grounded and practically relevant.

The rationale for this research extends beyond academic inquiry; it addresses a critical need within the maritime industry. As international regulations become more stringent and stakeholder expectations evolve, the role of education in shaping competent and environmentally conscious professionals becomes indispensable (Agrifoglio et al., 2017; Comtois & Slack, 2017). This study not only contributes to the academic discourse on maritime education but also provides actionable recommendations for policymakers, educators, and industry stakeholders. By enhancing the training of deck officers, this research seeks to advance the broader goals of safety, efficiency, and sustainability in maritime operations.

This research is driven by the conviction that maritime vocational education must evolve to meet the dual imperatives of competency and sustainability. Through a meticulous analysis of existing literature and the lived experiences of key stakeholders, this study aims to illuminate pathways for enhancing the training of deck officers. In doing so, it seeks to contribute to the development of a resilient and sustainable maritime industry, one that is equipped to navigate the challenges and opportunities of the 21st century.

2. RESEARCH METHOD

This study employs a qualitative approach, integrating Systematic Literature Review (SLR) and thematic analysis of perspectives gathered from interviews and questionnaires (Macke & Genari, 2019; Y. Xiao & Watson, 2019). The research method was designed to comprehensively explore the challenges and opportunities in maritime vocational education, particularly focusing on enhancing deck officer training and integrating sustainability into their professional competencies. By combining a rigorous review of existing literature with qualitative insights from maritime professionals, educators, and recent graduates, the methodology provides a robust framework for addressing the research objectives.

The Systematic Literature Review serves as the foundation for the research, providing a critical synthesis of existing studies and publications related to maritime education, STCW competencies, and sustainability. The SLR process involves identifying, selecting, and analyzing scholarly articles, reports, and industry white papers that discuss key aspects of deck officer training and maritime sustainability. This method allows for the identification of current trends, gaps, and best practices in the field. The review focuses on studies that address competency frameworks, the role of sustainability in maritime operations, and the integration of advanced technologies such as simulation and e-learning in vocational training. Through this analysis, the research establishes a comprehensive understanding of the theoretical and practical underpinnings necessary for enhancing the training of deck officers.

Complementing the literature review, the qualitative component of the study captures the lived experiences and insights of ten individuals from the maritime sector. These participants include two seasoned maritime professionals with extensive experience in deck operations and leadership roles within port and shipping industries, six educators specializing in maritime vocational training, and two recent graduates who have transitioned into junior deck officer roles. The selection of participants was guided by their relevance to the research objectives and their ability to provide diverse perspectives on the effectiveness and challenges of current training programs.

Data collection for the qualitative analysis involved a combination of semi-structured interviews and detailed questionnaires. The interviews were designed to delve deeply into the participants' experiences, focusing on specific aspects of deck officer training, such as navigation, cargo handling, emergency response, and environmental management. The questionnaires, on the other hand, provided structured insights into the participants' perceptions of the gaps and opportunities in maritime education. This dual approach ensured that the data captured both the depth and breadth of perspectives, offering a holistic view of the challenges faced by deck officers and the potential for improvement in their training programs.

Thematic analysis was employed to interpret the qualitative data, enabling the identification of recurring patterns, themes, and insights across the participants' responses. This process involved coding the data, categorizing it into key themes, and synthesizing the findings to address the research questions (Creswell & Clark, 2011; Wilson, 2001). Themes that emerged included the need for enhanced simulation-based training, the importance of sustainability-focused curricula, and the challenges of

transitioning from education to professional roles. The analysis also highlighted the perspectives of educators on the effectiveness of current teaching methodologies and the insights of industry professionals on the evolving demands of maritime operations.

By integrating the findings from the SLR with the qualitative insights, the research achieves a comprehensive analysis of the challenges and opportunities in maritime vocational education. The synthesis of these methodologies allows for the triangulation of data, ensuring the validity and reliability of the findings. The SLR provides a theoretical framework for understanding the broader context of deck officer training, while the qualitative analysis adds depth and nuance by capturing the practical experiences of those directly involved in the field. This combination of methods not only strengthens the research but also ensures that the recommendations are grounded in both theory and practice.

The methodology reflects the study's commitment to a holistic and rigorous approach to understanding and addressing the complexities of maritime vocational education. By combining a systematic review of existing knowledge with the lived experiences of key stakeholders, the research provides actionable insights and practical recommendations for enhancing deck officer training and advancing the integration of sustainability in maritime operations.

3. SYSTEMATIC LITERATURE REVIEW

The role of deck officers in maritime operations is fundamental to ensuring the safety, efficiency, and sustainability of global shipping activities. The need for enhanced competencies, particularly in alignment with international standards such as the STCW, is a critical concern for maritime education (Lau & Ng, 2015; Sharma, 2023). Furthermore, the integration of sustainability into vocational training programs for deck officers represents an emerging priority in the maritime sector. A systematic exploration of existing literature reveals the complexity of these challenges and provides insights into innovative strategies for addressing them. This section synthesizes theoretical and empirical studies that inform the development of advanced training frameworks for deck officers, emphasizing practical applications and actionable solutions.

Maritime vocational education has long been recognized as the backbone of the global shipping industry, equipping seafarers with the skills necessary to perform their roles effectively (de Água et al., 2020). However, as the industry evolves, traditional training methods often fail to keep pace with emerging demands. Literature in this field

highlights the limitations of conventional approaches, which are predominantly focused on compliance with regulatory standards rather than fostering adaptive and critical thinking skills. For deck officers, this gap is particularly pronounced in areas such as advanced navigation techniques, emergency preparedness, and environmental management. The literature underscores the need for a paradigm shift toward competency-based training that emphasizes real-world problem-solving and decision-making.

One of the central themes in the literature is the importance of simulation-based training in enhancing the practical skills of deck officers. Simulations provide a controlled environment where trainees can practice complex tasks, such as ship handling, cargo operations, and collision avoidance, without the risks associated with real-world scenarios. Studies show that simulation-based training not only improves technical proficiency but also enhances cognitive and situational awareness, which are critical for effective decision-making under pressure. Moreover, the integration of advanced technologies, such as virtual and augmented reality, into simulation tools has further expanded the scope of training possibilities. These innovations allow trainees to experience realistic scenarios that closely mimic the challenges faced in actual maritime operations, thereby bridging the gap between theoretical knowledge and practical application.

In addition to technical training, the literature emphasizes the need for a comprehensive approach that incorporates sustainability principles into maritime education. The maritime industry is a significant contributor to global environmental challenges, including greenhouse gas emissions, marine pollution, and habitat destruction (Prokopenko & Miśkiewicz, 2020; Pu & Lam, 2021). As such, there is growing recognition of the need to train deck officers not only as navigators and managers but also as stewards of the marine environment. The integration of sustainability into training programs involves a multidimensional approach, encompassing regulatory compliance, operational efficiency, and ethical responsibility. Studies highlight the effectiveness of incorporating case studies, experiential learning, and cross-disciplinary collaboration into sustainability education, providing deck officers with the knowledge and skills needed to address environmental challenges proactively.

The role of STCW competencies in shaping maritime education is another critical area of focus in the literature. The STCW framework provides a standardized benchmark for the training and certification of seafarers, ensuring a baseline level of competence

across the industry (Ghosh et al., 2014; Young, 1995). However, the literature reveals significant variability in the implementation of STCW standards across training institutions, leading to disparities in the quality of education received by deck officers. To address this issue, researchers advocate for the adoption of best practices in curriculum design, instructional methods, and assessment strategies. These include the use of competency-based frameworks, continuous professional development for educators, and the incorporation of feedback mechanisms to align training outcomes with industry expectations.

The literature also explores the challenges associated with the transition from education to employment for deck officers. Graduates often face difficulties in applying their theoretical knowledge to the practical demands of maritime operations, particularly in high-pressure situations. This transition is further complicated by the dynamic nature of the maritime industry, where technological advancements and regulatory changes continuously reshape the operational landscape. To mitigate these challenges, studies recommend the establishment of mentorship programs, internships, and partnerships between training institutions and industry stakeholders. These initiatives provide trainees with opportunities to gain hands-on experience, build professional networks, and develop the adaptive skills needed to thrive in a rapidly changing environment.

The integration of qualitative insights into the literature review enhances its relevance and applicability. Perspectives from maritime professionals, educators, and graduates provide valuable context for interpreting the findings and identifying areas for improvement. Professionals highlight the importance of leadership, communication, and teamwork skills, which are often overlooked in traditional training programs. Educators emphasize the need for innovative teaching methodologies that engage learners and foster critical thinking. Graduates, on the other hand, point to the challenges of aligning educational outcomes with industry expectations, particularly in terms of preparedness for real-world challenges.

In synthesizing the literature, it becomes evident that a holistic approach is needed to advance the training of deck officers. This approach must integrate technical, cognitive, and ethical dimensions, ensuring that trainees are equipped to meet the diverse demands of their roles. Moreover, the adoption of a learner-centered framework, which prioritizes active engagement, continuous feedback, and individualized support, is essential for achieving meaningful learning outcomes. The literature also underscores the importance of collaboration among stakeholders, including training institutions, industry bodies, and

regulatory agencies, to ensure that training programs remain responsive to the evolving needs of the maritime sector.

The systematic review reveals several promising avenues for enhancing maritime vocational education. First, the use of technology-enabled learning tools, such as e-learning platforms, mobile applications, and gamified training modules, can significantly enhance the accessibility and effectiveness of training programs. Second, the incorporation of interdisciplinary perspectives, drawing on fields such as environmental science, systems thinking, and behavioral psychology, can enrich the content and delivery of sustainability education. Third, the adoption of competency-based assessment methods, which evaluate learners' ability to apply knowledge in real-world contexts, can provide a more accurate measure of training effectiveness.

The literature also highlights the potential for research to inform policy and practice in maritime education. By identifying gaps in existing training frameworks and proposing evidence-based solutions, research can contribute to the development of policies that promote standardization, innovation, and quality assurance. Furthermore, the findings of this review underscore the need for ongoing monitoring and evaluation of training programs, ensuring that they remain aligned with industry standards and emerging trends.

The systematic review demonstrates the critical importance of advancing maritime vocational education to address the dual imperatives of competency and sustainability. By synthesizing insights from theoretical and empirical studies, this review provides a comprehensive framework for understanding the challenges and opportunities in training deck officers. The findings highlight the need for innovative, holistic, and collaborative approaches to education, ensuring that the next generation of deck officers is well-equipped to navigate the complexities of the maritime industry. This review serves as a foundation for further research and practice, paving the way for transformative change in maritime vocational education.

4. RESULTS

The results of this research highlight the effectiveness and efficiency of current training practices in maritime vocational education, specifically for deck officers, while identifying areas for enhancement aligned with STCW competencies and sustainability principles. The outcomes are structured around key indicators, supported by

comprehensive data and tables, to ensure clarity and depth in addressing the research objectives.

Indicator 1: Effectiveness of Current Training Programs in Enhancing Deck Officer Competencies

The analysis of the qualitative data collected from maritime professionals, educators, and graduates revealed the strengths and limitations of current training programs. Participants emphasized the adequacy of training in technical skills such as navigation, cargo operations, and emergency response. However, there were notable gaps in integrating advanced technologies and sustainability principles into the curriculum.

Table 1: Effectiveness of Training Programs in Enhancing STCW Competencies

Competency Area	Professional Scores (n=2)	Educator Scores (n=6)	Graduate Scores (n=2)	Average Score (0–100)	Comments
Navigation Skills	92	88	85	88.3	Strong foundation; real-world simulation needed.
Cargo Handling	89	85	80	84.7	Adequate but lacks emphasis on hazardous cargo.
Emergency Preparedness	87	82	83	84.0	Effective but requires situational drills.
Leadership & Communication	78	80	76	78.0	Needs focused training for collaborative roles.
Sustainability Awareness	60	65	58	61.0	Critical gap; requires immediate integration.

The results show strong performance in technical areas but a clear deficit in leadership, communication, and sustainability awareness. While technical training adheres to STCW standards, the lack of holistic education in interpersonal and environmental skills may hinder deck officers' adaptability in dynamic maritime contexts.

Indicator 2: Integration of Sustainability Principles in Vocational Training

Participants agreed on the importance of sustainability in maritime operations, yet the data highlighted inconsistencies in how these principles are taught and applied. Educators reported limited resources and curricular constraints as barriers to effective integration.

Table 2: Perceived Integration of Sustainability in Training Programs

Sustainability Area	Professional Scores (n=2)	Educator Scores (n=6)	Graduate Scores (n=2)	Average Score (0–100)	Comments
Environmental Regulations	72	68	65	68.3	Basic knowledge provided; lacks practical training.
Operational Efficiency	75	70	67	70.7	Emphasis on fuel efficiency but limited in waste management.
Ethical Responsibility	55	60	50	55.0	Requires better focus in training frameworks.
Case-Based Learning	48	52	45	48.3	Limited use of real-world sustainability case studies.
Cross-disciplinary Collaboration	40	45	38	41.0	Minimal exposure to interdisciplinary approaches.

Analysis:

The integration of sustainability principles remains fragmented, with notable gaps in ethical responsibility and cross-disciplinary approaches. Although basic regulatory knowledge is conveyed, the lack of case-based and collaborative learning undermines practical application.

Indicator 3: Effectiveness of Technology-Driven Training and Real-World Preparedness

The inclusion of advanced training technologies such as simulation tools was highlighted as a key strength. However, graduates expressed the need for greater exposure to real-world scenarios and mentorship opportunities to bridge the gap between theoretical learning and professional practice.

Table 3: Evaluation of Technology-Driven Training and Professional Readiness

Technology Area	Professional Scores (n=2)	Educator Scores (n=6)	Graduate Scores (n=2)	Average Score (0–100)	Comments
Simulation Tools	90	85	88	87.7	Highly effective; recommended for expanded use.

Virtual Reality	78	75	72	75.0	Emerging tool with untapped potential.
E-Learning Modules	82	80	75	79.0	Accessible but lacks engagement in advanced topics.
Mentorship Opportunities	65	60	68	64.3	Essential for real-world readiness; underdeveloped.
Internship Placements	70	72	65	69.0	Effective but not universally accessible.

Technology-driven training, particularly simulations, is a major strength of current programs. However, gaps in mentorship and internship placements suggest a need for stronger industry partnerships to enhance real-world preparedness.

Synthesis with Systematic Literature Review

The findings align closely with insights from the systematic literature review. The literature underscored the importance of advanced simulation-based training, which is corroborated by the high scores in simulation effectiveness reported by participants. Similarly, the identified gaps in sustainability education and interdisciplinary approaches reflect broader trends in maritime education discussed in the review. The qualitative data provide additional depth by highlighting barriers such as resource limitations and curricular rigidity, which were not fully addressed in the literature.

The thematic analysis of participant responses further illustrates the interconnectedness of these challenges. Professionals emphasized the operational implications of inadequate sustainability training, while educators highlighted the constraints of implementing comprehensive curricula within existing frameworks. Graduates, representing the transition from education to practice, underscored the need for mentorship and experiential learning to bridge theoretical and practical knowledge.

The results of this study demonstrate the critical importance of enhancing maritime vocational education to address gaps in leadership, sustainability, and real-world readiness. While technical training is largely effective, the integration of holistic competencies remains a significant challenge. The findings suggest a need for targeted interventions, including:

a. Expanding simulation-based training to encompass leadership and sustainability scenarios.
b. Developing interdisciplinary curricula that integrate environmental science and ethics into maritime education.

c. Strengthening industry-academic partnerships to provide mentorship and internship opportunities.

The comprehensive data presented in the tables underscore the urgency of these interventions and provide a clear roadmap for future improvements. By addressing these gaps, maritime education can better equip deck officers to navigate the complexities of modern maritime operations while contributing to global sustainability goals.

5. DISCUSSION

This research aimed to explore how maritime vocational education, particularly for deck officers, can be enhanced to address the dual imperatives of competency development and sustainability. The qualitative results, analyzed alongside the systematic literature review, provide a rich foundation for discussing the study's findings and their broader implications. The discussion focuses on interpreting the findings in light of the research questions, comparing them to existing literature, identifying how the research addresses existing gaps, and proposing practical applications and future directions. The research questions focused on the effectiveness of current training programs, the integration of sustainability principles, and the role of technology-driven approaches in bridging the gap between education and professional practice. The qualitative results strongly align with these inquiries, providing insights into the strengths and weaknesses of existing frameworks.

For the question on the effectiveness of current training programs, the results indicate that technical competencies, such as navigation and cargo handling, are effectively covered, with participants consistently scoring these areas highly. This finding supports the premise that STCW standards provide a robust baseline for technical skill development. However, the research also revealed significant gaps in leadership and communication training, suggesting that current programs do not adequately prepare deck officers for collaborative and managerial roles. In addressing the integration of sustainability principles, the findings show a fragmented approach. While participants recognized the importance of environmental awareness and operational efficiency, they also highlighted the lack of practical applications and interdisciplinary collaboration in current training. This partial alignment with the research question underscores the need for a more comprehensive and systematic integration of sustainability into maritime education.

The third research question, regarding the effectiveness of technology-driven approaches, received mixed support from the findings. Participants praised simulation-based training for its effectiveness in teaching technical skills but noted limitations in mentorship opportunities and real-world preparedness. These results suggest that while technology is a powerful tool, it must be complemented by experiential learning and stronger industry-academic partnerships to fully address the needs of aspiring deck officers. The results align with the literature review in many respects, particularly regarding the strengths of simulation-based training and the challenges of integrating sustainability principles. The literature emphasized the transformative potential of advanced training technologies, a finding corroborated by the participants' positive evaluation of simulation tools (Dyagileva et al., 2020; G. Xiao et al., 2024). Similarly, the gaps in sustainability training identified in the results mirror the broader trends discussed in the literature, where environmental education in maritime programs remains underdeveloped.

However, notable differences also emerged. The qualitative findings highlighted the significant role of mentorship and real-world exposure, which was less emphasized in the literature. This divergence may stem from the practical experiences of the participants, particularly graduates, who face the realities of transitioning from education to professional roles. The findings also reveal a greater need for interdisciplinary approaches to sustainability training, an area that the literature often addresses theoretically but not in terms of practical implementation. These differences highlight the value of combining literature review with qualitative analysis. The qualitative data provide context-specific insights that enrich and extend the theoretical frameworks discussed in the literature. For instance, the emphasis on mentorship and internships reflects a critical gap in maritime education that literature often overlooks.

This study makes a significant contribution by addressing several gaps in existing research. First, it provides empirical evidence on the effectiveness of maritime training programs from the perspectives of key stakeholders: professionals, educators, and graduates. By integrating these perspectives, the research offers a holistic understanding of the challenges and opportunities in deck officer training. Second, the study bridges the gap between theoretical discussions of sustainability and their practical application in maritime education. The findings highlight specific areas for improvement, such as case-based learning and cross-disciplinary collaboration, which are often missing in existing training frameworks. By identifying these gaps, the research provides actionable

recommendations for enhancing the integration of sustainability into vocational education.

Third, the study addresses the limitations of previous research by emphasizing the role of mentorship and experiential learning. These elements, while frequently acknowledged in educational theory, are rarely explored in the context of maritime training. The findings underscore their importance in preparing graduates for the complexities of professional practice, offering a valuable addition to the existing body of knowledge. The strengths of this research lie in its comprehensive methodology and the depth of its analysis. The combination of systematic literature review and qualitative data collection ensures a robust and nuanced understanding of the research problem. The inclusion of diverse perspectives, spanning professionals, educators, and graduates, enriches the findings and provides a multi-faceted view of the challenges in maritime education. Additionally, the use of thematic analysis allows for the identification of recurring patterns and themes, ensuring that the findings are grounded in the data. The alignment of qualitative results with the literature review further enhances the validity and reliability of the research, demonstrating its coherence and rigor.

The findings have significant practical implications for maritime education and industry practices. For training institutions, the research provides a clear roadmap for enhancing the curriculum. This includes expanding simulation-based training to cover leadership and sustainability scenarios, developing interdisciplinary modules, and incorporating case-based learning into sustainability education. For industry stakeholders, the study highlights the importance of mentorship and internships in bridging the gap between education and professional practice (Baş et al., 2002; Baylon & Santos, 2011). By fostering stronger partnerships with training institutions, maritime companies can help prepare deck officers for real-world challenges while benefiting from a well-trained and adaptable workforce.

Policy implications also emerge from the findings. Regulatory bodies can use the research to refine STCW standards, ensuring that they address the evolving demands of the maritime industry. This includes updating competency requirements to include sustainability and interdisciplinary skills, as well as promoting the use of advanced training technologies. While this study provides valuable insights, it also highlights areas for future research. One potential avenue is to explore the long-term impact of enhanced training programs on the performance and adaptability of deck officers in professional

roles. Longitudinal studies could provide deeper insights into how training influences career development and operational effectiveness.

Another area for research is the development and evaluation of specific training interventions, such as sustainability modules or mentorship programs. By testing these interventions in real-world settings, researchers can assess their effectiveness and refine their implementation. Finally, future research could explore the role of cultural and regional differences in shaping maritime education. Given the global nature of the maritime industry, understanding how training programs can be tailored to different contexts would provide valuable insights for both educators and policymakers.

The discussion highlights the importance of advancing maritime vocational education to address the dual imperatives of competency and sustainability. By connecting the qualitative findings to the research questions, comparing them to the literature, and identifying areas for improvement, this research provides a comprehensive framework for enhancing deck officer training. The practical implications and future research directions outlined here underscore the study's relevance and impact, offering a pathway for transforming maritime education and practice in the face of evolving industry demands.

6. CONCLUSION

This research highlights the critical importance of enhancing maritime vocational education, particularly for deck officers, to meet the evolving demands of the maritime industry. By integrating a systematic literature review with qualitative insights from maritime professionals, educators, and graduates, the study provides a comprehensive understanding of the challenges and opportunities in maritime training. The findings reveal that while technical competencies aligned with STCW standards are effectively addressed, significant gaps remain in leadership, communication, sustainability education, and real-world preparedness. The integration of sustainability principles into training programs is shown to be fragmented, with limited practical applications and interdisciplinary approaches. Although technology-driven training, such as simulations, demonstrates high effectiveness, its full potential remains underutilized without complementary mentorship and experiential learning opportunities. These findings underscore the need for a holistic and innovative approach to maritime education that combines technical, cognitive, and ethical dimensions. This study contributes to the field by addressing critical gaps in maritime education and providing actionable

recommendations for curriculum development, policy updates, and industry-academic collaboration. By advancing the training of deck officers, the research supports the broader goals of safety, operational efficiency, and sustainability in maritime operations. Future research should explore the long-term impact of these enhancements and further refine training interventions to ensure a well-prepared and adaptive maritime workforce.

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