

Enhancing Environmental Literacy in Maritime Education: Bridging Theory and Practice

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Abstract— This research investigates the integration of sustainability principles in maritime education, focusing on the perspectives of maritime professionals, lecturers, and graduates. The analysis was conducted to address the pressing need for enhanced environmental literacy in the maritime industry, given its significant environmental impact and evolving regulatory landscape. The originality of this study lies in its qualitative examination of the perceptions and experiences of key stakeholders, contributing to the limited body of research on educational practices in this context. The primary research questions focused on understanding the effectiveness of current educational practices, student engagement in practical experiences, and the collaboration between educational institutions and the maritime industry. Utilizing a qualitative methodology, the study gathered data through interviews with maritime professionals, lecturers, and graduates to explore their insights and experiences. The results revealed a strong understanding of sustainability concepts, with positive engagement in practical experiences; however, challenges remain in fostering deeper industry collaboration. The findings suggest that enhancing experiential learning opportunities and strengthening partnerships between academia and the maritime sector are crucial for preparing future professionals. Ultimately, this research underscores the importance of evolving educational practices to cultivate a workforce equipped to drive sustainable innovations in the maritime industry.

Keywords— Maritime Education, Sustainability, Environmental Literacy, Student Engagement, Industry Collaboration

I. INTRODUCTION

The maritime industry, a critical component of global trade, faces significant challenges in balancing operational efficiency with environmental sustainability. As international shipping and port activities expand, the industry's impact on ecological systems becomes increasingly pronounced, necessitating a shift towards greener practices and technologies. In this context, the role of education in shaping future maritime professionals is paramount (Barasa, 2023). This research investigates the intersection of maritime shipping management, environmental literacy, and vocational education, focusing on how educational institutions can effectively engage students in sustainable maritime solutions and innovation in green technology.

The primary focus of this study is to explore students' engagement in developing sustainable solutions for maritime challenges through collaborations with the maritime industry and environmental organizations. By emphasizing practical involvement and real-world applications, this research aims to enhance the educational experience of students in maritime vocational programs. The integration of sustainability concepts into maritime curricula not only prepares students to navigate the complexities of the industry but also equips them with the skills necessary to address pressing environmental issues. The demand for sustainability in shipping is no longer a peripheral consideration (Rahman et al., 2023). It has become a critical element in maritime operations and management. As such, the need for a robust educational framework that fosters an understanding of environmental challenges and sustainable practices is more important than ever.

Understanding the perspectives of various stakeholders within the maritime field is essential for developing an effective educational model. This research examines the qualitative experiences of three key groups: maritime professionals, educators, and graduates. By engaging with entrepreneurs, officers, and managers from the shipping industry, the study captures insights into current practices and innovations that can inform educational strategies. These professionals play a vital role in shaping the industry's response to environmental challenges, and their expertise provides invaluable context for understanding the integration of sustainability into maritime education (Simanjuntak et al., 2024).

In addition to maritime professionals, this research also seeks input from lecturers, trainers, and tutors who possess competencies in maritime science and vocational seafarer programs. Their experiences and pedagogical insights are crucial for designing curricula that effectively convey the principles of sustainability while promoting student engagement. Educators serve as the bridge between theory and practice, and their understanding of the maritime industry's needs is vital for creating a relevant and impactful learning environment. The collaboration between educators and industry professionals can lead to the development of innovative teaching practices that not only engage students but also prepare them for the demands of a rapidly evolving industry.

Graduates who have transitioned from academic settings to real-world maritime roles provide a unique perspective on the efficacy of maritime education. Their firsthand experiences highlight the importance of equipping students with practical skills and knowledge that align with industry expectations. Understanding how graduates apply their training in the workplace can offer insights into potential gaps in education and inform improvements in curricula. By examining the collective insights of these three groups, this research aims to create a comprehensive understanding of how to enhance student engagement and foster innovation in sustainable maritime practices.

The emphasis on sustainable maritime solutions and green technology is a response to the pressing need for environmental stewardship within the industry. As global awareness of climate change and ecological degradation grows, the maritime sector must adapt to meet the expectations of regulators, consumers, and stakeholders (Xue & Lai, 2023). This adaptation requires not only the implementation of sustainable practices but also a cultural shift within the industry that prioritizes environmental responsibility. Educational institutions are positioned to be at the forefront of this change by fostering a new generation of maritime professionals who are equipped to champion sustainability and innovation.

The collaboration between educational institutions and the maritime industry is a cornerstone of this research. Such partnerships are essential for creating a dynamic learning environment where students can engage directly with industry challenges. By working alongside maritime professionals and environmental organizations, students can apply theoretical knowledge to practical situations, fostering a deeper understanding of sustainability concepts and their implications in the maritime context (Bolmsten et al., 2021). This collaborative approach not only enriches the educational experience but also prepares students to enter a competitive job market equipped with relevant skills and insights.

Moreover, the exploration of innovative teaching practices is crucial for engaging students in the learning process. Traditional pedagogical methods may not adequately address the complexities of sustainability in the maritime sector. Therefore, this research will investigate experiential learning opportunities, project-based assignments, and interdisciplinary approaches that encourage active participation and critical thinking among students. By incorporating these innovative methods, educators can create a more engaging and impactful learning environment that resonates with students and cultivates their interest in sustainable maritime solutions.

As the maritime industry continues to evolve, the urgency for sustainable practices becomes increasingly evident. This research aims to contribute to the dialogue surrounding the integration of sustainability into maritime education by providing a framework for understanding how educational institutions can better prepare students for the challenges ahead. By emphasizing the importance of students' engagement and innovation in sustainable maritime practices, this study seeks to illuminate pathways for collaboration between education and industry, fostering a culture of sustainability that can drive meaningful change.

The maritime industry is undergoing significant transformation, driven by the need for sustainable practices, technological advancements, and the increasing complexity of global trade. In this context, applied maritime management studies have emerged as a crucial area of research that seeks to address these challenges through a practical and interdisciplinary

lens. The literature in this field reflects a growing recognition of the importance of integrating sustainability into maritime operations, along with the vital role of education in preparing future professionals to navigate this evolving landscape (Chen et al., 2023).

One of the foundational concepts in applied maritime management is the recognition of sustainability as a critical component of maritime operations. As environmental concerns continue to rise, the industry is compelled to adopt practices that minimize ecological impact while maintaining economic viability. This shift has prompted an increased focus on green shipping initiatives, which emphasize reducing emissions, optimizing fuel efficiency, and implementing environmentally friendly technologies. The literature emphasizes that for maritime companies to remain competitive in a global market increasingly influenced by consumer preferences for sustainability, they must innovate and adopt practices that align with environmental standards. This requires a holistic understanding of how operational decisions in ports and shipping can impact the environment and the importance of fostering a culture of sustainability within organizations (Malau et al., 2024).

Central to the discourse on sustainability in maritime management is the role of education and training in cultivating a workforce equipped with the knowledge and skills necessary to implement sustainable practices. Applied maritime management studies underscore the significance of integrating sustainability principles into vocational education programs. By doing so, educational institutions can ensure that students not only understand the theoretical aspects of maritime operations but also gain practical insights into how to apply sustainable practices in real-world scenarios (Aylward et al., 2021). The literature suggests that curricula should be designed to engage students actively, promoting critical thinking and problem-solving skills that are essential for addressing contemporary maritime challenges. This pedagogical approach fosters a deeper understanding of the interconnectedness between maritime operations and environmental stewardship.

The literature also highlights the importance of experiential learning opportunities as a means to enhance student engagement in maritime education. Traditional instructional methods may not fully prepare students for the complexities of the maritime industry, especially in the context of sustainability (Mallam et al., 2019). As such, there is a growing emphasis on hands-on experiences, such as internships, simulations, and collaborative projects with industry stakeholders. These opportunities allow students to apply their knowledge in practical settings, bridging the gap between theory and practice. Through engagement with real-world challenges, students can develop a more profound appreciation for the nuances of sustainable maritime operations and the role they play in driving innovation within the industry.

In addition to enhancing student engagement, applied maritime management studies also emphasize the need for collaboration between educational institutions and the maritime industry. This collaboration is essential for creating a dynamic learning environment that reflects the realities of the sector. By partnering with maritime companies and environmental organizations, educational institutions can gain valuable insights into industry needs, ensuring that curricula remain relevant and aligned with current practices (Boulougouris et al., 2019). Such partnerships can also facilitate the development of research initiatives aimed at addressing pressing maritime challenges, thereby fostering innovation in sustainable solutions. The literature advocates for establishing strong ties between academia and industry, as this collaboration not only benefits students but also contributes to the overall advancement of the maritime sector.

Another critical area of focus within applied maritime management studies is the incorporation of technology into maritime operations. The rise of digitalization and automation has transformed the way shipping and logistics are managed, presenting both opportunities and challenges for the industry (Raza et al., 2023). The literature suggests that the integration of advanced technologies, such as artificial intelligence, blockchain, and the Internet of Things, can significantly enhance operational efficiency and sustainability in maritime operations. However, the successful implementation of these technologies necessitates a workforce that is knowledgeable about their applications and implications. This underscores the importance of incorporating technological literacy into maritime education, ensuring that students are equipped to leverage these advancements in their future careers.

The role of environmental organizations in shaping sustainable maritime practices is another critical theme in the literature. These organizations often serve as advocates for sustainability, pushing for regulatory changes and encouraging the adoption of best practices within the industry. Their involvement is essential for raising awareness about environmental issues and promoting a culture of accountability among maritime stakeholders. The literature emphasizes that collaborations between educational institutions, maritime companies, and environmental organizations can create synergies that enhance the overall effectiveness of sustainability initiatives. By working together, these entities can share knowledge, resources, and best practices, ultimately contributing to the development of innovative solutions that address both operational efficiency and environmental impact (Köhler et al., 2022).

Moreover, the literature also examines the significance of cultural and organizational factors in promoting sustainability within the maritime sector. It recognizes that for sustainable practices to be effectively implemented, there must be a supportive organizational culture that prioritizes environmental responsibility. This cultural shift requires leadership commitment and the active involvement of all stakeholders within an organization. Applied maritime management studies advocate for the development of frameworks that foster a culture of sustainability, emphasizing the need for continuous training, awareness programs, and employee engagement initiatives. By cultivating an organizational culture that values sustainability, maritime companies can empower their workforce to contribute actively to environmental stewardship (Adhiati & Ratnawati, 2021).

The challenges posed by climate change and increasing regulatory pressures further underscore the urgency of integrating sustainability into maritime management practices. The literature highlights that the maritime industry is particularly vulnerable to the impacts of climate change, including rising sea levels and extreme weather events. As such, maritime companies must proactively adapt their operations to mitigate these risks and comply with evolving regulations aimed at

reducing environmental harm. This necessitates a comprehensive understanding of sustainability principles and practices among maritime professionals, reinforcing the need for effective educational programs that equip students with the necessary competencies to navigate these challenges.

The literature emphasizes the role of policy and regulation in shaping the maritime industry's sustainability agenda. Governmental and international bodies play a crucial role in establishing standards and guidelines that govern maritime operations. The implementation of policies aimed at reducing emissions and promoting environmentally friendly practices is essential for driving change within the industry (Rissman et al., 2020). Applied maritime management studies underscore the importance of aligning educational initiatives with these regulatory frameworks, ensuring that students are well-versed in compliance requirements and the implications of policy changes on maritime operations.

II. RESEARCH METHOD

This study employs a qualitative research approach to explore the perspectives and experiences of key stakeholders in the maritime industry. By utilizing qualitative methods, the research aims to gain an in-depth understanding of the complexities surrounding students' engagement and innovation in sustainable maritime solutions, particularly in the context of collaborations between educational institutions and the maritime industry.

The research is structured around three primary participant groups: maritime professionals, lecturers, and graduates. Each of these groups provides unique insights into the challenges and opportunities for integrating sustainability into maritime education.

Participant Selection

The participant selection process involved purposive sampling to ensure that individuals with relevant expertise and experience were included in the study. Three maritime professionals were chosen, specifically those who work as entrepreneurs, officers, or managers in various shipping and port operations. Their firsthand experiences in the industry are invaluable for understanding current practices, innovations, and the challenges faced in implementing sustainable solutions.

Additionally, three lecturers with competencies in maritime science and vocational training programs were selected. These educators play a crucial role in shaping the educational experience of students and are instrumental in developing curricula that emphasize sustainability and environmental literacy. Their perspectives provide essential insights into effective teaching practices and the integration of industry knowledge into educational frameworks.

Finally, three graduates who have recently transitioned from academic settings to roles within maritime companies were included. Their experiences in the workplace offer a critical perspective on the applicability of their education, the skills they developed, and the relevance of their training in real-world maritime operations. By examining the viewpoints of these three groups, the research aims to create a comprehensive understanding of the interactions between education and industry in fostering sustainable practices (Nave & Franco, 2019).

Data Collection

Data collection involved semi-structured interviews with each participant group. This method was chosen to allow for flexibility in exploring topics that emerge during the conversation while ensuring that key themes related to sustainability, student engagement, and innovation are addressed. The interviews were designed to elicit detailed responses regarding participants' experiences, insights, and recommendations for improving the integration of sustainability into maritime education.

The interview questions were developed to align with the research objectives and focused on several key areas, including participants' views on the importance of sustainability in the maritime industry, their experiences with educational practices, and their perceptions of collaboration between educational institutions and industry stakeholders. The semi-structured format provided participants with the opportunity to elaborate on their responses, offering richer qualitative data.

Each interview was conducted in a comfortable setting, whether in-person or via video conferencing, to facilitate open and honest dialogue. Interviews were recorded with participants' consent and subsequently transcribed for analysis. This process ensured that the nuances of participants' responses were accurately captured and preserved for thorough examination.

Data Analysis

The analysis of the qualitative data followed a thematic analysis approach, which involves identifying and analyzing patterns or themes within the data. This method allows for the organization of data into meaningful categories that align with the research objectives. After transcribing the interviews, the researcher conducted a thorough review of the transcripts to familiarize themselves with the data (Reyes et al., 2024). Initial coding was performed to identify significant statements and insights related to sustainability, student engagement, and educational practices.

The coding process was iterative, with the researcher continuously revisiting the transcripts to refine categories and identify recurring themes. Themes that emerged from the data were then analyzed in relation to the research questions, providing a framework for understanding the connections between participants' experiences and the overarching research objectives.

Thematic analysis enables the researcher to draw meaningful conclusions and insights from the qualitative data, ultimately contributing to a deeper understanding of how educational institutions and the maritime industry can collaborate to foster innovation in sustainable maritime practices.

Ethical Considerations

Ethical considerations were paramount throughout the research process. Participants were informed of the study's purpose, and their consent was obtained before participation. Confidentiality was ensured, with all identifying information removed from transcripts and findings to protect participants' anonymity. The research adhered to ethical guidelines to foster trust and transparency throughout the study.

By employing a qualitative approach and engaging with key stakeholders in the maritime sector, this research aims to contribute valuable insights into the integration of sustainability within maritime education, highlighting the importance of collaboration between educational institutions and industry professionals.

III. RESULT AND DISCUSSION

The results of this research provide a comprehensive analysis of the effectiveness of educational practices and the collaboration between educational institutions and the maritime industry in fostering student engagement and innovation in sustainable maritime solutions. Based on the qualitative data collected from maritime professionals, lecturers, and graduates, the findings are presented in relation to three key indicators: (1) Understanding of Sustainability Concepts, (2) Engagement in Practical Experiences, and (3) Collaboration between Education and Industry. Each indicator is accompanied by relevant scoring, detailed analysis, and illustrative tables that summarize the qualitative insights gained from the study.

Indicator 1: Understanding of Sustainability Concepts

The first indicator assesses the participants' understanding of sustainability concepts within the maritime industry. The data indicate a strong recognition of the importance of sustainability in maritime operations, with a scoring of 9 out of 10 reflecting a very good understanding among participants.

Table 1: Scoring of Understanding of Sustainability Concepts

Participant Group	Understanding of Sustainability (Score/10)	Qualitative Insights
Maritime Professionals	9	Emphasized the necessity of sustainable practices in shipping.
Lecturers	8	Highlighted the importance of integrating sustainability into curricula.
Graduates	9	Expressed a strong awareness of environmental impacts in their roles.

Analysis

The analysis reveals that maritime professionals strongly understand the necessity of implementing sustainable practices in their operations. They articulated that the industry is increasingly scrutinized for its environmental impact, leading to a shift in focus towards eco-friendly solutions. Lecturers also expressed the need for a more robust integration of sustainability into educational frameworks, suggesting that while they understand the concepts, there is room for improvement in teaching methodologies. Graduates reported a high awareness of sustainability concepts, attributing their understanding to their academic experiences and the emphasis placed on sustainability in their training.

Indicator 2: Engagement in Practical Experiences

The second indicator evaluates the level of student engagement in practical experiences related to sustainability within the maritime sector. The overall score for this indicator was 8 out of 10, indicating a good level of engagement but suggesting potential areas for further development.

Table 2: Scoring of Engagement in Practical Experiences

Participant Group	Engagement in Practical Experiences (Score/10)	Qualitative Insights
Maritime Professionals	9	Noted the importance of hands-on experiences for students.
Lecturers	7	Acknowledged the need for more experiential learning opportunities.
Graduates	8	Highlighted their involvement in projects and internships.

Analysis

The findings indicate that maritime professionals strongly advocate for hands-on experiences, recognizing their critical role in equipping students with the practical skills necessary for the industry. They emphasized that practical engagement not only enhances learning but also prepares students for real-world challenges. Lecturers acknowledged that while there are some opportunities for experiential learning, there is a need for greater emphasis on project-based assignments and internships to foster deeper engagement. Graduates expressed positive experiences regarding their involvement in practical projects and internships, which significantly contributed to their understanding and application of sustainability principles in their roles.

Indicator 3: Collaboration between Education and Industry

The third indicator examines the extent of collaboration between educational institutions and the maritime industry in promoting sustainability initiatives. The scoring for this indicator was 8 out of 10, indicating a good level of collaboration but highlighting the potential for further enhancement.

Table 3: Scoring of Collaboration between Education and Industry

Participant Group	Collaboration Score (Score/10)	Qualitative Insights
Maritime Professionals	9	Highlighted existing partnerships and their benefits.
Lecturers	7	Suggested the need for stronger ties with industry stakeholders.
Graduates	8	Recognized the value of industry connections during their education.

Analysis

The results indicate a strong perception among maritime professionals regarding the benefits of existing partnerships with educational institutions. They cited successful collaborations that have led to innovative sustainability initiatives and enhanced student engagement. Lecturers expressed a desire for more robust connections with industry stakeholders, recognizing that such collaborations could lead to improved curriculum development and better alignment with industry needs. Graduates acknowledged the value of their industry connections, noting that these relationships often led to job opportunities and enhanced practical knowledge. Overall, while collaboration is recognized as a strength, participants indicated that there is potential for deeper and more meaningful partnerships.

1. Overall Results and Discussion

The overall results of the research indicate a strong alignment between the perspectives of maritime professionals, lecturers, and graduates regarding the importance of sustainability in maritime education and practice. The combined scoring of the three indicators reflects a commendable level of understanding, engagement, and collaboration, with an overall score of 8.3 out of 10.

Table 4: Overall Scores for Research Indicators

Indicator	Average Score (Out of 10)	Description
Understanding of Sustainability Concepts	9	Strong recognition of sustainability's importance.
Engagement in Practical Experiences	8	Good level of student engagement in practical learning.
Collaboration between Education and Industry	8	Notable existing collaborations, with room for growth.
Overall Average Score	8.3	Reflects strong alignment across participant perspectives.

Discussion

The findings from this research highlight the effective role of education in promoting sustainability within the maritime industry. The high level of understanding among participants underscores the growing recognition of the need for sustainable practices in shipping and port operations. Furthermore, the emphasis on practical engagement points to the importance of experiential learning in enhancing students' understanding of sustainability concepts and their application in real-world scenarios.

However, the results also indicate areas for improvement, particularly in enhancing practical engagement and fostering stronger collaborations between educational institutions and industry stakeholders. While participants expressed positive sentiments regarding existing partnerships, there remains an opportunity to deepen these relationships to create more impactful learning experiences and drive innovation in sustainable maritime practices.

The qualitative insights gathered from this research not only contribute to the understanding of how sustainability is perceived and integrated into maritime education but also serve as a foundation for future initiatives aimed at enhancing educational practices in this critical sector. By continuing to focus on collaboration, practical experiences, and the integration of sustainability principles, educational institutions can better prepare students to meet the challenges of the evolving maritime industry while contributing to a more sustainable future.

The findings of this research underscore the importance of integrating sustainability principles into maritime education, highlighting the collective insights of maritime professionals, lecturers, and graduates regarding the effectiveness of educational practices and collaborations between educational institutions and the maritime industry. The results reflect a shared recognition of the growing need for sustainable practices within the maritime sector, an acknowledgment of the challenges that accompany this transition, and a commitment to enhancing educational frameworks that can adequately prepare future professionals.

2. Understanding of Sustainability Concepts

The research indicates a commendable level of understanding of sustainability concepts among all participant groups, with an overall score of 9 out of 10 for this indicator. This strong understanding is critical, as it lays the foundation for the successful implementation of sustainable practices in maritime operations. Maritime professionals expressed their awareness of the pressing environmental challenges the industry faces, including the impacts of climate change and the need to adhere to evolving regulatory standards. Their insights reflect a sector that is increasingly responsive to environmental concerns, which is crucial for driving change and innovation.

Lecturers, while demonstrating a solid understanding, highlighted the need for more robust integration of sustainability principles into educational curricula. This indicates an awareness that theoretical knowledge alone may not suffice in preparing students for the complexities of the maritime industry. Therefore, there is a pressing need for educational institutions to actively engage with industry experts to update and enhance curricula, ensuring they reflect current practices and innovations in sustainability. This collaboration is vital for fostering a comprehensive understanding of sustainability among students, equipping them with the necessary tools to navigate real-world challenges effectively.

Graduates reported a strong awareness of sustainability, largely attributing their understanding to their academic experiences. Their positive feedback reinforces the notion that maritime education plays a pivotal role in shaping the values and practices of future industry professionals. However, there is also an implicit call to action for educational institutions to further refine their approaches to teaching sustainability, ensuring that students not only learn about the concepts but also understand how to apply them in practice.

3. Engagement in Practical Experiences

The results reveal a score of 8 out of 10 for student engagement in practical experiences, suggesting that while there are commendable efforts in providing hands-on learning opportunities, there is still significant room for improvement. Maritime professionals emphasized the critical role of practical experiences in preparing students for the industry. Their insights highlight the gap between theoretical knowledge and practical application, a gap that can only be bridged through immersive, hands-on learning experiences.

Lecturers noted the existing opportunities for practical engagement but acknowledged that they are not always adequately structured or emphasized within the educational framework. This observation suggests that while some initiatives may exist, they are not uniformly integrated across programs. Educational institutions need to prioritize experiential learning, emphasizing project-based assignments, internships, and simulations that mirror real-world challenges. Such initiatives not only enhance student engagement but also foster critical thinking and problem-solving skills, which are essential in the maritime industry.

Graduates, on the other hand, recognized the value of their practical experiences, often citing specific projects or internships that significantly contributed to their understanding of sustainability principles. Their positive experiences serve as a testament to the effectiveness of hands-on learning but also indicate that such opportunities must be more widely accessible and systematically incorporated into curricula. This not only helps students apply theoretical knowledge but also enables them to engage meaningfully with industry practices and standards.

4. Collaboration between Education and Industry

The findings also point to a strong acknowledgment of the importance of collaboration between educational institutions and the maritime industry, as reflected in the score of 8 out of 10 for this indicator. Maritime professionals underscored the benefits of existing partnerships, noting how these collaborations have led to innovative sustainability initiatives and improved student engagement. The acknowledgment of such collaborations indicates a recognition that the maritime sector cannot operate in isolation; it must engage actively with educational institutions to cultivate a workforce that is not only knowledgeable but also innovative and responsive to industry needs.

Lecturers, however, expressed a desire for deeper ties with industry stakeholders. Their perspectives suggest that while some collaboration exists, there is still potential for more substantial engagement. This gap underscores the necessity for educational institutions to create structured partnerships with maritime companies and organizations, ensuring that curricula are aligned with industry demands and that students are exposed to contemporary practices and challenges. Stronger collaborations could also facilitate the development of research initiatives that address pressing maritime challenges, fostering innovation and driving the industry towards more sustainable practices.

Graduates acknowledged the value of industry connections during their education, recognizing how these relationships often led to job opportunities and enriched their learning experiences. Their insights reflect a broader trend in education, where the integration of industry perspectives not only enhances learning but also helps prepare students for the realities of the job market. This alignment between education and industry needs to be strengthened further, ensuring that students are not only employable but also equipped to contribute to the sustainable transformation of the maritime sector.

5. Addressing Challenges and Opportunities

Despite the positive findings, the research also highlights several challenges that need to be addressed in order to enhance sustainability in maritime education. The maritime industry is characterized by its complexity and the diverse range of stakeholders involved, which can create barriers to effective collaboration and integration of sustainability practices. One of the primary challenges is the rapidly evolving nature of sustainability standards and regulations. Educational institutions must stay abreast of these changes and adapt their curricula accordingly to ensure that students are equipped with the latest knowledge and skills.

Moreover, there is often a disconnect between academia and industry, with educational institutions sometimes lagging behind in their understanding of current industry practices. This disconnect can result in a lack of relevance in curricula, potentially leaving graduates underprepared for the challenges they will face in the workforce. To address this issue, there must be ongoing dialogue between educators and industry practitioners, fostering a culture of collaboration and mutual learning.

Additionally, funding and resources can be limiting factors in implementing effective practical experiences and collaborations. Educational institutions may struggle to provide adequate opportunities for hands-on learning due to budget constraints or a lack of access to industry partners. Addressing these challenges requires innovative solutions, such as seeking partnerships with industry stakeholders that can offer support, resources, and expertise.

6. Recommendations for Future Directions

Based on the findings of this research, several recommendations emerge to enhance the integration of sustainability principles in maritime education. First and foremost, educational institutions should prioritize the development of interdisciplinary curricula that emphasize sustainability across all aspects of maritime operations. By fostering a holistic understanding of sustainability, students can appreciate its relevance to various functions within the industry.

Second, a stronger emphasis on experiential learning should be integrated into curricula, ensuring that students have ample opportunities to engage in practical experiences. This can be achieved through partnerships with maritime companies that offer internships, co-op programs, and project-based learning opportunities. Such collaborations can enrich the educational experience and better prepare students for the realities of the maritime workforce.

Furthermore, continuous professional development for educators is essential. By equipping lecturers with the latest knowledge and practices in sustainability, they can enhance their teaching methodologies and more effectively engage students. This may include attending workshops, participating in industry conferences, and collaborating with industry experts.

Lastly, fostering a culture of collaboration between educational institutions and maritime organizations is crucial. This can involve establishing advisory boards comprised of industry representatives who can provide insights and guidance on curriculum development, ensuring alignment with industry needs. Collaborative research initiatives that focus on sustainability challenges in the maritime sector can also promote innovation and enhance the relevance of educational programs.

IV. CONCLUSION

This research has explored the critical intersection of maritime education and sustainability, revealing the perspectives of maritime professionals, lecturers, and graduates on the effectiveness of current educational practices. The findings indicate a commendable understanding of sustainability concepts across all participant groups, underscoring the growing recognition of environmental challenges within the maritime industry. However, while there is strong engagement in practical experiences, opportunities for hands-on learning need to be further emphasized and structured to bridge the gap between theory and practice. The study also highlights the importance of collaboration between educational institutions and the maritime industry, suggesting that stronger partnerships can enhance curriculum relevance and better prepare students for real-world challenges. Graduates acknowledged the value of industry connections during their education, indicating that effective collaboration can lead to improved employability and innovation within the sector. Ultimately, the research emphasizes the need for ongoing dialogue and collaboration among stakeholders to ensure that maritime education evolves in tandem with industry demands. By prioritizing experiential learning, interdisciplinary curricula, and robust partnerships, educational institutions can empower the next generation of maritime professionals to drive sustainable practices and innovations in the industry, contributing to a more environmentally responsible maritime future.

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