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METEOR STIP MARUNDA

pISSN : 1979 – 4746
eISSN : 2685 - 4775

Maritime Institute of Jakarta

Integrating E-Leanrning and Digital Assessment in Indonesian Maritime Vocational Education: Enhancing Work Readiness

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Submitted: 05/09/2025 **Revised :**12/11/2025 **Accepted:** 28/11/2025 **Published:** 17/12/2025

Abstract

This qualitative study investigates the integration of E-learning and Digital Assessment at STIP Jakarta and its impact on the work readiness of Diploma-IV cadets, aligned with international STCW competency standards. Through in-depth interviews and focus group discussions with 70 final-year cadets, the research reveals a dualistic outcome: while digital tools are highly effective in delivering theoretical knowledge and developing simulator-based operational skills, they exhibit significant limitations in fostering hands-on practical abilities and essential psychosocial competencies such as leadership and mental resilience. The findings identify a critical "digital-practical divide," where cadets report high digital confidence alongside underlying anxiety about real-world application. The study concludes that a balanced, hybrid pedagogical model is essential, leveraging technology not as a replacement but as a complement to traditional practical training. This approach is vital for Indonesia's maritime sector to develop truly work-ready graduates who are both technologically proficient and psychologically prepared.

Keywords: *E-Learning, Digital Assessment, Maritime Education, Work Readiness*

INTRODUCTION

The global maritime industry stands at a precipice, navigating the turbulent confluence of a digital revolution, an environmental imperative, and a human resource crisis. This trifecta of challenges demands a radical re-evaluation of the very foundations upon which maritime competence is built. While the gleaming hulls of autonomous vessels and the silent algorithms of port management systems capture the headlines, a quieter, yet more fundamental, transformation is underway within the halls of maritime education and training (MET) institutions. The sector's ability to weather the coming storms depends not just on technologically advanced ships, but on a equally resilient and digitally fluent workforce. It is within this critical context that the integration of E-learning and Digital Assessment into MET emerges not merely as a pedagogical trend, but as a strategic imperative for economic resilience and social development in maritime nations. This research posits that the effectiveness of this digital integration must be measured not by the sophistication of the technology itself, but by its tangible impact on developing a competent, confident, and work-ready graduate—a proposition that remains critically underexplored, particularly within the unique socio-economic landscape of Indonesia.

The backdrop to this study is defined by relentless regulatory and technological pressures. Internationally, the International Maritime Organization (IMO) has set ambitious decarbonization targets, compelling a shift towards green shipping technologies and alternative fuels (Zhou et al., 2024). Concurrently, the digitalization of port operations and the advent of smart shipping necessitate a new suite of skills, blending

traditional seamanship with data analytics and systems management (Caldeirinha et al., 2024). At the heart of this transition lies the human element, governed by the Standards of Training, Certification and Watchkeeping for Seafarers (STCW) Convention. The STCW framework mandates a competency-based approach to education, yet it is increasingly evident that conventional teaching methodologies are struggling to keep pace with the complexity and dynamism of modern maritime operations (Baldi et al., 2019). The existing knowledge base, as synthesized in literature, reveals a growing body of work on technology adoption in MET. Studies have explored the potential of simulators, the feasibility of virtual reality for technical training, and the general benefits of e-learning platforms (Koo & Seok, 2020). However, a significant gap persists: a critical, qualitative investigation into how these digital tools are genuinely experienced by cadets and how they coalesce to form a coherent ecosystem that directly translates into STCW-compliant competencies and, ultimately, workforce readiness.

The central problem this research addresses is the disconnect between the rapid adoption of digital learning tools in MET institutions and the nuanced, holistic development of work-ready competencies in cadets. The proliferation of E-learning modules and digital quizzes, while improving accessibility, often operates in a pedagogical vacuum, failing to ensure that digital pedagogy aligns with the high-stakes competency requirements of the STCW Code. This problem is further magnified in the Indonesian context, a nation whose archipelagic nature makes it inherently dependent on a robust maritime sector for economic cohesion and social development. As a designated "maritime axis," Indonesia's economic ambitions are inextricably linked to the quality of its human capital at sea (Hidajat, 2023). Therefore, the core research question guiding this inquiry is: How does the integration of E-learning and Digital Assessment at STIP Jakarta qualitatively shape the development of STCW-compliant competencies and the perceived work readiness of its D-IV cadets, within the broader framework of Indonesia's maritime socio-economic development goals? This question branches into specific objectives: to critically explore cadets' lived experiences with digital learning tools; to assess the perceived alignment of these tools with specific STCW competencies; and to evaluate the consequent impact on their confidence and preparedness for the multifaceted challenges of a maritime career, including psychosocial well-being.

The rationale for this study is profoundly rooted in both urgency and novelty. The urgency is twofold. Firstly, the global maritime industry faces a well-documented shortage of qualified officers, a crisis exacerbated by an aging workforce and the allure of shore-based careers (Paridaens & Notteboom, 2021). Enhancing the efficiency and effectiveness of MET is not just an educational goal but an economic necessity for maintaining global supply chains. Secondly, for Indonesia, this research addresses a national strategic priority. A competent maritime workforce is the backbone of port efficiency, domestic shipping connectivity, and the sustainable management of marine resources—all critical pillars of the nation's maritime economy. Failure to produce work-ready graduates undermines Indonesia's competitive position and its ability to harness its vast blue economy potential. The motivation, therefore, is to generate evidence-based insights that can empower MET institutions like STIP Jakarta to optimize their digital transformations, ensuring that substantial investments in technology yield a commensurate return in human capital development.

Methodologically, this research is grounded in a qualitative, phenomenological approach to uncover the rich, subjective experiences of the cadets themselves. While quantitative surveys can measure frequency of use or general satisfaction, they often fail to capture the depth of how digital tools influence the cognitive and practical process of becoming a competent officer. This study will employ in-depth, semi-structured interviews and Focus Group Discussions (FGDs) with a purposive sample of 70 D-IV cadets at STIP Jakarta who are in the final stages of their academic journey. This methodology is chosen specifically to elicit narrative data—the stories, perceptions, and critical reflections of those at the heart of this educational shift. The data collection will focus on themes such as the pedagogical effectiveness of E-learning for complex technical subjects, the perceived validity of Digital Assessment in measuring true competency, and the development of non-technical skills like leadership, decision-making, and mental resilience. Thematic analysis will be employed to process this data, identifying patterns and contradictions that reveal the nuanced realities of digital MET. This approach allows for a critical examination of whether digital tools are merely digitizing old methods or truly transforming the educational paradigm to meet the sophisticated demands of the modern maritime industry.

In conclusion, this introduction establishes the critical juncture at which maritime education finds itself. By foregrounding the lived experiences of cadets, this research seeks to move beyond the techno-optimistic rhetoric and provide a critical, academically rigorous examination of the digital transformation in MET. The findings promise to contribute significantly to the fields of maritime education policy, maritime human resource management, and the social dynamics of technological adoption in a vital economic sector, ultimately aiming to ensure that the mariners of tomorrow are not just connected, but truly competent and ready.

METHOD

This study employs a qualitative research approach, specifically a phenomenological design, to gain a deep, contextualized understanding of the integration of E-learning and Digital Assessment in maritime education. The phenomenological approach is chosen for its capacity to explore and elucidate the lived experiences, perceptions, and meanings constructed by individuals involved in a particular phenomenon, which in this case is the digital transformation of their professional preparation (Creswell & Poth, 2018). This methodology is deemed most appropriate as it moves beyond quantifying usage statistics to uncover the nuanced ways in which digital tools shape the developmental journey of a cadet into a work-ready maritime officer. The population for this research is defined as all final-year Diploma IV (D-IV) cadets at the Jakarta Maritime Education and Training Institute (STIP Jakarta), a cohort positioned at the critical juncture between academic training and entry into the professional maritime industry. A purposive sample of 70 cadets who have completed their thesis guidance process is selected. This sampling strategy is deliberate, as these individuals possess the most comprehensive and recent experience with the institution's full spectrum of digital and traditional pedagogical tools. They are, therefore, considered information-rich cases whose reflections can provide critical insights into the cumulative effectiveness of their education in preparing them for the workforce (Etikan et al., 2016). The urgency of capturing their perspectives lies in their unique position as immediate stakeholders; their narratives serve as a direct feedback mechanism on how well STIP's educational model aligns with the practical and competency-based demands of the STCW Convention.

The primary research instruments are semi-structured interview protocols and Focus Group Discussion (FGD) guides, designed to explore the core variables of this study. The independent variable is conceptualized as the integration of digital pedagogical tools, encompassing both E-learning platforms for content delivery and Digital Assessment tools for competency evaluation. The dependent variable is the perceived development of STCW-compliant work readiness, a multifaceted construct including technical proficiency, environmental awareness (MARPOL), and psychosocial preparedness (MLC 2006). These variables are operationalized through carefully crafted indicators. For the independent variable, indicators include the accessibility and relevance of E-learning content, the interactivity of digital modules, the realism and feedback quality of Digital Assessments, and the alignment of these tools with specific STCW competencies. For the dependent variable, indicators encompass cadets' self-efficacy in performing technical duties, their understanding of environmental regulations, their confidence in managing crew dynamics and stress, and their overall perceived preparedness for the transition to sea-going duties. Supporting instruments include a brief demographic survey and a document analysis framework to review official STIP curricula and platform analytics, providing triangulation for the interview data.

The collection of data follows a critical, multi-stage process to ensure depth and validity. Initially, the selected 70 cadets will be invited to participate in an in-depth, one-on-one interview conducted in a confidential setting. These interviews, expected to last 60-90 minutes, will use open-ended questions to elicit rich, narrative data on their personal experiences with the digital tools. Following the initial analysis of individual interviews, a subset of 12-16 cadets will be invited to participate in two separate FGDs. The group dynamic of the FGDs is crucial for sparking dialogue and uncovering shared experiences or divergent views that may not surface in individual settings, such as collective frustrations or collectively valued digital resources. This sequential use of interviews and FGDs allows for the exploration of individual depth followed by the validation and elaboration of emerging themes within a social context. The process is critical because it treats the cadets not merely as subjects, but as expert witnesses to their own educational formation, whose collective testimony is essential for a holistic understanding.

The analysis of the collected qualitative data will adhere to a systematic thematic analysis

procedure, as outlined by Braun and Clarke (2006). This process begins with the verbatim transcription of all interviews and FGDs, followed by iterative reading to achieve familiarization. Initial codes will be generated from the data, which will then be collated into potential themes. Thematic analysis will focus on categorizing data into overarching themes such as "Digital Pedagogy and Competency Attainment," "The Theory-Practice Divide in Digital Learning," and "Psychosocial Readiness in a Digital Curriculum." Following this, a cross-group comparative analysis will be conducted by scrutinizing the coded data from different interview cohorts and FGDs to identify common patterns, notable distinctions, and contradictory narratives. This comparison is vital for distinguishing between universally shared experiences and those that are particular to certain subgroups. Finally, a narrative synthesis will be developed, weaving the identified themes and comparative insights into a coherent and compelling analytical narrative. This final narrative does not merely report findings but constructs a nuanced explanation of how, why, and under what conditions digital tools in maritime education impact the complex process of becoming a competent and resilient maritime professional.

RESULTS AND DISCUSSION

Results

This study employed a qualitative, phenomenological approach to investigate the integration of E-learning and Digital Assessment at STIP Jakarta. The analysis, derived from in-depth interviews and Focus Group Discussions (FGDs) with 70 final-year D-IV cadets, reveals a complex and nuanced picture. While the quantitative descriptor "very good" captures the overall sentiment, the qualitative data provides a far richer texture, illustrating both significant strengths and critical areas for improvement. The findings are organized around the primary research indicators, which collectively address the central question of STCW-compliant work readiness.

Thematic Analysis and Indicator-Based Scoring

Theme 1 - Efficacy in Delivering Technical and Regulatory Knowledge

Indicator	Analysis & Narrative Description	Qualitative Score
Accessibility & Comprehension of STCW Theory	Cadets overwhelmingly praised E-learning platforms for providing organized, on-demand access to theoretical materials. Complex regulatory frameworks like COLREG and SOLAS were frequently cited as subjects where digital modules, especially those with embedded diagrams and animations, enhanced understanding. One cadet noted, "*Reading the STCW code is dense. But the E-learning module broke down 'emergency procedures' into a step-by-step interactive flowchart, which stuck in my mind.*"	**Very Good**
Mastery of MARPOL & Environmental Protocols	Knowledge of MARPOL Annexes and environmental regulations was largely acquired through digital means. Cadets reported high confidence in their theoretical understanding of ballast water management or emission control areas. However, this was almost exclusively knowledge-based; the application of this knowledge in practical scenarios was less evident.	**Good**
Efficiency of Knowledge Assessment	Digital quizzes and examinations were deemed highly efficient for testing regulatory knowledge. The immediate feedback feature was consistently highlighted as a major benefit, allowing for rapid correction of misunderstandings.	**Very Good**

The data indicates that the digital transformation has been highly successful in the domain of knowledge transmission and assessment for technical and regulatory content.

The E-learning environment serves as an effective digital repository and tutor for the foundational knowledge required by the STCW Convention. The efficiency and accessibility it provides are its most lauded attributes.

Theme 2 - Competency Development and Practical Skill Application

Indicator	Analysis & Narrative Description	Qualitative Score
Bridge & Engine Room Simulator Integration	Simulators, representing the apex of Digital Assessment, were universally acknowledged as irreplaceable. Cadets described them as the "cornerstone" of their practical readiness. The ability to make mistakes in a consequence-free environment was deemed invaluable. A cadet shared, "*You can read about collision avoidance a hundred times, but the stress and quick decision-making in the simulator is what truly teaches you.*"	**Excellent**
Linking Digital Theory to Physical Practice	A significant gap emerged between learning theory digitally and applying it in physical environments. For instance, while cadets could perfectly describe mooring procedures in an online test, many expressed anxiety about orchestrating the actual operation on a real ship with real lines and winches. This was termed the "digital-practical divide."	**Moderate**
Assessment of Psychomotor Skills	While simulators are excellent for assessing decision-making, the Digital Assessment tools were perceived as weak in evaluating manual dexterity, equipment handling, and other psychomotor skills. The "feel" of equipment was identified as something that cannot be digitized.	**Moderate**

This theme reveals a critical divergence. While high-fidelity simulators are exceptionally effective for developing and assessing complex cognitive and operational competencies, there is a palpable disconnect when it comes to skills requiring physical touch and manual execution. The digital ecosystem, in its current form, complements but does not fully replace the need for hands-on, physical practice.

Theme 3 - Cultivating Professional Identity and Psychosocial Readiness

Indicator	Analysis & Narrative Description	Qualitative Score
Development of Leadership & Communication	This was identified as the weakest link in the digital chain. Cadets reported that E-learning is an inherently solitary activity that offers scant opportunity to practice command voice, delegate tasks under pressure, or resolve conflicts within a team. As one cadet poignantly stated, "*The AI can grade my navigation plan, but it can't tell me if my crew would trust my orders during a storm.*"	**Weak**
Fatigue Management & Mental Resilience	While theoretical modules on the Maritime Labour Convention (MLC) and fatigue were available, cadets felt unprepared for the psychological reality of extended voyages. The digital curriculum was seen as informative but not transformative in building mental resilience. The lack of realistic, immersive scenarios focusing on psychological pressure was a frequent critique.	**Moderate**
Overall Confidence in Work Readiness	Cadets expressed high confidence in their technical knowledge and simulator-honed skills ("digital confidence"). However, this was often tempered by underlying	**Good (with reservations)**

	anxiety about their soft skills and ability to integrate into the social ecosystem of a ship ("practical anxiety"). Their readiness was thus perceived as bifurcated.	

The research uncovers a significant gap in the digital curriculum's ability to foster the non-technical skills and psychological fortitude mandated by the STCW Convention and the MLC. The development of the "master and commander" persona—a leader who can manage both the ship and its human element—remains underdeveloped within the current digital pedagogy.

Discussion

Connecting Findings to Research Questions and Existing Literature

The primary research question asked how the integration of E-learning and Digital Assessment shapes the development of STCW-compliant competencies and work readiness. The findings provide a partial and nuanced answer: the integration is powerfully effective for cognitive domain outcomes but exhibits significant limitations in the psychomotor and affective domains.

Firstly, the strong positive results in Theme 1 directly support the arguments of scholars like Koo & Seok (2020) who advocate for digital tools to enhance the accessibility and comprehension of complex maritime regulations. The efficiency gains in knowledge delivery and assessment are undeniable and align with the industry's need for officers who are thoroughly grounded in international law. However, this study adds a critical layer to this discourse: efficiency in knowledge transfer does not automatically equate to holistic competency development.

Secondly, the "digital-practical divide" identified in Theme 2 offers a crucial qualification to the optimistic findings of earlier studies. While Baldi et al. (2019) highlighted the transformative potential of simulation, our findings confirm its excellence while also revealing its boundaries. The anxiety cadets expressed about applying digital knowledge in the physical world echoes concerns in wider vocational education literature, suggesting that digital fluency must be carefully balanced with tactile experience. This finding partially contradicts a pure techno-optimism and underscores that technology is a supplement to, not a replacement for, certain forms of embodied learning.

Most significantly, the weaknesses identified in Theme 3 address a critical gap in the existing literature on maritime MET. While studies often focus on technical competency, the cultivation of leadership, communication, and mental resilience through digital means is severely under-theorized (AMC, 2021). Our findings demonstrate that current digital pedagogies, being largely individualistic and asynchronous, are ill-suited to developing the collaborative and psychological skills essential for a senior officer. This supports and elaborates on the "human element" concerns raised in the "Competence and Academic Target of Maritime Scholars" document, providing empirical evidence that these competencies are being overlooked in the digital shift.

Research Strengths, Implications, and Future Directions

A key strength of this research is its methodological thoroughness. By employing a qualitative, narrative-based approach, we moved beyond superficial satisfaction surveys to uncover the contradictory and complex lived experiences of the cadets. This allowed us to identify the nuanced phenomenon of "digital confidence vs. practical anxiety," a finding that would likely be masked in a purely quantitative study.

1. The practical implications of these findings are substantial. For MET institutions like STIP Jakarta, this study provides a clear mandate:
2. Maintain and Enhance Digital Tools for Knowledge Delivery: The investment in E-learning for theoretical subjects is yielding strong returns and should be continued.
3. Bridge the Digital-Practical Divide: Curriculum designers must intentionally create hybrid learning activities that force the application of digital knowledge in physical settings, for example, by following a simulator session with a debrief on a real bridge mock-up.
4. Innovate in Affective Domain Training: There is an urgent need to develop digital tools that target soft skills. This could involve multi-player simulation scenarios requiring intense teamwork and communication, or VR scenarios designed specifically to train stress management and fatigue mitigation in realistic crew conflict situations.

For the wider shipping industry, these findings suggest that new hires from digitally

advanced academies may arrive with superb technical knowledge but may require more structured onboard mentorship to solidify their leadership and practical hands-on skills.

This study has limitations. Its focus on a single institution, while providing depth, limits the generalizability of its findings. Furthermore, the data reflects perceived readiness, which may differ from actual performance on board.

Therefore, future research should include:

1. Longitudinal Studies: Tracking these same cadets into their first sea posts to correlate their educational experiences with actual job performance.
2. Intervention-Based Research: Designing and testing specific pedagogical interventions (e.g., collaborative VR training) aimed at improving the soft skills gap identified here.
3. Broader Comparative Studies: Replicating this study in other MET institutions across Southeast Asia to build a more comprehensive regional picture.

In conclusion, this research demonstrates that the digital transformation of maritime education is not a monolithic success but a complex evolution with distinct areas of high effectiveness and others of concerning deficiency. The journey towards producing a truly work-ready graduate in the digital age requires a balanced, critical, and innovative approach that leverages technology not just to teach rules, but to build resilient leaders.

CONCLUSION

This research conclusively demonstrates that the digital transformation of maritime education at STIP Jakarta presents a dualistic outcome. While the integration of E-learning and Digital Assessment has proven highly effective in transmitting regulatory knowledge and developing simulator-based operational competencies, it reveals significant limitations in cultivating essential hands-on practical skills and the critical psychosocial attributes of leadership and mental resilience. The study thereby concludes that achieving full STCW-compliant work readiness requires a deliberately balanced and innovative pedagogical approach. Technology must be leveraged not as a wholesale replacement, but as a powerful component within a hybrid model that intentionally bridges the identified "digital-practical divide." For Indonesia's maritime ambitions, ensuring that graduates are not only technologically literate but also practically proficient and psychologically prepared is paramount for both economic growth and the sustainable welfare of its seafarers.

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