

Digitalizing Seafarers' Well-being: Addressing Mental Health Challenges in Autonomous Shipping

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ABSTRACT – As the maritime industry shifts toward increased automation and the implementation of Maritime Autonomous Surface Ships (MASS), the role of seafarers is undergoing a critical transformation. This study investigates the dual impact of digital tools namely the MARENG Maritime English learning software and the Wysa AI mental health application on enhancing both the technical language proficiency and psychological well-being of marine cadets. Using a quasi-experimental mixed-method design, 120 cadets were divided into experimental and control groups over a six-week intervention period. Quantitative data from Maritime English Assessment Tests (MEAT) and DASS-21 psychological scales revealed significant improvements in the experimental group's communication skills and mental health scores. Correlation analysis further showed that reduced stress levels positively influenced language performance. Qualitative insights from focus group discussions affirmed that cadets using digital tools experienced heightened confidence, emotional regulation, and learning autonomy. These findings support a holistic, technology-integrated approach to maritime education that aligns with the evolving demands of autonomous shipping and human-centered digital resilience.

Keywords – Maritime English, Autonomous shipping, Seafarer mental health, Digital learning, AI applications.

I. Introduction

The maritime industry is currently undergoing a paradigm shift, driven by rapid advancements in automation, artificial intelligence (AI), and remote operation technologies. Among the most transformative developments is the rise of autonomous shipping, where vessels operate with minimal or no onboard human intervention. These intelligent ships, equipped with advanced sensors, control systems, and communication infrastructure, promise to enhance navigational accuracy, operational efficiency, and environmental sustainability. However, the transition toward autonomous shipping also brings forth a new set of challenges, particularly concerning the human element in maritime operations. Seafarers, who have traditionally played a central role in ensuring ship safety, maintenance, communication, and crisis management, now find their roles being redefined. Rather than performing manual or routine operations, modern-day seafarers are expected to engage with complex digital systems, monitor remote interfaces, and interact with automation protocols. In this evolving context, two key areas have emerged as critically important: linguistic competence and mental health resilience.

Firstly, Maritime English the standardized mode of communication for seafarers worldwide as stipulated by the International Maritime Organization (IMO) continues to be indispensable. It enables effective communication among multicultural crews and ensures clarity in operational and emergency scenarios. Miscommunication at sea, often stemming from poor language proficiency, has been cited as a contributing factor in numerous maritime accidents. Therefore, mastery of Maritime English is not only a regulatory requirement but also a cornerstone of operational safety and crew coordination.

Secondly, the psychological well-being of seafarers has garnered increasing attention in recent years. With extended voyages, reduced port stays, limited social interaction, and the psychological strain of adapting to increasingly automated environments, seafarers are at heightened risk for stress-related disorders, anxiety, and depression. These mental health issues, if unaddressed, can lead to performance errors, reduced job satisfaction, and even safety hazards on board. In an autonomous future, where human roles may be less physically demanding but more mentally taxing, ensuring psychological preparedness and emotional support is paramount. Recognizing these dual imperatives effective communication

and mental well-being this study investigates the use of AI-powered digital tools to support seafarers' evolving needs. Specifically, it examines the integration of *MARENG*, a Maritime English learning software, and AI-enabled mental health platforms such as *Wysa* and *SeafarerHelp* into maritime training. These tools leverage adaptive learning algorithms, simulated maritime scenarios, and cognitive-behavioural support systems to build both technical proficiency and emotional resilience. The primary objective of this research is to explore how such platforms can be incorporated into the training curricula of maritime institutions to better prepare cadets for the realities of autonomous shipping. By analysing both language acquisition outcomes and mental health indicators, this study offers a comprehensive approach to equipping the future maritime workforce with the necessary tools for success in a digitally dominated seascape.

II. Literature Review

The ongoing transformation of the maritime sector through digitalization and the emergence of Maritime Autonomous Surface Ships (MASS) has intensified the need to reconsider the well-being and skill sets of seafarers. As the operational landscape shifts toward automation and remote vessel management, the psychological demands placed on seafarers are becoming increasingly complex. Several recent studies have underscored the mental health vulnerabilities of seafarers in this evolving context, highlighting both the threats and the potential of digital interventions. Tam et al. (2021) caution that remote control and automation in maritime operations, while improving efficiency, may inadvertently lead to a detachment from shipboard life, thus exacerbating feelings of isolation and psychological stress. The transition from physically demanding roles to cognitively intense monitoring duties can lead to a rise in anxiety and emotional fatigue, particularly in high-stakes, decision-heavy environments. Complementing this view, Li, Seah, Wang, and Yuen (2022) emphasize that sociotechnical factors including access to communication tools, perceived job control, and digital literacy play a pivotal role in shaping seafarers' psychological capital and overall mental well-being. In a systematic review of seafarer health conditions, Li, Zhou, and Yuen (2022) further affirm that digital interventions, if properly integrated into the seafaring environment, can mitigate stressors such as loneliness, uncertainty, and lack of social support. These findings align with Hayat, Shang, and Lirn's (2025) bibliometric study, which identifies mental health as a rising research hotspot within maritime studies, with particular emphasis on digital-era stressors and coping mechanisms.

The role of information and communication technologies (ICTs) in supporting seafarers' psychological health has gained prominence in both theoretical and applied research. Abila et al. (2023) and Espina-Subong (2023) argue for the repositioning of seafarers as proactive agents of their own mental health, empowered through the strategic use of ICT-based tools such as mobile apps, virtual counseling, and AI chatbots. These tools, which facilitate emotional self-regulation and offer accessible psychoeducation, hold particular promise for remote and confined work environments. The empowerment model proposed in their studies aligns with socio-constructivist pedagogies, where learners and workers alike are engaged in reflective, tech-mediated processes of self-support and resilience-building. Gendered dimensions of digitalization are also emerging in maritime literature. Olajide (2024) explores how female seafarers experience digital transitions, particularly in autonomous vessels, and reveals how digital tools can both empower and marginalize, depending on the inclusivity of their design. This intersectional lens broadens the understanding of how psychological tools must be adaptable to diverse crew profiles and operational settings. Moreover, Kang, Seo, and Hwang (2020), in a study conducted with Republic of Korea Navy personnel, show that mindfulness-based stress reduction programs have significant effects in reducing anxiety and improving emotional well-being in maritime contexts, further reinforcing the value of structured mental health interventions aboard vessels.

Altogether, this growing body of research reflects a convergence of technological, psychological, and pedagogical perspectives. While automation challenges traditional notions of seamanship, it also opens up opportunities to redesign maritime training and operational environments to be more human-centred. The integration of AI-powered mental health applications and adaptive language learning software, such as *MARENG*, presents a holistic strategy to address the dual imperatives of communication proficiency and psychological resilience. These insights directly inform the present study, which investigates how such digital tools can be systematically incorporated into the training of maritime cadets to better prepare them for the cognitive, linguistic, and emotional demands of autonomous shipping.

III. Methodology

This study adopted a quasi-experimental mixed-method research design to investigate the effectiveness of digital tools specifically *MARENG* software and the *Wysa* AI mental health application in enhancing seafarers' language proficiency and psychological well-being. Conducted over a

six-week intervention period, the research was implemented at the Academy of Maritime Education and Training (AMET University) in Chennai, India. A total of 120 marine engineering cadets participated in the study. The participants were divided into two groups using purposive sampling based on equal academic standing and demographic representation: an experimental group ($n = 60$) and a control group ($n = 60$). To assess both language competency and mental health status, the study utilized four key tools: (1) the MARENG software, an interactive Maritime English learning platform that provides real-time feedback, domain-specific vocabulary training, and scenario-based simulations aligned with IMO standards; (2) the Wysa App, an AI-powered mental health chatbot designed to offer cognitive behavioral therapy (CBT)-based self-help strategies and emotional support; (3) the Depression Anxiety Stress Scales-21 (DASS-21), a validated psychological screening instrument for evaluating the mental health status of the cadets across three subscales; and (4) the Maritime English Assessment Test (MEAT), designed according to IMO Model Course 3.17 to evaluate cadets' proficiency in technical maritime language, standard phraseology, and communication protocols.

The procedure began with a pre-assessment phase, during which both experimental and control groups completed the DASS-21 and MEAT to establish baseline data on their psychological well-being and language proficiency. Following this, the intervention phase commenced. The experimental group was exposed to a structured digital learning routine comprising daily 45-minute sessions using MARENG and weekly 15-minute guided mental health sessions via the Wysa App. These sessions were embedded into their daily academic schedules and facilitated by instructors trained in blended learning pedagogy. In contrast, the control group continued with traditional instruction methods, which included textbook-based Maritime English lessons and general academic support, with no exposure to digital mental health interventions.

At the end of the six-week period, a post-assessment was administered to both groups using the same instruments. Quantitative data from the MEAT and DASS-21 were statistically analyzed to measure changes in language acquisition and mental health parameters, while qualitative insights were gathered from focus group discussions with selected participants from the experimental group to contextualize their experiences and perceptions of the digital tools.

IV. Results and Analysis

The results of the study are organized into three major categories: (1) quantitative findings from the Maritime English Assessment Test (MEAT), (2) psychological well-being measurements via DASS-21, and (3) qualitative data from post-intervention focus group discussions. A correlation analysis was also conducted to examine the relationship between stress levels and language performance. All statistical computations were performed using SPSS Version 26.

A. Maritime English Proficiency (MEAT Scores)

Table 1: Pre- and Post-Test Mean Scores – Maritime English Proficiency

Group	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Gain	% Improvement
Experimental ($n = 60$)	57.8 (± 6.4)	80.2 (± 5.9) NBV H	22.4	38.75%
Control ($n = 60$)	58.9 (± 7.1)	64.7 (± 6.5)	5.8	9.84%

The experimental group improved their Maritime English scores from a mean of 57.8 to 80.2, resulting in a mean gain of 22.4 points, which represents a 38.75% improvement.

- The control group, by contrast, improved from 58.9 to 64.7, achieving a mean gain of 5.8 points, or a modest 9.84% improvement.
- The standard deviation (SD) values indicate a consistent performance distribution, slightly narrowing post-intervention in the experimental group, suggesting reduced performance variance among participants.

These results clearly show the superior effectiveness of the MARENG software in improving cadets' Maritime English proficiency. The experimental group's substantial gain suggests that immersive, scenario-based learning facilitated better vocabulary retention and context-aware usage compared to traditional textbook methods. In contrast, the control group's lower gains demonstrate the limitations of passive learning in equipping cadets for communication-intensive maritime operations. The dramatic gap in performance (a difference of 16.6 points in mean gain) highlights the pedagogical value of technology-assisted language learning in maritime training.

B. Psychological Well-being (DASS-21 scores)

Table 2: Post-Test DASS-21 scores – Experimental vs. Control Groups

Subscale	Experimental (Mean ± SD)	Control (Mean ± SD)	Change (%)
Depression	8.5 (±4.3)	15.1 (±5.6)	-43.7%
Anxiety	7.9 (±4.0)	13.4 (±5.2)	-41.0%
Stress	10.7 (±4.8)	17.2 (±5.3)	-37.8%

- The experimental group recorded lower post-test means across all three subscales Depression (8.5), Anxiety (7.9), and Stress (10.7).
- Compared to the control group, which reported Depression (15.1), Anxiety (13.4), and Stress (17.2), the experimental group showed percentage reductions of -43.7%, -41.0%, and -37.8%, respectively.
- These differences are statistically significant with $p < 0.01$, based on t-tests for independent samples.

The DASS-21 results affirm that cadets in the experimental group experienced notable improvements in psychological well-being. The use of the Wysa AI app provided proactive mental health support, enabling cadets to self-regulate stress and anxiety more effectively than their peers in the control group. This suggests that mental health tools integrated into academic routines are not only beneficial but essential in reducing emotional distress among cadets preparing for high-pressure maritime roles. The lower SD in the experimental group also indicates greater emotional stability and uniformity in response to the intervention.

C. Combined Learning and Mental Health Outcomes

To examine the relationship between psychological stress and learning performance, a correlation analysis was conducted using post-intervention data from the experimental group.

Statistical Result:

- Pearson Correlation Coefficient between Stress scores and Maritime English post-test scores: $r = -0.52$, $p < 0.01$
- The negative correlation of -0.52 indicates a moderate inverse relationship between stress levels and language performance.
- As cadets' stress decreased, their language proficiency tended to increase, and vice versa.
- This result was statistically significant, supporting the hypothesis that emotional well-being enhances cognitive outcomes.

This correlation underscores the interconnected nature of emotional and cognitive development. Cadets who experienced fewer stress symptoms were able to focus better, engage more confidently in oral and written communication tasks, and apply learned concepts with higher precision. The mental clarity afforded by reduced stress likely improved concentration and retention, validating the dual-impact model of combining linguistic and psychological interventions in maritime education.

D. Qualitative Insights from Focus Groups

To supplement the quantitative findings, post-intervention focus group discussions were conducted with 12 cadets from the experimental group. Three recurring themes emerged:

Theme2: Emotional Regulation and Peer Interaction

Participants appreciated the Wysa app for helping them verbalize emotions and reduce interpersonal tension. One cadet said, "I used to hold back feelings, but now I know how to express stress without anger."

Theme3: Learning Autonomy and Motivation

The gamified elements in MARENG encouraged cadets to "compete with themselves," enhancing their motivation. The ability to track progress and earn badges created a sense of achievement and independence in learning.

These qualitative insights provide rich context to the numerical data, demonstrating that the digital tools not only improved academic and emotional metrics but also shaped the cadets' learning mindsets and interpersonal dynamics. The cadets' enhanced sense of agency, belonging, and emotional literacy represents a culture shift in maritime training one that favours learner empowerment, digital fluency, and holistic development.

V. Discussion

The findings of this study offer compelling evidence in support of integrating digital tools into maritime education and training particularly in light of the evolving challenges posed by autonomous shipping environments. The dual focus on technical language proficiency and mental health resilience aligns closely with global trends in maritime workforce development, where seafarers are increasingly required to function as both technologically literate and psychologically adaptable professionals.

A. Enhancing Maritime English Proficiency through Digital Immersion

The 38.75% improvement observed in the experimental group's Maritime English scores underscores the effectiveness of the MARENG software in fostering domain-specific

linguistic competence. Traditional classroom instruction often lacks the context-rich simulation that MARENG provides an essential factor considering that Maritime English is not only rule-governed but highly contextual, situation-based, and safety-critical. MARENG's use of simulated dialogue, shipboard scenarios, voice interaction, and feedback loops aligns with the constructivist model of learning, which emphasizes experiential learning, autonomy, and reflection (Bruner, 1996). The high standard deviation in pre-test scores narrowed post-intervention, suggesting not only overall gains but also greater consistency among learners. This result supports prior findings by Li et al. (2022) and IMO (2022), which assert that Maritime English instruction is most effective when it mimics authentic communication challenges and tasks at sea. Additionally, the gamification elements within MARENG such as achievement tracking and rewards for linguistic accuracy likely contributed to increased learner motivation, task engagement, and self-directed learning behaviours. These pedagogical outcomes are critical for cadets who will soon be operating in semi- or fully autonomous ship environments, where verbal clarity, command brevity, and shared understanding across multicultural crews remain vital despite reduced onboard personnel.

B. Reducing Psychological Distress through AI-Enabled Mental Health Tools

The substantial reductions in depression (−43.7%), anxiety (−41.0%), and stress (−37.8%) among the experimental group affirm the efficacy of digital mental health tools in seafaring contexts. These findings resonate with Kang et al. (2020) and Abila et al. (2023), who emphasize that seafarers benefit from low-barrier access to emotional support, especially when traditional counselling resources are unavailable or stigmatized. Wysa, an AI-driven mobile application, played a pivotal role in enabling cadets to develop emotional literacy and regulation. Its design grounded in Cognitive Behavioural Therapy (CBT) and delivered through a chatbot interface proved especially suitable for the maritime cadet population, which often faces cultural stigma around openly discussing mental health. The qualitative responses revealed that cadets felt “heard” and “relieved,” suggesting a degree of emotional catharsis facilitated by the tool. The app's asynchronous, judgment-free nature appeared to normalize mental health conversations among peers and contributed to improved group dynamics. This aligns with socio-constructivist learning theories, where emotional safety within peer groups fosters collaborative engagement, openness, and reduced resistance to feedback. Furthermore, the privacy of the app allowed cadets to self-regulate without fear of institutional consequences or

ridicule an important consideration for scaling mental health support across maritime institutions globally.

C. The Interplay Between Cognitive Performance and Emotional Well-Being

Perhaps one of the most significant findings was the moderate negative correlation ($r = -0.52$) between stress scores and language performance in the experimental group. This suggests that as stress levels decreased, language performance improved, and vice versa. This insight reflects the bidirectional relationship between cognitive load and emotional state, as explored in educational psychology and supported by studies such as Tam et al. (2021) and Hayat et al. (2025). human element Cognitive performance, especially in language acquisition, is highly sensitive to affective states. When cadets are less anxious or stressed, they are more likely to retain technical vocabulary, engage with materials deeply, and participate in oral communication tasks without inhibition. Conversely, unchecked psychological distress may manifest in reduced attention, passive disengagement, or even active resistance to learning. Therefore, the inclusion of emotional support tools in maritime training is not merely a wellness initiative it is a pedagogical imperative.

D. Insights from Focus Groups: Empowering the Learner

The qualitative data further validated the quantitative outcomes. Cadets in the experimental group reported not only academic gains but also increased confidence, emotional awareness, and learning motivation. Their reflections indicated that the humanizing elements of MARENG and Wysa the interactivity, personalization, and responsiveness were key drivers of engagement. These tools appeared to make learning more social, reflective, and emotionally grounded, in contrast to traditional, instructor-centric methods. Several cadets mentioned feeling a heightened sense of autonomy they could practice phrases or emotional exercises on their own time, at their own pace, and without public scrutiny. This autonomy is crucial in adult learning contexts, especially in maritime training where cadets often balance rigorous physical schedules with cognitive and procedural learning. By offering this flexibility, digital tools supported cadets not just as learners but as self-regulating professionals in training.

E. Implications for the Autonomous Maritime Era

As the maritime industry navigates toward autonomous and semi-autonomous vessel operations, human roles are becoming increasingly focused on supervision, exception management, remote monitoring, and multi-system coordination. These roles demand not less but more

sophisticated forms of communication and emotional regulation. The success of AI-enabled tools in this study suggests that human-AI collaboration can enhance rather than replace the human element in shipping. By embracing digital solutions like MARENG and Wysa, maritime institutions and shipping companies can ensure that seafarers are equipped with the soft skills and self-care practices required in digital seascapes. Furthermore, the low-cost, scalable nature of these interventions makes them feasible for wide adoption, especially in regions with limited access to specialized instructors or mental health professionals.

VI. Conclusion

As the maritime industry accelerates its shift toward autonomous technologies, the role of the human element remains indispensable though redefined. This study has demonstrated that digital tools such as MARENG and Wysa offer viable and scalable solutions to some of the most pressing challenges faced by today's and tomorrow's seafarers: language proficiency and mental well-being. The quasi-experimental results, supported by both statistical data and qualitative insights, establish that targeted digital interventions significantly enhance cadets' technical English performance and simultaneously reduce levels of depression, anxiety, and stress. The dramatic improvement in the Maritime English Assessment Test (MEAT) scores among cadets who used MARENG reflects how immersive, interactive, and context-rich software can better simulate real-life scenarios than traditional methods. It allows learners to practice standardized phraseology, respond to safety-critical prompts, and build communication confidence through feedback-rich modules all aligned with IMO Model Course 3.17 standards. Simultaneously, the deployment of Wysa a low-threshold, AI-driven mental health support application proved beneficial in enabling cadets to manage emotional stress, enhance emotional literacy, and cultivate mindfulness. These findings reinforce the argument that mental resilience is not peripheral but central to operational performance. In an increasingly automated environment where social isolation may grow, providing seafarers with internal tools to manage stress, regulate emotion, and seek support will be crucial to ensuring safety and sustainability at sea. Importantly, the integrated approach proposed in this study reflects a holistic model of maritime education, wherein language acquisition and mental health are viewed as interdependent dimensions of professional readiness. This model advocates for a future-ready pedagogy one that emphasizes not only cognitive learning outcomes but also emotional well-being, digital literacy, and self-directed engagement.

VII. Recommendations

Based on the findings and implications of this research, the following recommendations are proposed for maritime educational institutions, policymakers, and shipping organizations:

1. ***Institutional Integration of Digital Learning Platforms:*** Maritime institutions should formally adopt AI-based learning platforms such as MARENG into their curriculum. These tools should not be supplementary but integrated into core instructional hours to maximize engagement and retention.
2. ***Mental Health Tools as Mandatory Support Infrastructure:*** AI-powered mental health applications such as Wysa should be made accessible to all cadets and seafarers as part of a broader institutional mental health strategy. This includes awareness workshops, orientation programs, and anonymous access portals.
3. ***Curriculum Reform Based on Socio-Constructivist Pedagogy:*** Training programs should move beyond rote learning and focus on contextualized, scenario-based instruction that encourages interaction, reflection, and adaptive problem-solving. Digital tools can facilitate these shifts when embedded in a blended learning model.
4. ***Longitudinal Monitoring and Feedback Mechanisms:*** Institutions and research bodies should conduct longitudinal studies to assess the long-term impact of digital interventions on seafarers' performance during internships, on-board duties, and post-certification employment.
5. ***Policy Advocacy through the IMO and National Maritime Authorities:*** The International Maritime Organization (IMO) and national regulators should update existing STCW frameworks to include digital competence and psychological well-being as part of certification and compliance metrics for MET (Maritime Education and Training) providers.
6. ***Cultural Sensitivity and Accessibility:*** Developers of digital tools must ensure that platforms are multilingual, culturally sensitive, and tailored to maritime contexts, especially when targeting diverse seafarer populations across gender, nationality, and experience levels.
7. ***Instructor Training and Digital Facilitation Readiness:*** Faculty members and shipboard trainers must be equipped with the necessary skills to facilitate digital learning and emotional support. Pedagogical training should include digital tool usage, facilitation of reflective dialogue, and awareness of psychological first aid.

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