Multicore Int. J. Multidiscip, Vol 2, No 2, November 2026
e-ISSN: 3108-933X

OPEN ACCESS

MIMP Marasofi International Media and Publishing

From Classroom to Coastline: Integrating Sustainability, Green Technology, and ESG Leadership into Maritime Vocational Curricula

Tata Heru Prabawa[1*], Chanra Purnama[2], Irfan Faozun[3]
Maritime Institute, Sekolah Tinggi Ilmu Pelayaran Jakarta, Indonesia[1-3]
[*]Corresponding author, e-mail: boedojo.jogo@stipmail.ac.id

Abstract— The transition toward low-carbon and environmentally responsible shipping is creating new competency requirements for maritime vocational graduates. This study examined the gap between sustainability competencies required by the maritime industry and those addressed in Nautika curricula, developed a Green Compass curriculum framework, and evaluated its initial instructional effectiveness. A sequential mixed-methods design was conducted across AMANJAYA, AMD, and STMT Malahayati from April 2025 to January 2026. The study involved 180 cadets and 15 industry stakeholders in the needs analysis, a 20-expert Delphi panel for framework validation, and a six-week pilot involving 60 cadets and a 60-cadet comparison group. Baseline competency was low, particularly in ESG Leadership (M=2.18/5.00), followed by Green Port Operations (M=2.61) and Technical Green Competency (M=2.84). Sustainability content represented approximately 5.3% of mapped curriculum contact hours, while ESG Leadership was not explicitly addressed. The pilot produced significant improvements in all domains, with the strongest gain in ESG Leadership (d=2.12). Delphi validation reached 88.4% consensus. The findings support integrating technical green competencies, green port operations, and ESG literacy into existing Nautika courses through interdisciplinary curriculum integration and lecturer professional development.

Keywords: *ESG leadership; green technology; maritime vocational education; sustainability curriculum; Nautika*

1. Introduction

The maritime industry is experiencing a major transition toward low-carbon, energy-efficient, and environmentally responsible operations. The International Maritime Organization (IMO) has established a revised greenhouse gas strategy that aims to achieve net-zero greenhouse gas emissions from international shipping by or around 2050, supported by interim emission-reduction targets for 2030 and 2040 [1]. These regulatory developments are changing the competency requirements for seafarers because operational decisions onboard increasingly influence fuel efficiency, carbon intensity, environmental compliance, and sustainability performance. Maritime vocational education must therefore respond to a professional environment in which environmental knowledge is becoming an integral component of operational competence.

The implementation of the Energy Efficiency Existing Ship Index (EEXI), Carbon Intensity Indicator (CII), and strengthened Ship Energy Efficiency Management Plan (SEEMP) requirements has expanded the environmental responsibilities of shipboard personnel [1], [2]. Deck officers are increasingly expected to understand operational measures affecting vessel carbon intensity, including voyage planning, speed management, trim optimization, auxiliary machinery use, and energy-efficient operations. Czermański et al. [2] demonstrated that implementation of EEXI creates substantial operational and economic implications for shipping organizations, while Bogusławski et al. [3] showed that technological

Received: 20 August 2026, Revised: 27 August 2026 , Accepted: 28 August 2026
https://doi.org/10.64123/mijm.v2.i2.2

transformation in shipping generates new competency requirements for maritime education and training. These developments indicate that environmental and technological competencies should be incorporated into maritime education before graduates enter professional employment.

Sustainability requirements also extend beyond vessel energy efficiency to port operations and broader environmental, social, and governance (ESG) practices. Maritime and port professionals increasingly require competencies related to environmental documentation, sustainability-oriented operations, stakeholder communication, and adaptation to green technologies [4], [5]. Wahid et al. [4] demonstrated the relevance of systematic competency indicators in maritime safety and management contexts, while Lopes et al. [5] identified changing competency requirements within maritime and port logistics. Green technology integration in vocational education likewise requires institutions to develop learning environments that connect technical knowledge with sustainability-oriented occupational practices [6].

The specific problem addressed in this study is the potential mismatch between emerging sustainability competency requirements and the existing Nautika curriculum in Indonesian maritime education. Conventional environmental instruction remains important because seafarers must comply with established pollution-prevention requirements, but emerging competencies associated with CII, EEXI, SEEMP, green port operations, alternative fuels, and ESG reporting require more explicit instructional attention. Research on seafarer competency has identified the importance of data-driven approaches for understanding changing occupational requirements [7], while studies of Indonesian vocational education have highlighted gaps in green competency development among teachers and students [6]. The problem is therefore not simply a lack of environmental knowledge but a broader curriculum alignment issue involving technical, operational, and professional communication competencies.

The scientific gap addressed by this study concerns the limited empirical integration of technical green competency, green port operations, and ESG leadership within a single maritime vocational curriculum model. Existing studies have examined maritime decarbonization, green technology, vocational green skills, and competency development separately [2], [5], [6]. However, limited evidence is available on how these dimensions can be systematically translated into an integrated Nautika curriculum and subsequently evaluated through an instructional intervention. The present study addresses this gap by combining stakeholder needs analysis, curriculum mapping, Delphi validation, and pilot implementation within three Indonesian maritime institutions.

The novelty of the study is the development of the Green Compass framework, which integrates three sustainability competency layers into existing Nautika courses rather than proposing a completely new standalone subject. The framework connects technical green knowledge with green port operational practices and ESG-related professional communication. This interdisciplinary approach reflects the stakeholder-oriented perspective that curriculum decisions should consider the expectations of students, employers, regulators, and educational institutions [8]. It also responds to evidence that competency-based education becomes more effective when learning activities are connected to authentic occupational practices and professional requirements [9], [10].

The study has three objectives. First, it identifies the current sustainability competency levels of Nautika cadets and determines the extent to which sustainability topics are represented in existing curricula. Second, it identifies industry priorities and develops a Delphi-validated framework for integrating sustainability competencies into Nautika education. Third, it evaluates whether a six-week Green Compass instructional module produces measurable improvements in Technical Green Competency, Green Port Operations, and ESG Leadership.

2. Method

This study employed a sequential mixed-methods design consisting of needs analysis, curriculum

framework development and Delphi validation, and pilot implementation with pre-test and post-test assessment. The research was conducted at AMANJAYA, AMD, and STMT Malahayati between April 2025 and January 2026. The sequential design was selected because the qualitative and documentary evidence obtained during the first phase was required to inform the development of the curriculum framework, while the subsequent quantitative intervention was used to examine its initial instructional effectiveness. The overall design followed established principles of mixed-methods research in which qualitative and quantitative evidence are combined to address complex educational problems [11].

The first phase involved a survey of 180 Level 2 and Level 3 Nautika cadets, with 60 cadets selected from each participating institution. The survey instrument consisted of 45 items distributed equally across three competency domains: Technical Green Competency, Green Port Operations, and ESG Leadership. Technical Green Competency covered CII calculation and management, EEXI parameters, alternative-fuel awareness, SEEMP requirements, and energy-efficiency operational measures. Green Port Operations covered shore-power procedures, waste reception facilities, green-port environmental requirements, sustainable cargo handling, and port environmental documentation. ESG Leadership covered interpretation of sustainability documents, environmental data reporting, communication with sustainability auditors, environmental management system documentation, and sustainability-related professional communication.

Each item was assessed using a five-point proficiency scale ranging from no knowledge to expert proficiency. The competency domains were analyzed using descriptive statistics to identify the general level of cadet preparedness. Differences among the three institutions were examined using one-way analysis of variance. The analytical procedure followed established statistical principles for comparing group means and interpreting educational assessment data [12].

The needs analysis also included semi-structured interviews with 15 maritime industry professionals. The participants consisted of five shipping company training managers, four port environmental officers, three classification society surveyors, and three maritime insurance representatives. Interviews examined the sustainability competencies assessed during recruitment, competency gaps observed among recent graduates, organizational training requirements, and priorities for curriculum integration. The interview data were organized thematically to identify recurring competency requirements, institutional training needs, and priorities for curriculum development. Thematic analysis was conducted following the established procedure proposed by Braun and Clarke [13], while qualitative interpretation was informed by broader principles of qualitative research and evaluation [14].

The researchers also analyzed official Nautika curriculum documents from the three participating institutions. Each curriculum component was mapped against Technical Green Competency, Green Port Operations, and ESG Leadership. The mapping recorded the number of contact hours associated with environmental compliance, alternative fuels, green port operations, CII/EEXI/SEEMP, and ESG-related content. Content was also classified according to whether it provided awareness, understanding, or application-level learning. This process enabled the researchers to compare the current curriculum supply with the competency priorities identified by cadets and industry stakeholders.

The second phase focused on development and validation of the Green Compass curriculum framework. The framework was constructed from the results of the needs analysis and curriculum mapping. It consisted of three integrated layers: Technical Green Foundation, Green Port Operations, and ESG Leadership. The first layer addressed CII, EEXI, SEEMP, energy-efficient voyage operations, and alternative-fuel awareness. The second addressed shore power, waste reception facilities, environmental inspections, sustainable cargo documentation, and port environmental clearance. The third addressed sustainability-report interpretation, environmental data communication, sustainability-audit interaction, environmental management system documentation, and professional communication. A Delphi panel consisting of 20 experts evaluated the framework. The panel included eight Nautika lecturers, seven

maritime industry professionals, and five maritime education policy specialists. Two Delphi rounds were conducted. During the first round, experts assessed the necessity and feasibility of each framework component using a five-point scale and provided qualitative comments. Components that did not reach the predetermined consensus threshold were revised and resubmitted during the second round. The Delphi approach was selected because it enables structured expert judgment to be consolidated when developing competency indicators and educational frameworks [4].

The third phase consisted of a six-week pilot implementation involving 60 Nautika cadets, with 20 cadets from each institution. A separate comparison group of 60 cadets, also comprising 20 cadets from each institution, completed the same pre-test and post-test assessments without receiving the intervention. The pilot consisted of nine instructional sessions of 100 minutes each. Three sessions addressed Technical Green Competency, three addressed Green Port Operations, and three addressed ESG Leadership.

Authentic professional materials were used as instructional resources. These materials included CII-related documentation, environmental inspection checklists, sustainability reports, and operational documents. Learning activities emphasized interpretation, application, professional communication, and problem-solving rather than conceptual memorization alone. This instructional strategy was informed by competency-based education approaches emphasizing authentic professional contexts and the connection between educational activities and occupational performance [9], [10].

Pre-test and post-test data were analyzed using paired-samples t-tests to determine whether competency scores changed significantly following the intervention. Cohen's d was used to estimate the magnitude of within-group improvement. The comparison group was examined to identify whether changes could plausibly be attributed to repeated testing or general maturation rather than the Green Compass intervention. The quantitative analysis was conducted using established statistical procedures for educational and behavioral research [12].

3. Results and Discussion

The baseline assessment demonstrated that sustainability competency among the 180 participating cadets was generally limited. As presented in Table 1, the combined mean score was 2.84 for Technical Green Competency, 2.61 for Green Port Operations, and 2.18 for ESG Leadership. Technical Green Competency and Green Port Operations were categorized as developing, while ESG Leadership was categorized as beginner. The findings indicate that the most pronounced competency gap occurred in the area involving sustainability communication, reporting, and leadership.

The differences among institutions were statistically significant for Technical Green Competency, $F(2,177)=5.84$, $p=.004$, Green Port Operations, $F(2,177)=4.62$, $p=.011$, and ESG Leadership, $F(2,177)=3.98$, $p=.021$. AMANJAYA consistently obtained the highest mean scores, while AMD obtained the lowest scores across the three domains. These differences suggest that institutional curriculum implementation, instructional exposure, and learning environments may influence sustainability competency, although the current study does not establish a causal relationship between institutional characteristics and competency outcomes.

Table 1. Baseline Sustainability Competency by Domain and Institution

Domain	AMANJAYA M(SD)	AMD M(SD)	STMT Malahayati M(SD)	Combined M(SD)
Technical Green Competency	3.06 (0.84)	2.64 (0.91)	2.82 (0.87)	2.84 (0.88)
Green Port Operations	2.78 (0.88)	2.44 (0.94)	2.62 (0.91)	2.61 (0.91)
ESG Leadership	2.38 (0.96)	2.02 (1.04)	2.14 (0.99)	2.18 (1.00)

Domain	AMANJAYA M(SD)	AMD M(SD)	STMT Malahayati M(SD)	Combined M(SD)
Overall Sustainability	2.74	2.37	2.53	2.54

Scale: 4.20–5.00 = Expert; 3.40–4.19 = Proficient; 2.60–3.39 = Developing; 1.80–2.59 = Beginner; 1.00–1.79 = No knowledge.

The curriculum audit provides an important explanation for the relatively low baseline competency. As shown in Table 2, sustainability content represented approximately 5.3% of the mapped curriculum contact hours across the three institutions. Environmental compliance based on MARPOL represented the largest component, while CII/EEXI/SEEMP received considerably less instructional attention. ESG Leadership was not explicitly identified in the curriculum documents examined.

The limited coverage of emerging green competencies is consistent with previous vocational education research. Mutohhari et al. [6] reported the need to strengthen green skills among vocational education students and teachers in Indonesia, while Li et al. [15] demonstrated that green technology integration requires institutional and pedagogical adaptation within technical and vocational education. These findings indicate that curriculum modernization should address both the content of green technology and the instructional capacity required to teach it effectively. In the maritime context, such modernization is particularly important because regulatory and technological changes are occurring simultaneously.

The industry interviews further confirmed the competency gap. Thirteen of the 15 interviewed stakeholders reported that their organizations provided sustainability-related regulatory training to recently recruited Nautika graduates during the first six months of employment. Eleven stakeholders indicated that charterer sustainability requirements had begun to influence crew-related decisions or documentation requirements. These findings indicate that industry organizations are already compensating for gaps in pre-employment sustainability education through additional training.

All 15 stakeholders ranked ESG Leadership as a high-priority area for curriculum integration. CII/EEXI/SEEMP competency was prioritized by 13 stakeholders, while Green Port Operations was prioritized by 11 stakeholders. The results demonstrate that industry expectations extend beyond technical environmental compliance to include professional communication, sustainability documentation, and stakeholder interaction. This finding corresponds with recent research identifying sustainability and interdisciplinary competencies as increasingly important within maritime and port occupations [5].

The stakeholder findings can also be interpreted through stakeholder theory. Freeman's stakeholder perspective emphasizes that educational institutions should consider the expectations of multiple constituencies when making strategic decisions [8]. In the context of maritime vocational education, these constituencies include cadets, employers, regulators, educational institutions, and maritime communities. A curriculum that responds only to minimum regulatory requirements may remain compliant while failing to address emerging occupational expectations.

Table 2. Sustainability Content in the Mapped Nautika Curriculum

Curriculum Domain	AMANJAYA	AMD	STMT Malahayati	Three-Institution Mean
Environmental Compliance Basics (MARPOL)	5.8 hr	4.2 hr	5.0 hr	5.0 hr (3.5%)
Alternative Fuel Systems	1.2 hr	0.4 hr	0.8 hr	0.8 hr (0.6%)
Green Port Operations	1.8 hr	1.0 hr	1.4 hr	1.4 hr (1.0%)
CII/EEXI/SEEMP	0.8 hr	0.2 hr	0.6 hr	0.5 hr (0.3%)
ESG Leadership	0 hr	0 hr	0 hr	0 hr (0.0%)

Curriculum Domain	AMANJAYA	AMD	STMT Malahayati	Three-Institution Mean
Total Sustainability Content	9.6 hr (6.7%)	5.8 hr (4.0%)	7.8 hr (5.4%)	7.7 hr (5.3%)

The Delphi process produced consensus on 14 of the 18 proposed framework components during the first round. Four components required further discussion: the sequencing of ESG Leadership relative to technical green content, the instructional time allocated to Green Port Operations, the assessment approach for ESG Leadership, and the placement of ESG Leadership within English Communication courses. The second round produced consensus on all four components. Overall expert endorsement of the Green Compass framework reached 88.4%.

The validated framework consists of three integrated layers. Technical Green Foundation contains eight contact hours integrated into seamanship and watchkeeping courses. Green Port Operations contains six contact hours integrated into cargo and port operations courses. ESG Leadership contains eight contact hours integrated into English Communication courses. The proposed distribution allows sustainability competencies to be introduced without creating a completely new standalone course.

The integration of ESG Leadership into English Communication reflects the interdisciplinary character of sustainability competency. ESG-related professional tasks require cadets to interpret documents, communicate environmental information, complete reporting requirements, and interact with external stakeholders. Hattingh et al. [10] emphasized the relevance of competency-based education in professional contexts, while Widaningsih et al. [16] highlighted the importance of aligning educator competencies with changing technical and occupational requirements. The Green Compass model therefore treats sustainability communication as an applied occupational competency rather than a purely managerial subject.

The pilot intervention produced substantial improvements in all three competency domains. Table 3 shows that the pilot group's Technical Green Competency increased from 2.82 to 3.94, Green Port Operations increased from 2.58 to 3.76, and ESG Leadership increased from 2.16 to 3.51. The overall sustainability score increased from 2.52 to 3.74. In contrast, the comparison group demonstrated only minimal changes between pre-test and post-test.

The paired-samples tests demonstrated statistically significant improvement across all domains. Technical Green Competency increased by 1.12 points, Green Port Operations by 1.18 points, and ESG Leadership by 1.35 points. The corresponding Cohen's d values were 1.91, 1.76, and 2.12, respectively. The overall sustainability competency produced a mean gain of 1.22 points and a Cohen's d of 2.84, indicating a very large within-group effect.

The largest relative improvement occurred in ESG Leadership. The result is plausible because ESG Leadership had the lowest baseline score and was not explicitly represented in the mapped curriculum. The use of authentic professional documents may have contributed to this improvement by connecting sustainability concepts with workplace tasks. The approach is consistent with competency-based educational principles that emphasize contextualized learning and the application of knowledge in professional settings [9], [10].

Table 3. Pre-Test and Post-Test Sustainability Competency Scores

Domain	Pilot Pre M(SD)	Pilot Post M(SD)	Comparison Pre M(SD)	Comparison Post M(SD)
Technical Green Competency	2.82 (0.86)	3.94 (0.74)	2.86 (0.88)	2.89 (0.87)
Green Port Operations	2.58 (0.91)	3.76 (0.78)	2.62 (0.93)	2.64 (0.92)

Domain	Pilot Pre M(SD)	Pilot Post M(SD)	Comparison Pre M(SD)	Comparison Post M(SD)
ESG Leadership	2.16 (0.98)	3.51 (0.82)	2.20 (1.01)	2.21 (1.00)
Overall Sustainability	2.52 (0.91)	3.74 (0.78)	2.56 (0.94)	2.58 (0.93)

Table 4. Pre-Test and Post-Test Effects in the Pilot Group

Domain	Mean Gain	Improvement	t(59)	p-value	Cohen's d
Technical Green Competency	1.12	39.70%	14.82	<.001	1.91
Green Port Operations	1.18	45.70%	13.64	<.001	1.76
ESG Leadership	1.35	62.50%	16.47	<.001	2.12
Overall Sustainability	1.22	48.40%	18.93	<.001	2.84

The comparison group showed changes of no more than 0.03 points across the assessed domains. This pattern provides supporting evidence that the improvements observed in the pilot group were associated with the instructional intervention rather than simple maturation or repeated exposure to the assessment. Nevertheless, the results should be interpreted within the limitations of the study. The intervention lasted only six weeks, the sample was limited to three institutions, and the assessment focused on immediate competency outcomes rather than long-term workplace performance.

The findings have several implications for maritime vocational education. First, sustainability should be treated as a cross-cutting professional competency rather than as an isolated environmental topic. Technical green competencies can be embedded within seamanship and watchkeeping courses, green port competencies can be integrated into cargo and port-operation courses, and ESG literacy can be integrated into professional English Communication. Such integration provides a relatively efficient mechanism for updating curriculum content without requiring extensive restructuring.

Second, lecturer professional development is essential for successful implementation. English Communication lecturers may have strong language and communication expertise but limited knowledge of CII, EEXI, SEEMP, green port operations, and ESG reporting. Widaningsih et al. [16] emphasized the importance of identifying and developing technical competencies among TVET educators in response to changing occupational environments. A short interdisciplinary professional-development program involving maritime lecturers, environmental specialists, and English Communication lecturers could therefore support implementation of the Green Compass framework.

Third, stronger industry collaboration is required to maintain curriculum relevance. Shipping companies, port authorities, classification societies, and maritime insurers can provide authentic documents, case studies, guest instruction, assessment scenarios, and current competency requirements. Lopes et al. [5] emphasized the changing competency needs of maritime and port logistics, while Shi et al. [7] demonstrated the importance of systematic competency analysis in maritime occupational contexts. Continuous collaboration would enable institutions to update sustainability content as regulatory and technological requirements evolve.

The results also have implications for the broader green transition of maritime human resources. Green shipping policies require not only technological investment but also a workforce capable of operating new systems, interpreting environmental information, complying with regulations, and communicating sustainability performance. Uygur et al. [17] demonstrated the complexity of maritime greenhouse gas mitigation and the importance of considering operational measures when evaluating decarbonization strategies. Arıcan et al. [18] similarly highlighted the increasing significance of carbon regulation for the maritime sector and the need to understand its broader organizational implications. Maritime vocational education can contribute to this transition by preparing cadets with competencies that connect regulatory

knowledge, operational practice, and sustainability communication.

4. Conclusion

This study identified a substantial gap between emerging sustainability competency requirements in maritime operations and the sustainability content represented in the Nautika curricula of AMANJAYA, AMD, and STMT Malahayati. The baseline assessment showed developing competency in Technical Green Competency and Green Port Operations, while ESG Leadership remained at the beginner level. Curriculum mapping indicated that sustainability content represented approximately 5.3% of the mapped curriculum contact hours, with no explicitly identified ESG Leadership content. These findings demonstrate that curriculum modernization should address not only environmental compliance but also emerging technical, operational, and professional sustainability competencies.

The Green Compass framework provides an integrated model consisting of Technical Green Foundation, Green Port Operations, and ESG Leadership. Delphi validation involving 20 experts produced 88.4% consensus, indicating strong agreement regarding the necessity and feasibility of the proposed framework. The six-week pilot produced statistically significant improvements across all three competency domains, with very large effect sizes. ESG Leadership demonstrated the largest relative improvement at 62.5% and a Cohen's d of 2.12, while overall sustainability competency produced a Cohen's d of 2.84.

The principal contribution of this study is the development and initial empirical evaluation of an integrated sustainability curriculum model for Nautika vocational education. The findings suggest that maritime institutions do not necessarily need to establish a separate sustainability course to respond to emerging industry requirements. A more feasible approach is to integrate technical green competencies into operational courses, green port competencies into cargo and port operations, and ESG literacy into professional English Communication. Implementation should be supported by interdisciplinary lecturer training, continuous industry collaboration, and longitudinal evaluation of cadet performance during cadetship and professional employment.

References

[1] International Maritime Organization, *2023 IMO Strategy on Reduction of GHG Emissions from Ships*. London, U.K.: IMO, 2023.

[2] E. Czermański, A. Oniszczuk-Jastrząbek, E. F. Spangenberg, L. Kozłowski, M. Adamowicz, and J. Jankiewicz, "Implementation of the Energy Efficiency Existing Ship Index: An important but costly step towards ocean protection," *Marine Policy*, vol. 145, 2022, Art. no. 105259, doi: 10.1016/j.marpol.2022.105259.

[3] K. Bogusławski, M. Gil, J. Nasur, and K. Wróbel, "Implications of autonomous shipping for maritime education and training: The cadet's perspective," *Maritime Economics & Logistics*, vol. 24, no. 2, pp. 327–343, 2022, doi: 10.1057/s41278-022-00217-x.

[4] A. Wahid, M. Y. Jinca, T. Rachman, and J. Malisan, "Determination of indicators of implementation of sea transportation safety management system for traditional shipping based on Delphi approach," *Sustainability*, vol. 15, no. 13, 2023, Art. no. 10080, doi: 10.3390/su151310080.

[5] L. S. Lopes, J. L. Nabais, C. Pinto, V. Caldeirinha, and T. Pinho, "Essential competencies in maritime and port logistics: A study on the current needs of the sector," *Sustainability*, vol. 17, no. 6, 2025, Art. no. 2378, doi: 10.3390/su17062378.

[6] F. Mutohhari, P. Sudira, F. D. Isnantyo, and N. W. A. Majid, "Generic green skills: Maturity level of vocational education teachers and students in Indonesia," *International Journal of Evaluation and Research in Education*, vol. 14, no. 1, pp. 179–187, 2025, doi: 10.11591/ijere.v14i1.29191.

[7] K. Shi, S. Fan, J. Weng, and Z. Yang, "Seafarer competency analysis: Data-driven model in restricted waters using Bayesian networks," *Ocean Engineering*, vol. 311, 2024, Art. no. 119001, doi: 10.1016/j.oceaneng.2024.119001.
[8] R. E. Freeman, *Strategic Management: A Stakeholder Approach*. Boston, MA, USA: Pitman, 1984.
[9] J. W. Creswell and V. L. Plano Clark, *Designing and Conducting Mixed Methods Research*, 3rd ed. Thousand Oaks, CA, USA: Sage Publications, 2017.
[10] A. Hattingh, S. Hodge, and T. Mavin, "Flight instructor perspectives on competency-based education: Insights into educator practice within an aviation context," *International Journal of Training Research*, vol. 20, no. 3, pp. 264–282, 2022, doi: 10.1080/14480220.2022.2063155.
[11] M. Q. Patton, *Qualitative Research & Evaluation Methods*, 4th ed. Thousand Oaks, CA, USA: Sage Publications, 2015.
[12] A. Field, *Discovering Statistics Using IBM SPSS Statistics*, 5th ed. London, U.K.: Sage Publications, 2018.
[13] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101, 2006, doi: 10.1191/1478088706qp063oa.
[14] H. Li, S. I. Khattak, X. Lu, and A. Khan, "Greening the way forward: A qualitative assessment of green technology integration and prospects in a Chinese technical and vocational institute," *Sustainability*, vol. 15, no. 6, 2023, Art. no. 65187, doi: 10.3390/su15065187.
[15] L. Widaningsih, S. Rahayu, V. Dwiyanti, and W. Widanengsih, "Analysis and mapping of technical competency needs for TVET teachers in the era of Industry 4.0," *Journal of Technical Education and Training*, vol. 17, no. 2, pp. 151–164, 2025, doi: 10.30880/jtet.2025.17.02.011.
[16] S. Uygur, P. Bolat, G. Kayısoğlu, E. Düzenli, F. Bolat, and O. Arslan, "Modelling maritime GHG emission measures impact assessment: A case study for container shipping by system dynamics," *Brodogradnja*, vol. 77, no. 2, 2026, doi: 10.21278/brod77207.
[17] O. H. Arıcan, O. Toprakçı, A. U. Ünal, and G. K. Özbağ, "Analyzing carbon regulation impacts on maritime sector using fuzzy Delphi–DEMATEL–ISM approach," *Systems*, vol. 13, no. 11, 2025, Art. no. 955, doi: 10.3390/systems13110955.
[18] Kementerian Perhubungan Republik Indonesia, *Peraturan Menteri Perhubungan Nomor PM 59 Tahun 2021 tentang Pengelolaan Lingkungan Hidup di Pelabuhan*. Jakarta, Indonesia: Kementerian Perhubungan, 2021.