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Exploring the strategies and pitfalls of using GPT-assisted software in technical writing: Looking through the experiences of maritime instructors and students

Jully Fe D. Razon, MAELT*[1], Dr. Ferdinand Bulusan[2]
[1, 2] Polytechnic University of the Philippines
*Corresponding Author e-mail: *razon.jully@gmail.com*

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Abstract

Aim: This study examined how AI-assisted writing tools are used, constrained, and interpreted in maritime technical documentation, a form of writing shaped by educational objectives as well as accountability, traceability, and safety-sensitive communication. It explored the strategies employed by maritime students and instructors, the pitfalls encountered in relation to professional and regulatory expectations, and the principles that should guide responsible AI integration in technical writing.

Methodology: A qualitative instrumental case study design was employed at One Maritime Academy during Academic Year 2024–2025. Participants included maritime students and faculty members with sustained engagement in technical writing and AI-assisted tools. Data were collected through semi-structured interviews and document analysis and analyzed using thematic analysis.

Results: Findings revealed that AI tools were used strategically rather than indiscriminately. Participants aligned specific tools with particular writing functions such as idea generation, structural support, and language refinement, while maintaining clear boundaries for convention-bound documents like log entries and incident reports. Key challenges included terminological inaccuracies, reduced authorship accountability, ethical ambiguity, and risks of superficial learning. These concerns emphasized the need for human verification, instructor guidance, and institutional support.

Conclusion: AI integration in maritime education is best understood as a matter of professional judgment rather than mere technological adoption. Effective and responsible use requires alignment with regulatory standards, explicit verification practices, and strong instructional mediation. The findings highlight the need for institutionally grounded frameworks that support ethical, pedagogically sound, and professionally accountable AI use in technical writing.

Keywords: *generative AI, maritime education, technical writing, professional judgment, STCW, regulated communication*

INTRODUCTION

Generative AI has moved with unusual speed from curiosity to routine academic support. In writing-intensive settings, students now use it to generate ideas, reorganize drafts, check grammar, paraphrase passages, and accelerate revision. Recent higher-education scholarship reflects both the attraction and the unease surrounding that shift. AI tools can widen access to language support and improve writing efficiency, but they also raise concerns about authorship, overreliance, shallow engagement, and the possibility that polished language may begin to stand in for disciplined thinking (Nguyen et al., 2024; Reeves & Sylvia, 2024; van Niekerk et al., 2025).

Most of that debate, though, still rests on a narrow assumption: that student writing is mainly academic in function. Essays, reflection papers, and course assignments dominate the literature. In those settings, writing is primarily a learning artifact. It demonstrates comprehension, argumentation, and language control, but it rarely serves as a document that might later be scrutinized for operational, legal, or compliance purposes. The present study examines a different environment altogether. In maritime education, written texts such as log entries and incident

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reports are not simply exercises in composition. They are professional records shaped by accountability, standardization, and safety-sensitive communication requirements (International Maritime Organization, 2025, 2026a, 2026b).

This distinction is especially important in the Philippine context. The Philippines remains one of the world's major suppliers of maritime professionals, and maritime higher education institutions carry a strong responsibility to prepare cadets not only for classroom assessment but also for shipboard documentation, international certification expectations, and compliance-oriented communication. Within Philippine maritime education, technical writing is therefore tied to institutional quality assurance, outcomes-based education, onboard training preparation, and alignment with international conventions. Students are not merely learning how to write well; they are learning how to document events, actions, observations, and decisions in ways that may later affect safety, accountability, and professional credibility.

That local reality changes the terms of AI integration. In a general academic essay, an imprecise but elegant sentence may still be tolerated if the larger argument remains understandable. In maritime technical writing, the same sentence may become a liability if it blurs the sequence of events, weakens traceability, softens responsibility, or introduces ambiguous terminology. Research on maritime communication risk increasingly underscores this concern. Standardized phraseology is intended to reduce misunderstanding, and recent studies indicate that lexical ambiguity, weak expression clarity, and misalignment with Standard Marine Communication Phrases may increase accident risk and compromise safety communication (Gabedava & Hu, 2025; International Maritime Organization, 2026b; Yin et al., 2024, 2025). The issue, then, is not simply whether AI can produce coherent text. The more serious question is whether AI-assisted output can remain faithful to the communicative discipline required in the maritime profession.

This study identifies this tension clearly. Participants distinguish between writing that may benefit from AI support and writing that must remain grounded in observation, equipment-derived data, or professional judgment. They do not reject AI outright. Instead, they place boundaries around it. That pattern suggests that AI use in maritime education is best understood not as adoption or resistance, but as negotiation within a regulated discourse environment. The study therefore addresses a meaningful gap in the literature: while AI-assisted writing has been widely discussed in higher education. This may be reviewed by instructors, assessors, shipboard supervisors, institutional quality assurance personnel, or regulatory bodies, much less is known about how it is actually used, constrained, and interpreted in safety- critical professional programs, particularly in maritime institutions where writing has both instructional and operational implications (Gabedava & Hu, 2025; Nguyen et al., 2024; Reeves & Sylvia, 2024; van Niekerk et al., 2025). This gap is particularly relevant for Philippine maritime schools, where curriculum design must balance global standards, local institutional policies, licensure and certification expectations, and the practical realities of preparing cadets for international shipboard environments.

The study makes the three contributions to the growing scholarship on AI-assisted writing in professional education. First, it offers a domain-specific account of AI-assisted writing in maritime education, with attention to the Philippine setting and to the institutional realities that shape cadet training. Second, it develops a theoretically grounded interpretation of selective AI use as a form of professional judgment rather than mere technological convenience. Third, it advances a curriculum and policy argument: maritime programs need explicit guidance on where AI may support writing, where it must be restricted, and how students should verify, revise, and take responsibility for AI-assisted technical documents. Such guidance can inform course outcomes, writing rubrics, assessment protocols, academic integrity policies, and faculty training in maritime higher education, particularly in a field where the functional consequences of writing are unusually high (Reeves & Sylvia, 2024; Verhulsdonck et al., 2024).

Review of Related Literature and Studies

This summarizes the pertinent literature and studies reviewed by the researcher to highlight the significance of the current investigation. It also provides a synthesis of the reviewed literature and studies, offering a comprehensive understanding of the topic.

Strategic AI use as an expression of professional judgement

The strategies reported by participants reveal a deliberate and discerning approach to AI use, closely mirroring patterns documented in higher education and technical communication research. Rather than relying on AI tools indiscriminately, participants described using them selectively, particularly during stages of writing that involve idea generation, organization, and surface-level language refinement. This practice aligns with a growing consensus that AI-assisted writing is most educationally beneficial when it functions as a cognitive support rather than as a substitute for disciplinary thinking or authorship (Rasul et al., 2023; Marzuki et al., 2023; Song & Wang, 2023).

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What distinguishes the present findings is the way strategic selectivity appears to be informed by an awareness of regulatory accountability. Similar to human-in-the-loop models proposed in technical communication literature, where AI contributes efficiency while humans retain responsibility for accuracy and final judgment (Verhulsdonck et al., 2024), maritime stakeholders in this study demonstrated an intuitive separation between supportive and authoritative writing tasks. Log entries and incident reports, in particular, were treated with heightened caution, reflecting their status as official records rather than purely academic exercises. This finding is directly reinforced by showing that AI-use strategies in maritime education are shaped by genre sensitivity and perceived risk, not merely by convenience or technological availability.

From a learning theory perspective, these practices are consistent with self-regulated and adult learning frameworks. Learners who actively evaluate AI-generated suggestions, decide which recommendations to accept, and revise content based on professional norms engage in the very metacognitive processes that support long-term competence (Zimmerman, 2002; Knowles et al., 2015). Empirical studies further confirm that such reflective engagement strengthens learning outcomes, whereas uncritical reliance on automation can weaken them (Chen & Gong, 2025; Singh et al., 2025). Viewed through a sociocultural lens, AI functions here as a mediational tool that supports learning through guided interaction rather than replacing cognitive effort (Vygotsky, 1978). The present findings, therefore, affirm that AI-assisted writing, when used strategically, can coexist with and even reinforce professional judgment.

Navigating regulatory, linguistic, and ethical constraints

Despite these strategic benefits, the study also highlights persistent challenges that maritime stakeholders must continually navigate. These challenges align closely with concerns raised in the literature regarding the limitations of generative AI in regulated and discipline-specific contexts. While AI systems are capable of producing fluent and coherent text, numerous studies caution that such fluency can obscure factual inaccuracies, terminological imprecision, or misalignment with domain conventions (Deraman, 2025; Khalifa et al., 2024). In maritime documentation, where precision and standardization are central to safety and compliance, these limitations carry particular weight.

Research on maritime communication offers a clear explanation for why such risks are amplified. The use of Standard Marine Communication Phrases and related conventions is intended to reduce ambiguity and mitigate human-factor risks by constraining linguistic variation (Frolova & Frolova, 2020; Kulikova, 2023). Quantitative and corpus-based studies further demonstrate that even minor deviations in wording or sequencing can contribute to communication failures and accident pathways (Zhi Lin Liu, 2025). Against this backdrop, participants' caution toward AI-generated paraphrasing and stylistic rewording appears well-founded. Tools designed to optimize linguistic variety or readability may inadvertently undermine the clarity and consistency demanded by international maritime conventions.

Ethical considerations further complicate AI use in this context. Across higher education, scholars have noted that ambiguous boundaries around acceptable AI assistance can blur authorship, complicate assessment, and foster dependency if left unaddressed (Hill & Hargis, 2024; Meishar-Tal, 2024). Scholars echo these concerns, emphasizing that AI integration is shaped by institutional policy clarity, digital literacy, and governance capacity (Doria, 2024; Co, 2025; Villarino, 2025). The present findings resonate strongly with this literature, as participants described an ongoing negotiation between leveraging AI for efficiency and preserving accountability in documents that may carry legal or operational implications. This is directly substantiated by demonstrating that pitfalls in AI use are structurally linked to the regulatory logic of maritime education rather than to individual misuse alone.

Toward a responsible and theoretically grounded framework

This called for identifying core principles that should underpin a framework for responsible AI integration in maritime technical writing. Synthesizing the study's findings with existing scholarship suggests that such a framework must be both pedagogically sound and regulatorily aligned. From a theoretical standpoint, constructivist and sociocultural perspectives emphasize that learning tools enhance understanding only when they mediate engagement rather than replace it (Bruner, 1966; Piaget, 1973; Vygotsky, 1978). The findings support this view by showing that AI contributes most meaningfully when learners remain actively involved in interpretation, verification, and decision-making.

Self-directed learning theory further reinforces the need for explicit guidance in AI use. Research demonstrates that when learners are trained to critically evaluate and regulate AI-generated content, metacognitive awareness and autonomy are strengthened rather than diminished (Topali et al., 2025; Salimi & Hajinia, 2024). In

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maritime education, where professional competence depends on sound judgment under conditions of uncertainty, this capacity is particularly essential.

Equally important is regulatory alignment. Maritime education operates within a framework of international conventions that govern not only what is taught but also how competence is documented and communicated. Studies on emerging technologies in maritime education consistently argue that innovation must preserve compliance with Standards of Training, Certification and Watchkeeping for Seafarers (STCW) requirements and standardized communication practices rather than dilute them (Campos Toresano et al., 2022; Meštrović et al., 2024; Yercan & Köseoğlu, 2023). The present findings extend this argument by illustrating that AI integration must be guided by explicit verification protocols, genre-sensitive guidelines, and faculty mediation to ensure that automation does not erode professional accountability.

Tool-specific implications further refine these principles. Generative tools such as ChatGPT and Gemini require clear checkpoints for verification and limits on autonomous generation of regulatory claims. Editorial tools such as Grammarly must be positioned as aids to surface accuracy rather than as indicators of conceptual correctness. Paraphrasing tools such as QuillBot demand especially careful regulation in standardized genres, where variation can compromise meaning. These distinctions highlight that responsible AI integration is not tool-neutral but context- and function-sensitive, echoing broader calls for human-centered AI governance in education (Verhulsdonck et al., 2024).

By examining AI-assisted writing within the specific context of maritime technical documentation, this study addresses a critical gap in existing research. While prior studies have explored AI use in general academic writing and examined emerging technologies in maritime education separately, few have investigated how AI tools are actually used in safety-critical maritime genres governed by international conventions. The present discussion demonstrates that AI-assisted writing in maritime education is best understood as a regulated professional practice shaped by pedagogical theory, linguistic standardization, and international maritime law.

In doing so, the study contributes to both scholarship and practice by reframing AI integration as a matter of professional judgment and institutional governance rather than technological adoption alone. It underscores that responsible AI use in maritime technical writing must be grounded in learning theory, ethical clarity, and regulatory fidelity, offering a coherent foundation for future curriculum development, policy formulation, and research in maritime education.

The body of literature reviewed converges on a central insight: artificial intelligence is most educationally meaningful when it is positioned as a supportive cognitive resource rather than an authoritative substitute for disciplinary thinking or professional authorship. Across higher education and language learning contexts, researchers consistently report that AI-assisted writing tools are most effective when they are used selectively for ideation, organization, and surface-level linguistic refinement, while responsibility for content accuracy and meaning-making remains firmly with the learner (Rasul et al., 2023; Marzuki et al., 2023; Song & Wang, 2023; Chen & Gong, 2025). The present study affirms this consensus but advances it by situating AI use within a safety-critical, regulation-bound professional domain, where selectivity is driven not only by pedagogical considerations but by professional judgment and accountability.

What distinguishes maritime technical writing from general academic writing, as reflected in both the literature and the findings, is the functional role of text itself. In conventional academic settings, written outputs often serve as learning artifacts, evaluated primarily for coherence, argumentation, and evidence use. In contrast, maritime documents such as log entries and incident reports function as operational and legal records, subject to audit, investigation, and regulatory scrutiny under international conventions such as the STCW. This distinction helps explain why participants in the study intuitively separated "supportive" writing tasks, where AI assistance was considered acceptable, from convention-governed documentation, where AI use was deliberately constrained. This practice resonates with human-in-the-loop models in technical communication, which emphasize that while AI may contribute efficiency, humans must retain authority over accuracy and judgment, particularly in high-stakes contexts (Verhulsdonck et al., 2024).

Maritime communication research provides further explanatory grounding for this restraint. Studies on Standard Marine Communication Phrases underscore that linguistic standardization is a safety mechanism rather than a stylistic preference, designed to minimize ambiguity and reduce human-factor risks at sea (Frolova & Frolova, 2020; Kulikova, 2023). Corpus-based risk analyses extend this argument by demonstrating how even minor lexical deviations can contribute to miscommunication and accident pathways (Liu et al., 2025). Within this framework, participants' reluctance to rely on AI for paraphrasing or stylistic variation in logbooks and reports appears not as resistance to innovation, but as a rational response to the communicative demands of a highly regulated profession.

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The fluency of AI-generated text, while advantageous in academic prose, becomes a potential liability when precision, traceability, and verifiability are non-negotiable.

From a learning theory perspective, the reviewed literature and the study's findings align strongly with self-regulated and adult learning frameworks. Research shows that learners who critically evaluate AI outputs, decide which suggestions to adopt, and revise content in light of disciplinary norms engage in metacognitive processes that support durable learning (Zimmerman, 2002; Knowles et al., 2015; Chen & Gong, 2025). In contrast, uncritical reliance on automation has been associated with surface learning and diminished writing self-efficacy (Bouzar et al., 2024). The participants' practices in this study reflect the former pattern. AI was used as a scaffold for understanding format, generating ideas, or polishing language, but its outputs were subjected to human verification, revision, and professional judgment. Viewed through a sociocultural lens, AI functions here as a mediational tool whose value is shaped by institutional norms, professional standards, and shared understandings of accountability (Vygotsky, 1978).

The maritime education literature further reinforces the necessity of this mediated approach. Studies examining emerging technologies in maritime training consistently argue that innovation must preserve competency standards and regulatory alignment, particularly as the sector navigates automation and digital transformation (Maghoromi, 2023; Campos Toresano et al., 2022; Meštrović et al., 2024). Rather than advocating unrestricted adoption, these works emphasize alignment with professional practice and international conventions. The present findings extend this argument by showing how AI integration is already being negotiated at the practitioner level, guided by learners' and instructors' awareness of documentation risk, professional responsibility, and convention literacy.

Pedagogically, research in maritime and task-based instruction provides important context for understanding why AI is perceived as helpful for certain functions but insufficient on its own. Learners in maritime programs consistently report challenges related to genre familiarity, technical vocabulary, and procedural conventions, particularly in writing tasks that differ substantially from general academic essays (Andiansyah et al., 2025; Heslop et al., 2024). AI-generated templates and examples can therefore serve as useful orientation tools, helping learners grasp structural expectations. However, both the literature and the present study emphasize that such support must be accompanied by expert validation, as AI lacks the experiential knowledge and situational awareness required to ensure regulatory accuracy.

Ethical scholarship on generative AI further clarifies why governance and boundary-setting emerge as recurring themes. Researchers argue that ambiguity surrounding acceptable AI use blurs authorship, complicates assessment, and risks fostering dependency if left unaddressed (Hill & Hargis, 2024; Meishar-Tal, 2025). In regulated professional education, these ethical concerns are inseparable from questions of accountability. The findings illustrate that maritime stakeholders do not simply worry about plagiarism or detection, but about whether AI-assisted text can be defended as professionally authentic and compliant. This reinforces the argument that responsible AI integration must be institutionally guided, theoretically grounded, and discipline-sensitive rather than left to individual discretion.

The reviewed literature and the present findings converge on a reframing of AI-assisted writing in maritime education. Rather than a neutral productivity tool, AI emerges as a regulated pedagogical aid whose legitimacy depends on task type, genre function, and professional consequence. The synthesis underscores that responsible AI use in maritime technical writing is best understood as an expression of professional judgment, shaped by learning theory, linguistic standardization, and international regulatory frameworks. This perspective extends current AI-in-education scholarship by demonstrating that, in safety-critical domains, the primary constraint on AI use is not technological capability but the functional role of writing itself. Such insights provide a coherent foundation for curriculum design, policy formulation, and future research that seeks to integrate AI without undermining professional standards or regulatory fidelity.

Theoretical Framework

Constructivist Learning Theory, associated with Jean Piaget and Jerome Bruner, explains learning as an active process in which individuals construct meaning through engagement, reflection, and revision rather than through passive reception of information. In the context of AI-assisted writing, this perspective is especially relevant because students do not simply receive text from AI tools but must evaluate, interpret, and reshape the outputs to meet task requirements. These findings reinforce the constructivist position that learning occurs through thoughtful interaction with tools and content, positioning AI as a cognitive support rather than a substitute for thinking.

Sociocultural Theory, developed by Lev Vygotsky, views learning as a socially situated process mediated by tools, norms, and institutional expectations. From this perspective, AI tools used in academic and technical

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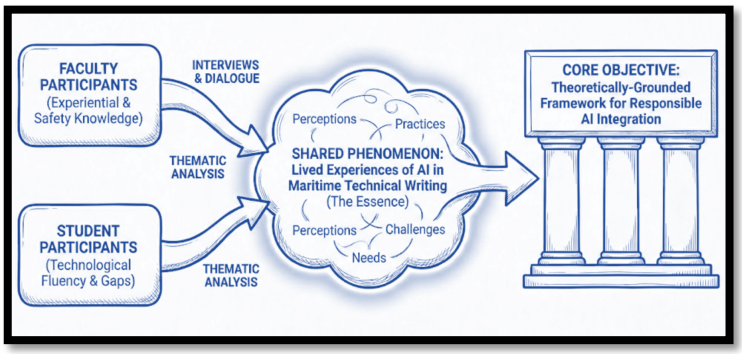
writing are not neutral technologies but cultural artifacts that operate within regulated educational and professional environments. Research has consistently shown that the value and risks of AI in writing depend on how these tools are embedded in instructional and institutional contexts, aligning closely with sociocultural theory, confirming that AI-assisted writing must be understood as a practice situated within broader regulatory and professional frameworks.

Self-Directed Learning Theory, articulated by Malcolm Knowles, highlights learners' capacity to take responsibility for their own learning by setting goals, selecting resources, and evaluating outcomes. AI writing tools provide learners with readily accessible support for drafting, revising, and refining texts, but their effectiveness depends on how thoughtfully they are used. In this sense, AI becomes a resource that supports autonomy rather than undermines it, provided that learners remain critical.

These theories and supporting studies explain how learners construct meaning through interaction with AI tools, how institutional and professional contexts shape acceptable use, and how individual agency governs responsible engagement. This integrated theoretical foundation provides a strong lens for examining AI-assisted writing in maritime technical communication.

Conceptual Framework

Figure 1
Research Paradigm



The research paradigm illustrated in this study serves as a visual map of how raw human experience is transformed into a structured, theoretically grounded framework for maritime education. At its core, this paradigm illustrates the journey from the subjective, lived realities of students and instructors to an objective, actionable guide that ensures safety and compliance in a high-stakes profession.

The process begins on the left side of the paradigm with the primary data source: the participants. These two distinct groups represent the converging forces within the classroom. On one hand, the faculty participants contribute the essential elements of experiential knowledge and safety consciousness. They act as custodians of maritime standards, viewing Artificial Intelligence (AI) through the lens of international regulations such as the STCW. On the other hand, the student participants bring technological fluency but also reveal significant competence gaps. While they are adept at using tools for convenience, their input exposes the critical "gap" between generating text and understanding its operational accuracy. These two groups are not merely data points; they are the active agents whose interactions define the reality of AI use in maritime technical writing.

Moving to the center of the diagram, the arrows converge into a "cloud" representing the shared phenomenon. In this research, the cloud symbolizes the complex, often messy lived experiences of participants as they navigate the use of AI in real time. This is where the study captures the stakeholders' actual perceptions, practices, challenges, and needs. It encompasses students' struggles with maritime terminology, instructors' concerns about fabricated citations, and the collective uncertainty about ethical boundaries. However, this chaotic mix of experiences does not immediately become a framework. It must first pass through the rigorous filter of Thematic Analysis. Through this analytical process, the researcher distills the "essence" of the phenomenon, separating mere noise from the critical truths that define the problem.

Finally, the arrow emerging from the cloud points to the study's ultimate output: the Theoretically-Grounded Framework for Responsible AI Integration. The diagram depicts this as a solid structure supported by pillars, representing the stability and order required in the maritime profession. This framework is not a theoretical

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abstraction but a direct response to the needs identified in the central cloud. It stands on pillars where instructors shift from being mere information providers to expert validators.

Statement of the Problem

The rapid integration of artificial intelligence (AI) in educational settings has significantly transformed writing practices, particularly in higher education. While AI-assisted writing tools offer benefits such as improved efficiency, language support, and idea generation, they also introduce critical pedagogical and professional concerns, including issues of authorship, overreliance, shallow learning, and ethical ambiguity. These concerns become more complex in professional programs such as maritime education, where technical writing serves not only as a learning activity but also as a form of safety-critical and regulation-bound communication.

In maritime technical documentation, such as log entries and incident reports, accuracy, standardization, and traceability are essential due to their operational, legal, and safety implications. The use of AI in such contexts raises important questions regarding its appropriateness, reliability, and alignment with international maritime conventions. Despite the growing body of research on AI-assisted writing in general academic contexts, there remains limited understanding of how AI tools are used, interpreted, and regulated within safety-critical professional education.

Furthermore, there is a lack of clear institutional guidelines and pedagogical frameworks that define responsible AI use in maritime technical writing. This gap places both students and instructors in a position where they must rely on informal judgment rather than structured guidance, potentially compromising both learning outcomes and professional standards.

Given these challenges, there is a need to systematically examine how AI-assisted writing tools are utilized in maritime education, identify the risks and limitations associated with their use, and develop principles that can guide responsible, ethical, and pedagogically sound integration of AI in technical writing.

Research Objectives

General Objective

To examine the use, limitations, and responsible integration of AI-assisted writing tools in maritime technical documentation.

Specific Objectives

1. To identify the strategies employed by maritime students and instructors in using AI-assisted writing tools for technical documentation.
2. To determine the pitfalls associated with AI use in relation to international maritime conventions and professional standards.
3. To develop core principles for a theoretically grounded framework that supports responsible and effective AI integration in maritime technical writing.

Research Questions

1. What strategies do the research participants in One Maritime Academy employ in using AI-assisted writing tools for maritime technical documentation?
2. What pitfalls in AI use concerning international maritime conventions do they constantly navigate?
3. What core principles of a theoretically grounded framework should be embodied in the emergent research framework to ensure responsible and effective AI integration into maritime technical writing?

Methodology

Research Design

This study employs a qualitative instrumental case study design to investigate how AI-assisted writing tools are used, constrained, and evaluated within maritime technical documentation at One Maritime Academy. The case is bounded by institution, participant group, time frame, and task type: Academic Year 2024 - 2025, senior maritime students and experienced maritime instructors, and two convention-governed genres, namely log entries and incident reports. The design is instrumental because the academy is not treated as an end in itself. Rather, it serves as an analytically useful site through which a broader issue can be examined: the integration of AI-assisted writing in a professional learning environment where writing has regulatory and operational consequences.

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A qualitative approach was appropriate because the research questions focus on strategies, judgments, concerns, and emergent principles rather than on measurement or causal inference. The study sought to understand how participants interpret acceptable AI use in relation to maritime writing tasks, how they negotiate perceived benefits and risks, and how those negotiations are shaped by institutional and professional expectations. Such questions are best addressed through context-sensitive inquiry rather than decontextualized metrics

Population and Sampling

Participants were selected purposively. Faculty participants were instructors in Maritime Training Program 1 and Maritime Training Program 2 with extensive professional backgrounds, including substantial sea service and several years of teaching experience in maritime education. Student participants were senior students in Maritime Transportation and Marine Engineering programs who regularly used AI tools such as ChatGPT, Gemini, Grammarly, and QuillBot at different stages of writing. This participant profile ensured that all respondents had direct, sustained engagement with both maritime technical writing and AI-assisted support within a common instructional environment.

The case is deliberately bounded by place, time, participants, and task, in accordance with established case study design principles (Yin, 2018). The setting is confined to One Maritime Academy during Academic Year 2024 - 2025. Participants are bounded to four (4) senior maritime students and six (6) faculty members directly involved in Maritime Training Program 1 and Maritime Training Program 2, ensuring that all data are grounded in shared curricular structures, instructional expectations, and professional standards. The phenomenon under investigation is further delimited to AI-assisted writing practices related to two high-stakes maritime genres, log entries and incident reports, both of which are governed by international maritime conventions and carry significant implications for safety, accountability, and regulatory compliance.

Research Instruments

The primary instrument for data collection was a semi-structured interview protocol designed to elicit the participants' strategies, challenges, and judgment-based practices in using AI-assisted writing tools for maritime technical documentation. The protocol was developed in alignment with the study's research questions and was organized around key areas such as AI-supported writing strategies, perceived risks in convention-bound documentation, ethical use, verification practices, and recommendations for responsible integration in maritime education. Consistent with the use of interview protocols in qualitative inquiry, the instrument contained predetermined questions and follow-up prompts to ensure consistency across participants while still allowing sufficient flexibility for deeper probing and the emergence of unanticipated insights (Roberts, R.E. 2020; Ruslin et al., 2022).

To establish content validity, the interview protocol underwent expert validation by three (3) validators composed of specialists in maritime education, technical writing, qualitative research, and/or AI-assisted learning. The validators examined each item in terms of relevance, clarity, alignment with the research objectives, appropriateness to the maritime context, and capacity to generate meaningful qualitative data. Their evaluations were quantified using the Content Validity Index (CVI)**.** Items were considered acceptable when they met the recommended minimum threshold of I-CVI = 0.78 or higher for item-level validity and S-CVI/Ave = 0.90 or higher for overall scale validity. The protocol was subjected to pilot testing with 5 non-participant respondents who shared characteristics similar to the target participants but were not included in the final data collection. The pilot testing helped determine whether the questions were understandable, logically sequenced, and capable of eliciting responses relevant to maritime technical writing and AI use. Feedback from both the expert validators and pilot participants was used to refine the wording, remove possible ambiguity, improve the order of questions, and ensure that the protocol could capture participants' actual experiences without leading or limiting their responses. Through expert validation, CVI computation, and pilot testing, the final interview protocol was strengthened as a credible and context-sensitive instrument for exploring responsible AI integration in maritime technical documentation.

Data Collection

Data were collected through semi-structured interviews and document review. Prior to the actual data gathering, institutional permission was secured from One Maritime Academy, and eligible participants were invited based on the inclusion criteria established for the study. The purpose of the research, the voluntary nature of participation, confidentiality measures, and the right to withdraw were explained to each participant before informed consent was obtained.

The interviews were conducted either face-to-face or through an online meeting platform, depending on the availability and preference of the participants. Each interview lasted approximately 30 to 60 minutes. With the consent of the participants, interviews were audio-recorded to ensure accuracy in transcription. When recording was not

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preferred or when clarification was needed during the exchange, supplementary field notes were taken to capture relevant observations, key expressions, and contextual details.

The semi-structured interview protocol guided the data-gathering process while allowing participants to elaborate on their experiences, examples, and concerns. Faculty participants were asked about their observations of students' AI-assisted writing practices, documentation standards, verification expectations, and professional concerns related to maritime technical communication. Student participants were asked about the AI tools they used, the stages of writing in which these tools were applied, the difficulties they encountered, and the ways they checked or revised AI-generated outputs.

In addition to interviews, selected student writing outputs and relevant instructional materials were reviewed to provide contextual support for the participants' responses. These documents were not treated as independent measures of performance but as supplementary qualitative data that helped clarify how AI-assisted writing practices appeared in actual maritime writing tasks. All interview recordings, transcripts, notes, and documents were organized securely and anonymized before analysis.

Treatment of Data

The data were analyzed through a systematic thematic analysis process, which enables the identification of recurring patterns of meaning across participant groups while remaining anchored in the study's theoretical framework, following Braun and Clarke's six-phase approach (Braun & Clarke, 2006; Braun & Clarke, 2021). This method was selected because it offers enough structure to support rigor while remaining flexible enough to capture recurring patterns of meaning across participant groups (Bowen, 2009; Creswell & Poth, 2018). Coding focused on how participants described AI use across writing stages, how they differentiated between writing tasks, what kinds of linguistic or ethical problems they identified, and what principles appeared to guide or justify their decisions. Within this design, multiple qualitative data sources are integrated to enhance analytic depth and credibility through triangulation.

The first phase involved familiarization with the data through repeated reading of transcripts and review of supporting documents. Initial notes were made to identify significant statements related to AI use, maritime documentation, ethical concerns, and instructional guidance. In the second phase, preliminary codes were generated from meaningful segments of the data. These codes captured patterns such as selective AI use, tool-specific functions, terminological inaccuracies, instructor validation, overreliance, and safety-related caution. The third phase involved organizing related codes into potential themes. These themes were reviewed and refined in the fourth phase to ensure that they accurately represented the data and remained aligned with the research objectives. In the fifth phase, the final themes were defined and named according to their conceptual relevance to the study. The sixth phase involved writing the analysis in a manner that connected participants' experiences with the theoretical framework and related literature.

Ethical Considerations

Ethical safeguards were observed throughout the study. Institutional permission was obtained prior to data collection. Participation was voluntary, informed consent was secured, confidentiality was maintained, and participants were informed of their right to withdraw at any time without penalty. These protections were especially important because the topic intersects with assessment, authorship, and professional standards, all of which can produce hesitation if participants are not assured that their responses will be handled responsibly.

RESULTS and DISCUSSION

Strategies employed in using AI-assisted writing tools for maritime technical documentation

The analysis yielded three interrelated findings. First, participants used AI strategically rather than indiscriminately, matching different tools to different writing functions. Second, they drew clear boundaries around when AI use was acceptable, especially in relation to convention-bound documents that require observational accuracy and traceable authorship. Third, their reliance on informal vigilance and instructor consultation pointed to the need for a more explicit institutional framework for responsible AI integration (Nguyen et al., 2024; van Niekerk et al., 2025).

A consistent pattern across the data is that AI is not approached as a single, all-purpose writing solution. Participants distribute writing tasks across multiple tools. Grammar and surface correctness are commonly delegated

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to editing platforms. Idea expansion, examples, and structural support are often sought from generative tools. Paraphrasing or rewording, meanwhile, is handled by still another class of applications. This differentiated use suggests more than familiarity. It points to an emerging form of functional AI literacy in which students recognize that the value of a tool depends on the nature of the task it is being asked to perform.

This matters because it complicates common narratives about student dependence. The data do not support a simple picture of students handing their writing over to automation in a uniform way. Instead, students appear to be segmenting the writing process, assigning bounded roles to bounded tools. That does not eliminate risk, but it does show that many participants are already thinking in terms of limits. From a constructivist perspective, this is significant. AI becomes part of a process of mediated composition rather than a substitute for thinking. Learners remain involved in selecting, rejecting, combining, and reshaping outputs, which is consistent with the view that knowledge develops through active engagement rather than passive reception. That interpretation is consistent with recent higher-education work showing patterned forms of human-AI collaboration rather than uniform automation of authorship (Nguyen et al., 2024; van Niekerk et al., 2025).

At the same time, the finding should not be romanticized. Functional differentiation is not the same as deep critical literacy. A student may know which tool produces the cleanest sentence and still fail to question whether that sentence is technically appropriate. Still, this pattern is a meaningful starting point. It shows that the issue is not use versus non-use, but whether use is sufficiently disciplined by the communicative demands of the profession.

Pitfalls in AI use concerning international maritime conventions

One of the most compelling findings in the study is the boundary participants draw between different kinds of writing. Log entries, weather observations, and routine operational records are consistently treated as inappropriate sites for AI assistance. Reports, longer explanations, and research-oriented writing are treated differently. They may still invite caution, but they are regarded as more open to support in brainstorming, organization, and language refinement.

This distinction reveals that participants are not evaluating AI in generic terms. They are evaluating it through the epistemic status of the text. Some documents are interpretive and developmental; others are evidentiary. In the latter case, the core requirement is not simply coherence but fidelity to observation, equipment-derived data, and standardized procedure. That finding coheres with STCW's competence-centered logic and with the broader maritime communication literature emphasizing precision, standardization, and accountability (Gabedava & Hu, 2025; International Maritime Organization, 2025, 2026a, 2026b; Yin et al., 2024, 2025).

The importance of this boundary becomes clearer when read alongside the maritime safety literature. Communication failures remain a significant contributor to maritime incidents, and lexical ambiguity has been identified as a particularly influential factor in accident pathways (Yin et al., 2024, 2025). In such contexts, the main risk of AI is not that it produces awkward language. It is that it may produce fluent language that sounds authoritative while drifting away from the precision demanded by regulated communication. The present study suggests that participants already sense this problem. Their selective restraint is therefore better understood as situated risk management than as mere technological conservatism.

Another recurring theme in the data is the importance of prompt formulation. Participants describe checking the "right prompt" before using AI, particularly when the task involves analysis, explanation, or format support. This reflects a growing awareness that AI outputs are contingent rather than autonomous. The usefulness of the response depends, at least in part, on how the task is framed.

Prompting, however, is only one layer of control. Participants also emphasize verification. They cross-check AI outputs against prior knowledge, instructor guidance, maritime terminology, and expected reporting conventions. This becomes especially important when dealing with acronyms, technical vocabulary, and standardized expressions. In other words, the workflow does not end when AI produces a paragraph. It continues through interpretation, correction, and judgment. That pattern aligns with self-directed learning theory, which emphasizes planning, monitoring, and evaluative control as central dimensions of learning (Knowles et al., 2015; Zimmerman, 2002).

Still, the findings also reveal the fragility of purely individual regulation. Not all students verify with the same care. Faculty accounts suggest that some outputs remain shallow, overly derivative, or insufficiently reflective. There is evidence that AI can encourage convenience at the expense of depth when students lack strong disciplinary grounding. This makes instructor mediation indispensable. In the present context, instructors are not simply content experts or assessors. They function as validators of what counts as acceptable writing support in a safety-critical field. This pattern aligns with self-directed learning perspectives that emphasize planning, monitoring, and evaluative control, and with emerging technical communication scholarship that argues for explicit human judgment in AI-assisted content development (Knowles et al., 2015; Verhulsdonck et al., 2024; Zimmerman, 2002).

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Participants and faculty consistently report that AI struggles with maritime terminology, specialized acronyms, and standardized phraseology. This is a decisive finding. It shows that the central problem of AI-assisted writing in this context is not poor surface fluency. Often, the opposite is true. The output is readable, grammatically smooth, and formally plausible. The problem is that this fluency can conceal technical drift. A sentence may sound professional while remaining terminologically imprecise or operationally misleading.

This condition may be described as fluency without fidelity. It captures a risk that is particularly acute in maritime communication, where standardized language is not a stylistic preference but a safety mechanism. General writing pedagogy often values variation, elegance, and stylistic flexibility. Maritime technical writing does not always reward those qualities. In many instances, stability, consistency, and terminological discipline matter more. AI-generated paraphrasing may therefore improve an academic paragraph while weakening a convention-bound report.

This finding reinforces the argument that responsible AI use cannot be judged solely by whether a text reads well. The more relevant question is whether the text remains aligned with domain-specific communicative expectations. Recent maritime risk studies support this concern by linking lexical ambiguity and weak phraseological alignment to accident pathways and miscommunication risk (Gabedava & Hu, 2025; International Maritime Organization, 2026b; Yin et al., 2024, 2025). In regulated environments, textual plausibility is not enough. Meaning must remain professionally accountable.

Core principles of Theoretically grounded framework

The final major finding concerns what participants believe is still missing. Students and instructors do not call for a blanket prohibition on AI. Nor do they argue that unrestricted use is desirable. What emerges instead is the need for clearer institutional guidance: explicit distinctions between acceptable and unacceptable use, mandatory verification expectations, clearer treatment of AI as a tool rather than a source, and more visible pedagogical roles for instructors in monitoring and validating writing support. This implication is also supported by broader scholarship on AI in academic writing and technical communication, which increasingly argues that ethical and effective use depends on governance, transparency, and human-centered oversight rather than tool access alone (Reeves & Sylvia, 2024; van Niekerk et al., 2025; Verhulsdonck et al., 2024).

This is where the study's framework contribution becomes especially important. At present, many of the participants' responsible practices remain informal. They rely on instinct, prior professional knowledge, and case-by-case caution. That is valuable, but it is not enough for a field in which documentation can carry safety and compliance implications. Institutional governance is needed as a meso-level structure between broad international regulation and individual classroom practice. Without it, the burden of responsible use falls too heavily on uneven personal judgment.

Theoretically, this point allows the study to synthesize its three learning lenses. Constructivism explains why students need to remain active interpreters rather than passive receivers of AI output (Bruner, 1966; Piaget, 1973). Sociocultural theory explains why writing practices are shaped by disciplinary norms, institutional rules, and professional expectations (Vygotsky, 1978). Self-directed learning theory explains why effective AI use depends on planning, monitoring, and restraint (Knowles et al., 2015; Zimmerman, 2002). These perspectives support a clear conclusion: responsible AI integration in maritime education is not primarily a matter of access to tools. It is a matter of guided participation in a regulated communicative practice.

The findings carry direct implications for curriculum development, educational leadership, and policy-making in maritime education. At the curriculum level, AI-assisted writing should not be treated as a generic digital skill but as a discipline-specific competence embedded in maritime technical communication courses. Course outcomes, writing rubrics, and assessment tasks may explicitly distinguish between permissible AI-supported activities, such as brainstorming, outlining, and grammar refinement, and restricted tasks, such as generating log entries, incident reports, or convention-bound statements without verification. For educational leaders, the findings point to the need for coordinated faculty development, shared validation practices, and institutional mechanisms that help instructors guide AI use consistently across programs. At the policy level, maritime institutions may develop clear AI-use guidelines that define acceptable assistance, required disclosure, verification protocols, and accountability measures. These implications suggest that responsible AI integration should be governed not only by individual teacher discretion but by curriculum structures, leadership support, and institutional policies aligned with professional and regulatory standards.

Conclusions

This study offers a grounded and integrative understanding of AI-assisted writing in maritime education by drawing together participants' strategies, challenges, and articulated needs across the three Statements of the Problem.

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First, the maritime students and educators employ AI-assisted writing tools through selective, purposeful, and professionally informed strategies. AI is positioned as a supportive aid for idea development and linguistic refinement rather than as a substitute for authoritative writing. At the same time, participants explicitly draw boundaries around safety-critical documentation. These practices suggest that AI use in maritime writing is already being regulated informally by professional norms, reflecting sociocultural alignment with maritime standards and constructivist engagement in task-appropriate tool selection.

Second, the stakeholders continue to navigate significant pitfalls in AI-related risks through heightened vigilance rather than avoidance. Persistent terminological and factual inaccuracies, particularly in relation to SOLAS, GMDSS, and STCW-aligned content, compel users to adopt verification behaviors and instructor consultation. Alongside accuracy issues, participants openly acknowledge the cognitive and ethical risks of over-reliance. These accounts support a broader conclusion that AI's pedagogical value is contingent on guided use; without such guidance, the tool risks undermining constructivist learning processes and self-directed regulation essential to maritime competence.

Third, the findings point to the need for a formally articulated, theoretically grounded AI integration framework. Participants consistently frame this need as a safeguard rather than a restriction, emphasizing clarity, ethics, and safety. Participants further underscore the centrality of human expertise and that instructors play a critical role in determining whether the information that the AI has given people is reliable or not. This reinforces a sociocultural view of instructors as custodians of disciplinary norms and a self-directed learning perspective that highlights the necessity of scaffolding learners' regulatory capacities through institutional support.

Recommendations

Based on the conclusions of the study, the following recommendations are proposed as part of a coherent course of action to ensure responsible, pedagogically sound, and context-appropriate integration of AI-assisted writing in maritime education. These recommendations are grounded in participant experiences and articulated needs, and they reflect the realities of a safety-critical, regulation-driven learning environment.

First, the institution may develop and institutionalize a formal AI-Assisted Writing Guide specifically tailored to maritime technical communication. Participants consistently emphasized that the absence of clear guidance generates confusion rather than flexibility. Such a guide would function as a shared sociocultural reference point, aligning AI use with professional norms and regulatory accountability.

Second, task- contingent AI use may be explicitly embedded into course design and assessment guidelines. Formalizing this distinction at the curriculum level would legitimize students' existing professional judgment while preventing misuse in safety-critical documentation. From a constructivist standpoint, this recommendation supports meaningful learning by ensuring that AI augments, rather than replaces, cognitive engagement where judgment and interpretation are required.

Third, AI integration may be formally taught as part of the writing process, emphasizing AI use during brainstorming and linguistic refinement while reinforcing human responsibility for verification and final decision-making. Instructional modeling of this phased approach would help students internalize AI as a scaffold rather than a shortcut, strengthening constructivist learning and reducing the risk of passive dependence.

Fourth, the institution may institutionalize mandatory verification and cross-checking protocols for all AI-assisted outputs, particularly those involving technical terminology, regulations, and numerical data. Embedding verification steps into writing tasks, such as requiring references to manuals, instructor validation, or annotated justifications, would transform these risks into opportunities for deeper learning and reinforce professional accountability.

Fifth, AI literacy, critical evaluation, and ethical authorship may be included as explicit learning outcomes in maritime communication and technical writing courses. Reflective components, process documentation, and authorship declarations may be incorporated into assessments. This would support self-directed learning by strengthening students' capacity to plan, monitor, and evaluate their own AI use responsibly.

Sixth, the institution should strengthen the pedagogical role of instructors as validators, ethical guides, and professional role models rather than positioning them as mere detectors of AI use. Professional development programs should therefore equip instructors not only with technical AI skills but also with strategies for modeling verification, ethical judgment, and reflective practice.

Finally, the institution may implement sustained and inclusive training programs for all stakeholders, including students, faculty, and administrators. Such training should address not only how to use AI tools but also their limitations, ethical implications, and alignment with maritime regulations. Such training would directly support self-

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directed learning by providing learners with the scaffolding necessary to regulate their use of powerful technologies over time.

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