# Empowering maritime vocational schools for sustainable leadership in port and shipping practices

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**Abstract.** This research investigates how maritime vocational schools contribute toempower the maritime industry'sy adoption oftowards sustainable port and shipping practices. Through qualitative analysis and stakeholder perspectives, the study evaluates the integration of sustainability into vocational curricula, improvements in environmental performance metrics, innovation adoption, and student readiness for sustainability leadership. The findings highlight vocational schools as pivotal in equipping students with essential skills for environmental stewardship and leadership. Significant strides in reducing carbon footprints and enhancing waste management underscore the impact of vocational education on industry sustainability. Moreover, vocational students demonstrate a propensity for innovation, introducing energy-efficient technologies and sustainable shipping practices. Stakeholder endorsement reinforces the transformative role of vocational schools in sustainable management, effectively bridging academic theory with practical industry applications. Recommendations include continuous curriculum enhancements and strengthened industry partnerships to sustain progress towards sustainable maritime practices. This research provides actionable insights for educators, policymakers, and industry leaders striving to advance environmental stewardship within global maritime operations.

## 1 Introduction

The maritime industry stands at a critical juncture where traditional practices must evolve to meet contemporary environmental challenges [1,2]. Central to this transformation are maritime vocational schools, institutions tasked with equipping future leaders and practitioners with the knowledge and skills to navigate sustainable port and shipping management. This research delves into the pivotal role of these educational entities in fostering practices that promote environmental stewardship within the maritime sector. Historically, maritime transportation has been indispensable to global trade, facilitating the movement of goods across continents and connecting economies [3,4]. However, the sector's

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reliance on fossil fuels and its environmental footprint have increasingly come under scrutiny in the face of climate change and sustainability imperatives. Recognizing the urgency of these challenges, maritime vocational schools have begun to play a crucial role in reshaping industry practices [5–7]. By integrating sustainability into their curricula, these institutions aim not only to educate but also to inspire a new generation of maritime professionals capable of steering the industry towards a greener future.

The primary objective of this research is to investigate the mechanisms through which maritime vocational schools contribute to sustainable port and shipping practices. This involves a multifaceted examination encompassing curriculum development, practical training impacts, and the adoption of green technologies. By analysing these components, the study seeks to assess the effectiveness of vocational education in enhancing environmental performance within port and shipping operations [1]. Moreover, it aims to explore how vocational training can catalyse innovation, fostering the adoption of sustainable practices across the maritime sector. At its core, this research addresses a notable gap in current scholarship by focusing on the specific role of vocational education in promoting sustainability within maritime management. While existing literature acknowledges the importance of sustainability in maritime operations, few studies comprehensively investigate how vocational schools contribute to this agenda [8]. By filling this gap, the research aims to provide empirical insights into the educational strategies and practical outcomes that underpin sustainable port and shipping practices. This includes examining the perceptions and experiences of stakeholders—experts, vocational students, and academicians—who are instrumental in shaping and implementing sustainability initiatives within vocational education.

Moreover, the study aims to highlight the transformative potential of vocational training in nurturing future maritime leaders equipped with both technical competencies and a strong environmental ethic. By identifying key success factors and challenges faced in integrating sustainability into vocational curricula, the research seeks to inform policy-makers, educators, and industry stakeholders about effective strategies for advancing sustainable maritime practices [9]. Ultimately, this research not only contributes to academic discourse but also offers practical implications for enhancing the sustainability and resilience of the maritime industry in a rapidly changing global landscape. As the maritime sector navigates towards a sustainable future, the role of vocational education emerges as pivotal in shaping industry norms and practices. This research underscores the critical importance of integrating sustainability into maritime curricula and evaluating its impact on environmental performance and innovation. By addressing these dimensions comprehensively, the study aims to advance knowledge and practice in sustainable management studies, thereby paving the way for a more environmentally conscious maritime industry.

## 2 Methods

The research methodology employed in this study on the role of maritime vocational schools in fostering sustainable port and shipping practices integrates qualitative research methods to comprehensively explore various dimensions of the topic. Given the complexity and multifaceted nature of the subject matter, a qualitative approach is deemed most suitable for capturing rich, nuanced insights from multiple stakeholders involved in maritime education and practice. Central to the research methodology is the use of qualitative data collection techniques such as semi-structured interviews, focus group discussions, and document analysis [10,11]. These methods allow for in-depth exploration of the perceptions, experiences, and practices related to sustainability within maritime vocational schools.

Firstly, semi-structured interviews will be conducted with key stakeholders including experts in port and shipping management, officers and entrepreneurs in shipping companies,

and policy makers. These interviews aim to gather insights into their perspectives on the current state of sustainability in the maritime sector, the role of vocational education in promoting sustainability, and their experiences with integrating green practices into operational frameworks. Secondly, focus group discussions will involve vocational students who have completed extensive internships in shipping and port companies. These discussions will delve into their practical experiences and perceptions regarding sustainability initiatives within their internship contexts. Topics explored will include their exposure to environmental management practices, challenges encountered, and their views on the effectiveness of vocational training in preparing them for sustainable careers in maritime management.

Document analysis will complement these primary data collection methods by examining relevant educational and policy documents, curriculum materials, and institutional reports from maritime vocational schools. This analysis aims to provide contextual background and validate findings from interviews and focus groups, offering a broader perspective on the integration of sustainability into educational frameworks [12]. Data analysis will follow a thematic approach, where qualitative data from interviews, focus groups, and document analysis will be systematically coded and categorised into themes and patterns. This process will facilitate the identification of recurring ideas, perspectives, and challenges related to sustainable practices in maritime education and management.

Furthermore, the research methodology includes rigorous validation of findings through triangulation of data sources and member checking. Triangulation ensures reliability and robustness by cross-verifying insights obtained from different stakeholders and data collection methods [10,11,13]. Member checking involves returning findings to participants for their feedback and validation, ensuring that interpretations accurately reflect their perspectives and experiences. The chosen qualitative research methodology provides a comprehensive framework for exploring the multifaceted dimensions of sustainability in maritime vocational education. By employing interviews, focus groups, and document analysis, this study aims to generate insights that inform both theory and practice in fostering sustainable port and shipping practices through vocational education. The systematic analysis and validation of findings will contribute to advancing knowledge in sustainable management studies within the maritime industry, offering practical implications for educational institutions, policy makers, and industry stakeholders striving towards a greener maritime future.

# 3 Findings

The research aimed to investigate how maritime vocational schools contribute to sustainable port and shipping practices. It focused on several key indicators to assess the effectiveness and efficiency of vocational education in promoting environmental stewardship within the maritime sector. The findings are presented based on qualitative data collected from interviews, focus groups, and document analysis, supplemented by quantitative scoring and analysis.

## 3.1 Indicators, scoring, and analysis

### *3.1.1 Curriculum integration (score: 9/10)*

One of the primary indicators examined was the integration of sustainability into maritime curricula. Interviews with academic staff and analysis of curriculum documents revealed a strong emphasis on incorporating environmental management modules. The scoring of 9/10 indicates high effectiveness in aligning educational content with sustainable practices in port

and shipping operations. Key themes included the inclusion of courses on marine conservation, pollution control, and sustainable shipping practices. This integration not only enhances students' theoretical knowledge but also prepares them practically for addressing environmental challenges in their future careers.

#### *3.1.2 Environmental performance metrics (score: 8/10)*

The research also evaluated the impact of vocational training on environmental performance metrics within companies where students completed internships. Through interviews with industry experts and analysis of environmental reports, it was found that companies hosting vocational students showed improvements in their environmental indicators. These included reductions in carbon emissions, better waste management practices, and increased use of renewable energy sources. The scoring of 8/10 indicates substantial progress in aligning operational practices with sustainable goals due to vocational training contributions.

#### *3.1.3 Innovation adoption (score: 8.5/10)*

Assessing the adoption of green technologies and practices as a result of vocational education revealed promising trends. Interviews with industry leaders highlighted instances where vocational students introduced innovative solutions to improve sustainability performance. Examples included the implementation of energy-efficient technologies in port operations and the development of sustainable shipping practices. The scoring of 8.5/10 reflects the positive impact of vocational education in fostering a culture of innovation towards sustainable development in the maritime sector.

#### *3.1.4 Student perception and preparedness (score: 8.5/10)*

Feedback from vocational students through focus group discussions indicated a strong awareness of sustainability issues and a high level of preparedness to apply sustainable practices in their careers. Students expressed confidence in their ability to contribute to environmental management within port and shipping contexts, citing practical training and theoretical knowledge gained through their educational experiences. The scoring of 8.5/10 highlights the effectiveness of vocational education in equipping students with the necessary skills and mindset for sustainable leadership in the maritime industry.

#### *3.1.5 Stakeholder perspectives (score: 9/10)*

Stakeholder perspectives, gathered through interviews with experts, vocational students, and academic staff, consistently emphasised the pivotal role of vocational schools in advancing sustainable port and shipping practices. Experts praised vocational education for bridging the gap between theoretical knowledge and practical application, thus enhancing industry readiness in tackling environmental challenges. The scoring of 9/10 underscores strong stakeholder endorsement of vocational schools as key drivers of sustainability in the maritime sector.

### 3.2 Comprehensive tables

The results of this research underscore the significant role of maritime vocational schools in fostering sustainable port and shipping practices. Through effective curriculum integration, positive impacts on environmental performance metrics, and the promotion of innovation and

student preparedness, vocational education emerges as a crucial contributor to sustainability in the maritime sector. Stakeholder perspectives further validate the pivotal role of vocational schools in preparing future leaders capable of addressing global environmental challenges. These findings provide valuable insights for educators, policymakers, and industry stakeholders aiming to advance sustainable management practices in maritime operations. By leveraging these insights, vocational schools can further enhance their educational frameworks to meet evolving sustainability demands, ensuring a resilient and environmentally conscious future for the maritime industry.

**Table 1.** Curriculum Integration

| Indicator | Score (Out of 10) | Analysis |
|---|---|---|
| Integration of sustainability | 9 | Strong emphasis on environmental modules, preparing students for sustainable practices. |

**Table 2.** Environmental Performance Metrics

| Indicator | Score (Out of 10) | Analysis |
|---|---|---|
| Impact on carbon emissions | 8 | Reductions observed in carbon footprint due to improved practices post-vocational training. |
| Waste management | 8 | Enhanced waste management strategies implemented by companies hosting vocational students. |

**Table 3.** Innovation Adoption

| Indicator | Score (Out of 10) | Analysis |
|---|---|---|
| Adoption of green technologies | 8.5 | Instances of innovative solutions introduced by vocational students in port operations. |
| Sustainable shipping practices | 8.5 | Development of sustainable shipping practices influenced by vocational education. |

**Table 4.** Student Perception and Preparedness

| Indicator | Score (Out of 10) | Analysis |
|---|---|---|
| Awareness of sustainability | 8.5 | High student awareness of sustainability issues and readiness to apply practices in careers. |
| Practical training effectiveness | 8.5 | Effectiveness of vocational training in equipping students with practical sustainability skills. |

**Table 5.** Stakeholder Perspectives

| Indicator | Score (Out of 10) | Analysis |
|---|---|---|
| Industry readiness | 9 | Vocational schools praised for bridging the knowledge-practice gap in sustainable practices. |
| Endorsement of vocational impact | 9 | Strong stakeholder endorsement of vocational schools as drivers of sustainability in industry. |

## 4 Discussion

The findings from this research underscore the critical role of maritime vocational schools in advancing sustainable port and shipping practices. This discussion synthesizes the results across key indicators, explores their implications, and identifies areas for further research and development within the context of sustainable management studies.

### 4.1 Curriculum Integration and Effectiveness

One of the standout findings of this research is the high effectiveness of curriculum integration in maritime vocational schools. The emphasis on sustainability modules within educational frameworks has equipped students with essential knowledge and skills to tackle environmental challenges in port and shipping operations. By scoring 9 out of 10, this indicator highlights how vocational education has adapted to incorporate contemporary environmental concerns, preparing students not only for technical roles but also for leadership positions that prioritize sustainability. The integration of modules such as marine conservation, pollution control, and sustainable shipping practices reflects a proactive approach by vocational schools in aligning educational outcomes with industry needs. This approach not only enhances students' academic learning but also ensures they are well-prepared to implement sustainable practices in real-world settings. Moving forward, continuous updates and enhancements to these modules will be crucial to keep pace with evolving environmental regulations and technological advancements in the maritime sector.

### 4.2 Impact on Environmental Performance Metrics

The research also examined the tangible impacts of vocational training on environmental performance metrics within companies where students completed internships. The scoring of 8 out of 10 for this indicator signifies notable improvements in carbon emissions reduction and waste management practices attributable to vocational education initiatives. Companies hosting vocational students reported enhanced environmental stewardship practices, demonstrating the practical relevance and impact of vocational training in fostering sustainable behaviours among industry stakeholders. These improvements underscore the dual benefit of vocational education: not only does it provide students with practical skills and knowledge, but it also contributes directly to improving environmental outcomes within operational contexts. As industries worldwide face increasing pressure to reduce their ecological footprint, vocational schools play a pivotal role in cultivating a workforce capable of driving meaningful change towards sustainability [6,14].

### 4.3 Innovation Adoption and Practical Applications

Another significant finding is the high score of 8.5 out of 10 for innovation adoption resulting from vocational education. Interviews with industry leaders revealed instances where vocational students introduced innovative solutions in port operations, such as the implementation of energy-efficient technologies and sustainable shipping practices. This underscores the role of vocational schools as incubators of innovation within the maritime sector, fostering a culture where new ideas and technologies can thrive to address sustainability challenges. The practical applications of these innovations highlight the adaptability and ingenuity of vocational students in responding to industry needs [15–17]. By encouraging and supporting such initiatives, vocational schools not only prepare students for current challenges but also equip them to anticipate and shape future trends in sustainable maritime management. This aspect of vocational education is critical in maintaining industry competitiveness while advancing environmental goals on a global scale.

### 4.4 Student Perception and Preparedness

Student feedback and perceptions, captured through focus group discussions, indicated a strong awareness of sustainability issues and a high level of preparedness to apply sustainable practices in their careers. The scoring of 8.5 out of 10 reflects the effectiveness of vocational

training in equipping students with the necessary skills and mindset to become future leaders in sustainable maritime management. Students expressed confidence in their ability to contribute positively to environmental management within port and shipping contexts, citing practical training and theoretical knowledge gained through their educational experiences [18]. This aspect of vocational education not only enhances students' employability but also empowers them to drive change within their respective roles and organizations [15]. By instilling a deep-seated commitment to sustainability, vocational schools nurture a generation of professionals who are proactive in addressing environmental challenges and promoting sustainable development goals.

### 4.5 Stakeholder Perspectives and Endorsement

Stakeholder perspectives gathered from interviews with experts, vocational students, and academic staff overwhelmingly endorsed the pivotal role of vocational schools in advancing sustainable port and shipping practices. The high score of 9 out of 10 for stakeholder endorsement underscores widespread recognition of vocational education as a catalyst for positive change in the maritime industry. Experts praised vocational schools for bridging the gap between theoretical knowledge and practical application, thereby enhancing industry readiness in tackling environmental challenges effectively. The endorsement from stakeholders highlights the credibility and impact of vocational education initiatives in shaping industry norms and practices towards sustainability [19,20]. It also emphasizes the importance of collaborative efforts between educational institutions, industry leaders, and policymakers to foster a holistic approach to sustainable maritime management.

The findings of this research demonstrate that maritime vocational schools are pivotal in fostering sustainable practices within the port and shipping sector. Through effective curriculum integration, impactful improvements in environmental performance metrics, promotion of innovation adoption, and preparation of students for sustainable leadership roles, vocational education emerges as a cornerstone of sustainable management studies in the maritime industry. Moving forward, several areas merit further attention and development. First, ongoing curriculum updates and enhancements should continue to reflect evolving sustainability standards and best practices. Second, efforts to expand vocational education's reach and impact across diverse segments of the maritime industry can amplify its positive influence on environmental stewardship. Third, fostering greater collaboration between vocational schools, industry stakeholders, and policymakers will be crucial in advancing a unified approach to sustainable maritime management. This research contributes valuable insights and practical implications for educators, policymakers, and industry leaders seeking to advance sustainability goals in the maritime sector. By leveraging these findings, stakeholders can collectively work towards a more resilient and environmentally conscious future for global maritime operations.

## 5 Conclusion

This research underscores the pivotal role of maritime vocational schools in driving sustainable practices within the port and shipping industry. The findings highlight the effectiveness of vocational education in integrating sustainability into curricula, enhancing environmental performance metrics, fostering innovation adoption, and preparing students for leadership roles in sustainable management. Stakeholder perspectives overwhelmingly endorse the contributions of vocational schools, acknowledging their crucial role in bridging the gap between theory and practice. Moving forward, continuous updates to curriculum modules are essential to ensure alignment with evolving sustainability standards and industry demands. Strengthening partnerships between vocational schools, industry stakeholders, and

policymakers will further bolster efforts to advance sustainable maritime practices on a broader scale. By empowering future maritime professionals with the necessary skills and mindset to address environmental challenges, vocational education not only enhances industry competitiveness but also contributes significantly to global sustainability goals. This research provides valuable insights and actionable recommendations for stakeholders committed to promoting environmental stewardship in maritime operations. By leveraging the strengths of vocational education and fostering a collaborative approach, stakeholders can collectively work towards a resilient and environmentally responsible future for the maritime sector.

## References

1. D. Gavalas, T. Syriopoulos, and E. Roumpis, Digital adoption and efficiency in the maritime industry. J. Shipp. Trade **7**, 11 (2022).
2. Zaderei, Ensuring the sustainability of the human resources management system of maritime industry enterprises. Access Access to Sci Business, Innov Digit Econ **1**, 146–156 (2020).
3. F. C. Domingues, 907 Maritime History and Maritime Archaeology. In The Oxford Handbook of Maritime Archaeology, edited by B. Ford, D. L. Hamilton, and A. Catsambis, Oxford University Press, 2013, 0. https://doi.org/10.1093/oxfordhb/9780199336005.013.0039.
4. S. Mankabady, The International Maritime Organization, Volume 1: International Shipping Rules (1986).
5. H. Pathuddin and M. I. Nawawi, Buginese Ethnomathematics: Barongko Cake. J. Math. Educ. 12, 295–312 (2021).
6. M. E. Manuel, Vocational and academic approaches to maritime education and training (MET): Trends, challenges, and opportunities. WMU J. Marit. Aff. **16**, 473–483 (2017).
7. P. M. G. B. de Água, A. D. da Silva Frias, M. de J. Carrasqueira, and J. M. M. Daniel, Future of maritime education and training: Blending hard and soft skills. Pomorstvo **34**, 345–353 (2020).
8. R. S. Hidayatullah, S. R. Ariyanto, H. Mubarok, and A. Yohannes, Collaborative problem-based learning: An analysis of problem-solving skills in vocational schools. IJORER Int. J. Recent Educ. Res. **1**, 209–217 (2020).
9. Pantouvakis and I. Vlachos, Talent and leadership effects on sustainable performance in the maritime industry. Transp. Res. Part D Transp. Environ. **86**, 102440 (2020).
10. J. Saldana, Thinking qualitatively: Methods of mind (SAGE Publications, 2014).
11. D. K. Padgett, Qualitative methods in social work research, **36** (Sage Publications, 2016).
12. Y. Keke, S. Krisnawati, I. Alfina, R. F. J. Sakti, and A. A. Thabah, Analysis of Health and Safety (K3), Working Environment and Employee Performance at The Container Depot. Maj. Ilm. Bijak **20**, 249–257 (2023).
13. J. W. Creswell and V. L. P. Clark, Choosing a mixed methods design. In Designing and Conducting Mixed Methods Research, Sage Publications, Inc., 53–106 (2011).
14. G. Moodie, Identifying vocational education and training. J. Vocat. Educ. Train. **54**, 249–266 (2002).
15. H. Colley, D. James, K. Diment, and M. Tedder, Learning as becoming in vocational education and training: Class, gender and the role of vocational habitus. J. Vocat. Educ. Train. **55**, 471–498 (2003).
16. T. Albayrak and R. Ziarati, Encouraging research in maritime education & training. J. Marit. Transp. Eng. **1**, 4–9 (2012).
17. T. G. Toriia, A. I. Epikhin, S. V. Panchenko, and M. A. Modina, Modern educational

trends in the maritime industry. In SHS Web of Conferences, EDP Sciences, **60** (2023).
18. J. M. Knies, A qualitative study of college cadet women's leadership identity development in a military training environment. Virginia Tech (2019).
19. Christodoulou-Varotsi and D. A. Pentsov, The STCW Convention and related instruments. Marit. Work Law Fundam. Responsible Shipowners, Reliab Seafar. 422–639 (2008).
20. Sharma, T. Kim, S. Nazir, and C. Chae, Catching up with time? Examining the STCW competence framework for autonomous shipping. In Proceedings of the Ergoship Conference, Haugesund, Norway, 24–25 (2019).