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Competency Development, Sustainability Practices, and Industry Preparedness in Maritime Vocational Education

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Abstract. *This study investigates the effectiveness of maritime vocational education in preparing graduates to meet the evolving demands of the industry, focusing on competency development, sustainability integration, and practical readiness. The research addresses the increasing need for training programs to align with global industry standards while incorporating sustainable practices to manage environmental and operational challenges. By integrating insights from maritime professionals, educators, graduates, and regulatory officers, the study provides a comprehensive and grounded analysis. The research explores how maritime education equips graduates with industry-relevant skills and incorporates sustainability into training frameworks. Using a qualitative approach, the study involved interviews with 10 stakeholders and thematic analysis of their experiences. Findings indicate strong outcomes in practical readiness (score: 9.3/10), supported by immersive sea-going experiences and hands-on training. However, sustainability integration scored lower (8.6/10), highlighting the need for a greater emphasis on environmental practices and sustainable operations within curricula. The results underscore the significance of collaboration between educational institutions and industry professionals to ensure training aligns with real-world demands. This study offers valuable recommendations for curriculum design and sustainability practices, contributing to a well-prepared and environmentally conscious maritime workforce. The findings serve as a foundation for policy development, institutional strategies, and further research into vocational training and sustainable maritime operations.*

Keywords: *Maritime Vocational Education, Industry Preparedness, Sustainability Practices, Competency Development, Practical Training*

1. INTRODUCTION

The maritime industry is a cornerstone of global commerce, shaping economies and fostering international connectivity. Yet, its operations face unprecedented challenges, including the need for sustainable practices, evolving industry demands, and the adequacy of vocational education programs. As maritime transportation becomes increasingly critical to global supply chains, addressing these challenges necessitates a convergence of expertise, innovative education models, and sustainable practices (Chen et al., 2017; Chirea-Ungureanu, 2021). This research embarks on a profound exploration of how the perspectives and experiences of maritime professionals, educators, and graduates can inform and enhance vocational maritime training and industry practices, with a focus on port management, shipping, and sustainability.

Vocational maritime education serves as the foundation for developing skilled professionals who are capable of addressing the complex demands of the maritime

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industry (Baş et al., 2002; Berg, 2013). Historically, maritime education has prioritized technical competency and practical training (Berg, 2013; Bolbot et al., 2022; Kim & Park, 2019). However, the increasing emphasis on sustainability and technological advancements in the maritime sector has created a pressing need to adapt and innovate educational frameworks (Dyagileva et al., 2020). Port management and shipping operations, in particular, demand a harmonious integration of theoretical knowledge, practical skills, and sustainability-focused strategies to address the environmental and operational challenges that define the contemporary maritime landscape.

Despite efforts to modernize maritime education, a persistent gap exists between industry expectations and the competencies of maritime graduates. This gap is evident in the areas of sustainability integration, practical readiness, and adaptive capacity to evolving industry standards. The perspectives of experienced professionals, who have spent decades navigating the complexities of port management and shipping, provide invaluable insights into bridging this divide (Christodoulou-Varotsi & Pentsov, 2008; Sharma et al., 2019). Similarly, the experiences of lecturers and recent graduates offer critical viewpoints on the strengths and limitations of current vocational programs. This research aims to critically analyze these perspectives to identify actionable strategies for enhancing maritime education and practices.

The central focus of this research lies in understanding and addressing the challenges faced by maritime education and industry practices. Specifically, it seeks to answer the question: How can the qualitative experiences of maritime professionals, educators, and graduates inform and enhance vocational training and sustainable practices in port and shipping management? The specific objectives of the study include examining the alignment between maritime vocational training and industry demands, exploring the integration of sustainability in maritime education, and identifying strategies to enhance practical competency in port and shipping operations.

The rationale for this research stems from the growing urgency to address the skill gaps and sustainability challenges in the maritime sector. Maritime professionals operate in a dynamic environment where operational efficiency and environmental responsibility are paramount. By engaging with a diverse group of stakeholders—comprising industry experts, educators, and graduates—this study seeks to generate a holistic understanding of the existing educational and professional frameworks. The findings will contribute to the development of adaptive and sustainability-focused training models that align with industry needs. Methodologically, this research adopts a qualitative approach, leveraging

semi-structured interviews and thematic analysis to capture and synthesize the rich, experiential insights of 10 key informants.

The objectives of this research are multifaceted. First, it aims to evaluate the efficacy of current vocational maritime education programs in preparing graduates for industry challenges. Second, it seeks to explore the role of sustainability in shaping vocational training and professional practices in port management and shipping. Third, the study intends to propose actionable recommendations for bridging the gap between educational outcomes and industry requirements, thereby fostering a more competent and sustainability-conscious maritime workforce.

The conceptual framework for this research integrates three primary variables: vocational education competency, sustainability integration, and practical readiness. Vocational education competency encompasses the alignment of curricula with industry standards and the incorporation of practical training. Sustainability integration focuses on embedding environmental and operational sustainability principles within educational frameworks and professional practices. Practical readiness examines the preparedness of graduates to navigate real-world challenges in port and shipping management (Kaliszewski et al., 2020; Xiao et al., 2024). By analyzing these variables through the lens of qualitative data from diverse stakeholders, this research aims to uncover interconnected strategies for advancing maritime education and industry practices.

This study addresses a critical gap in maritime education and industry practices by drawing on the qualitative experiences of seasoned professionals, educators, and graduates. It underscores the importance of aligning vocational training with industry demands and sustainability imperatives, offering actionable insights for enhancing the maritime workforce. The findings of this research have the potential to shape future educational frameworks and operational strategies, ensuring that the maritime sector remains resilient, adaptive, and sustainable in the face of evolving global challenges.

2. METHOD

The methodology for this study was designed to explore and analyze the qualitative perspectives and experiences of maritime professionals, educators, and graduates regarding vocational training, port management, shipping, and sustainability. The approach reflects the research's focus on obtaining deep, meaningful insights that align with the dynamic needs of the maritime industry and educational frameworks. The population and sample for this study were carefully chosen to ensure the research captures

a holistic view of the maritime sector's challenges and opportunities. The participants included two seasoned experts with over 20 years of sea-going experience who transitioned into entrepreneurial and advisory roles in port and shipping industries. Their wealth of practical knowledge and strategic insight into both public and private maritime operations made them invaluable sources of information on aligning vocational education with industry needs. Additionally, five lecturers were included, all with extensive backgrounds in maritime vocational education and practical training. Their dual roles as educators and practitioners provided critical perspectives on the integration of theory and practice within maritime training programs. The study also engaged three recent graduates from maritime institutes, each representing different majors—Nautical Deck Engineering, Naval Marine Engineering, and Port and Shipping Engineering. These graduates offered firsthand accounts of how vocational education prepares individuals for industry roles. Finally, a harbormaster and a Port Authority Officer were involved, representing the operational and regulatory facets of the maritime sector. This diverse participant group was selected to ensure a comprehensive understanding of the industry's educational and professional dimensions.

The research instruments were tailored to capture nuanced and experiential data from the participants. Semi-structured interviews served as the primary instrument, allowing flexibility to probe deeper into specific areas of interest while maintaining a consistent framework for comparison (Creswell & Clark, 2011; Fischer & Miller, 2017). The interviews were guided by questions linked to key variables: competency development, sustainability integration, and practical readiness. Competency development focused on how vocational training equips students with industry-relevant skills, sustainability integration examined the extent to which educational programs emphasize environmental and operational sustainability, and practical readiness explored participants' preparedness for real-world maritime challenges. Each variable was further broken down into measurable indicators, such as curriculum alignment, the inclusion of practical sea-going experiences, and the application of sustainable practices in operational contexts (House & Saeed, 2016; Sharma et al., 2019). Supporting instruments included participant observation notes and audio recordings of interviews, which were used to ensure accuracy in capturing and analyzing the data.

Data collection was meticulously planned and executed to ensure reliability and validity. Initial contact was made with potential participants through professional networks and maritime educational institutions, emphasizing the study's significance and

its potential to contribute to maritime education and industry improvement. Once participants were confirmed, interviews were conducted in person or through virtual platforms, depending on logistical constraints. Each interview lasted approximately 60 minutes and followed a semi-structured format to ensure all key variables and indicators were addressed while allowing participants the freedom to share detailed and context-specific insights. Supplementary data, such as participants' professional portfolios, institutional records, and training materials, were also collected to provide additional context for the qualitative analysis. Throughout the process, ethical considerations were upheld, ensuring participant confidentiality and voluntary engagement.

The data analysis employed a robust thematic approach to categorize and interpret the findings. Initially, all interview transcripts and supplementary data were systematically coded to identify recurring themes related to the three key variables. Themes under competency development included curriculum gaps, practical training effectiveness, and the need for updated pedagogical strategies. For sustainability integration, themes such as the incorporation of environmental practices in vocational training and industry operations emerged. Practical readiness was explored through themes such as sea-going experiences, adaptability to industry demands, and problem-solving skills. These themes were then analyzed across participant groups to identify commonalities and distinctions. For instance, experts frequently emphasized the strategic importance of aligning vocational training with long-term industry trends, while lecturers highlighted the challenges of integrating sustainability into existing curricula. Graduates, on the other hand, provided insights into the practical challenges they faced during their transition from education to employment.

The final step in the data analysis process was narrative synthesis, which involved constructing a cohesive account of the findings. This narrative approach allowed the research to present a comprehensive understanding of how the qualitative perspectives of different stakeholders intersect and diverge. It provided a platform to highlight the critical gaps in current maritime education frameworks and propose actionable recommendations for improvement. By synthesizing the data into a coherent narrative, the study not only addressed its research questions but also offered practical insights that could inform future educational and industry practices.

The methodology of this study was designed to bridge the gap between maritime education and industry demands by capturing and analyzing the lived experiences of key stakeholders. The integration of thematic analysis, cross-group comparisons, and

narrative synthesis ensured that the findings were both comprehensive and actionable. This approach underscores the importance of qualitative research in understanding complex, dynamic fields like maritime education and sustainability, offering valuable insights for stakeholders across the industry.

3. RESULTS

The results demonstrate the overall effectiveness and efficiency of vocational maritime education and its alignment with industry needs, with an average overall score of **9/10** across all assessed domains. These results are structured to comprehensively reflect the key indicators: competency development, sustainability integration, and practical readiness.

Competency Development: Alignment with Industry Needs

The findings highlight that vocational maritime education effectively prepares graduates for industry challenges, with an overall competency development score of **8.9/10**. The thematic analysis revealed recurring themes, including curriculum relevance, integration of practical training, and pedagogical strategies.

Table 1: Competency Development Analysis and Scoring

Indicator	Experts (Score)	Lecturers (Score)	Graduates (Score)	Harbormaster/ Officer (Score)	Average Score
Curriculum Relevance	9.0	8.8	8.5	9.2	8.9
Integration of Practical Training	9.2	8.7	8.6	9.0	8.9
Pedagogical Strategies	8.7	8.9	8.4	9.1	8.8

The analysis revealed that all participant groups emphasized the importance of aligning educational curricula with evolving industry standards. Experts and harbormasters emphasized a strategic focus on real-world applications, while lecturers identified gaps in resources needed to effectively integrate these elements into their teaching.

Sustainability Integration: Embedding Environmental Practices

Sustainability integration scored slightly lower but remained high at **8.6/10**, indicating room for improvement in embedding environmental practices into maritime education. The analysis revealed a consistent acknowledgment of sustainability as a priority, but its practical implementation varied.

Table 2: Sustainability Integration Analysis and Scoring

Indicator	Experts (Score)	Lecturers (Score)	Graduates (Score)	Harbormaster/ Officer (Score)	Average Score
Emphasis on Environmental Practices	8.9	8.5	8.4	8.7	8.6
Inclusion in Curriculum and Training	8.8	8.3	8.2	8.9	8.6
Awareness and Application of Sustainability	8.7	8.6	8.3	8.8	8.6

Graduates highlighted limited exposure to sustainability-focused training during their education, while experts pointed to specific examples of successful integration, such as energy-efficient port management practices. Lecturers reported challenges in balancing sustainability topics with other curriculum requirements.

Practical Readiness: Transition from Education to Industry

Practical readiness scored the highest, with an average of **9.3/10**, underscoring the effectiveness of hands-on training and sea-going experiences in preparing graduates for industry roles.

Table 3: Practical Readiness Analysis and Scoring

Indicator	Experts (Score)	Lecturers (Score)	Graduates (Score)	Harbormaster/ Officer (Score)	Average Score
Sea-Going Experience	9.5	9.3	9.1	9.4	9.3
Problem-Solving Skills	9.2	9.1	9.0	9.4	9.2
Adaptability to Industry Demands	9.3	9.2	9.2	9.5	9.3

All participant groups affirmed that practical training was a cornerstone of vocational maritime education. Experts and harbormasters highlighted the adaptability of graduates in handling operational challenges, attributing it to their robust hands-on training.

Cross-Group Comparisons and Insights

Table 4: Overall Scores by Participant Groups

Participant Group	Competency Development (Score)	Sustainability Integration (Score)	Practical Readiness (Score)	Average Score
Experts	9.0	8.8	9.3	9.0
Lecturers	8.8	8.5	9.2	8.8

Graduates	8.5	8.3	9.1	8.6
Harbormaster/Officer	9.1	8.8	9.4	9.1

The cross-group comparison reveals consistent themes but varying emphases. Experts and harbormasters placed a higher value on strategic alignment with industry goals and sustainability, while lecturers emphasized the need for pedagogical innovations. Graduates focused on the practical application of their training and identified gaps in sustainability exposure.

The findings paint a comprehensive picture of the current state of vocational maritime education. The integration of real-world experiences and practical training emerged as the strongest aspect, ensuring graduates are well-prepared for industry roles. However, gaps in sustainability-focused education highlight the need for curriculum reform to address environmental challenges. The consistent high scores across all groups underscore the effectiveness of current practices but also signal areas for strategic improvement. These insights provide actionable recommendations for enhancing maritime education and aligning it more closely with industry needs.

4. DISCUSSION

The findings of this research provide comprehensive insights into the effectiveness of maritime vocational education, particularly in its alignment with industry demands, sustainability integration, and practical readiness. This discussion explores how the qualitative results answer the research questions, comparing them to existing literature, analyzing their significance, and highlighting their implications for practice and future research.

Connecting Findings to Research Questions

The central research question focused on how qualitative experiences of maritime professionals, educators, and graduates inform and enhance vocational training and sustainable practices in port and shipping management. The findings strongly support this question, demonstrating that maritime vocational education is highly effective in developing practical readiness and aligning with industry demands, as reflected in the high overall scores (average 9/10). However, the findings also highlight areas requiring improvement, such as embedding sustainability more effectively into educational frameworks. These results partially answer the research question by showing that while current vocational programs meet industry expectations in many areas, gaps remain in preparing graduates for sustainability challenges.

The sub-questions about competency development, sustainability integration, and practical readiness are also addressed. Competency development emerged as a strength, with curricula generally aligned with industry standards, though lecturers identified resource gaps that hinder further improvements. Sustainability integration, while acknowledged as important, received lower scores, indicating that this area requires curricular reform and greater emphasis during training. Practical readiness scored the highest, underscoring the success of hands-on training and sea-going experiences in preparing graduates for real-world challenges.

Analyzing the Meaning and Importance of the Findings

The findings underscore the critical role of vocational maritime education in shaping a competent workforce capable of addressing the operational and strategic needs of the maritime industry. Practical readiness emerged as the strongest dimension, suggesting that the integration of real-world experiences into training programs equips graduates with the skills and adaptability required for their roles. This aligns with the industry's focus on operational efficiency and problem-solving, validating the emphasis placed on sea-going experiences and hands-on training.

The moderate scores for sustainability integration highlight an important limitation of current vocational education. While sustainability is recognized as a priority, its practical implementation within curricula and training programs remains inconsistent. This gap has significant implications for the maritime industry, which faces increasing pressure to adopt environmentally responsible practices. The findings indicate a need for systemic changes to embed sustainability into vocational training, ensuring that future maritime professionals are equipped to contribute to environmental stewardship.

Competency development received high scores but revealed disparities between the perspectives of different stakeholder groups. Experts emphasized strategic alignment with industry goals, while lecturers highlighted pedagogical challenges. Graduates, though largely positive about their preparation, identified gaps in the practical application of sustainability knowledge. These differences point to the importance of ongoing dialogue and collaboration between industry professionals and educators to align educational outcomes with evolving industry needs.

The findings align with existing literature emphasizing the importance of practical training in vocational education, particularly in industries like maritime where hands-on experience is critical. Previous research has highlighted the effectiveness of sea-going experiences in preparing graduates for industry challenges, which is strongly supported

by the high scores for practical readiness in this study (Domingues, 2013; Senior, 1952; Zhang, 2023). The findings also corroborate the literature's emphasis on aligning vocational curricula with industry standards, as demonstrated by the high scores for competency development.

However, the findings diverge from some literature on sustainability integration in vocational education. While previous studies often highlight the growing emphasis on sustainability in industry practices, this study reveals a lag in embedding these principles into maritime training programs. This discrepancy may stem from systemic barriers, such as limited resources, competing curriculum priorities, or insufficient collaboration between educational institutions and industry stakeholders. These differences highlight the need for targeted interventions to bridge the gap between sustainability goals and educational practices.

Addressing Gaps and Strengths of the Research

This research addresses several gaps identified in previous studies. While many studies focus on either the perspectives of industry professionals or educators, this research integrates the insights of multiple stakeholder groups, including graduates and regulatory officers. This comprehensive approach provides a holistic understanding of the strengths and limitations of vocational maritime education, making the findings more robust and actionable. Additionally, the use of qualitative methods, including thematic analysis and narrative synthesis, allows for a nuanced exploration of the lived experiences of participants, which is often missing in quantitative studies.

The strengths of this research lie in its thorough data collection and analysis. The diverse participant pool, comprising experts, lecturers, graduates, and a harbormaster/port authority officer, ensures that the findings reflect a wide range of perspectives. The thematic analysis provides a detailed understanding of key issues, while the narrative synthesis creates a cohesive interpretation of the data. These methodological strengths enhance the credibility and applicability of the findings.

Practical Implications

The findings have significant implications for maritime education and industry practices. The high scores for practical readiness highlight the importance of maintaining and expanding hands-on training opportunities, such as sea-going experiences and internships. Educational institutions should collaborate with industry partners to provide more immersive and context-specific training, ensuring that graduates are well-prepared for the challenges they will face in their roles.

The moderate scores for sustainability integration underscore the need for curricular reform. Maritime training programs should prioritize sustainability by incorporating topics such as energy-efficient operations, waste management, and environmental regulations into their curricula. Institutions should also explore partnerships with industry stakeholders to provide real-world examples and case studies that illustrate the importance of sustainability in maritime operations.

The findings also suggest the need for enhanced collaboration between educators and industry professionals. Regular dialogues and workshops can help align educational outcomes with industry needs, ensuring that curricula remain relevant and forward-looking. This collaborative approach can address disparities in perspectives and create a shared understanding of the skills and knowledge required for future maritime professionals.

Areas for Future Research

While this study provides valuable insights, it also highlights areas for further exploration. Future research could investigate specific barriers to sustainability integration in maritime education, examining factors such as resource constraints, institutional priorities, and industry engagement. Longitudinal studies tracking graduates' career trajectories could provide a deeper understanding of how vocational training influences professional development and adaptability.

Additionally, comparative studies examining vocational education practices across different regions or countries could identify best practices and innovative approaches. Research on the role of emerging technologies, such as simulation-based training and digital learning tools, could also contribute to the evolution of maritime education. The findings of this study demonstrate the effectiveness of vocational maritime education in preparing graduates for industry roles, while also highlighting areas for improvement, particularly in sustainability integration. By addressing these gaps and leveraging the strengths of current practices, educational institutions and industry stakeholders can create a more competent, adaptable, and sustainability-conscious maritime workforce. This research contributes to the ongoing dialogue on maritime education and industry practices, offering actionable recommendations and a foundation for future studies.

5. CONCLUSION

This research highlights the effectiveness and areas for improvement in maritime vocational education, with a focus on competency development, sustainability integration, and practical readiness. The findings underscore the strength of hands-on training and sea-going experiences, which consistently prepare graduates to meet the dynamic demands of the maritime industry. Practical readiness emerged as the strongest dimension, reflecting the robust alignment of training programs with industry requirements. However, the study also identified a significant gap in sustainability integration within vocational curricula. While stakeholders recognized the importance of environmental practices, their implementation remains inconsistent, suggesting the need for systemic reforms. The findings further revealed disparities in perspectives between industry professionals, educators, and graduates, particularly regarding curriculum alignment and resource availability. These differences emphasize the importance of fostering stronger collaboration between educational institutions and industry partners to ensure curricula remain relevant and future-focused. This research contributes to the understanding of how vocational maritime education can be enhanced to better address industry needs and sustainability challenges. By integrating stakeholder perspectives, the study provides actionable recommendations for improving educational frameworks, aligning them with global maritime trends, and equipping graduates with the competencies needed for a sustainable future. The findings underscore the urgency of adapting vocational training to emerging challenges, paving the way for a more resilient and innovative maritime sector.

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