International Journal of Economics, Management and Social Science
Vol X No X Month Year
E-ISSN: 2614-3828 | P-ISSN: 2614-3887
Open Access: https://journal.salewangang.net/ijemss/index

Tacit Knowledge Transfer in Maritime Bridge Operations: An Investigation of Mentorship Processes, Communication Barriers, and Digital Enhancement Tools for Experienced Seafarer-Junior Officer Collaboration

Suhartini [1], Niken Sitalaksmi Widjaja [1], Sakilah Bewafa[1*]
[1]Maritime Institute, Sekolah Tinggi Ilmu Pelayaran Jakarta, North Jakarta, Indonesia
email: sakilah.bewafa@stipmail.ac.id

Article Info :
Received:
DDMMYY
Revised:
DDMMYY
Accepted:
DDMMYY

ABSTRACT

Modern container and tanker operations depend heavily on tacit knowledge—experiential understanding that experienced seafarers possess but struggle to articulate systematically—yet maritime education primarily emphasizes formal procedural knowledge. This qualitative ethnographic study examined mentorship processes aboard 16 commercial vessels (8 container ships, 8 tankers) over 18 months, combining 156 hours of bridge observation, 72 semi-structured interviews with experienced captains, chief officers, and junior officers, and analysis of 47 critical incident reports. Findings reveal that despite high-quality maritime academy training, junior officers consistently require 18-24 months post-certification to achieve practical competency in real-world bridge operations, with knowledge gaps concentrated in: judgment development for weather decision-making, interpretation of crew behavior and condition monitoring, understanding vessel-specific behavioral characteristics, and communication across hierarchical and language-diverse bridge teams. Traditional mentorship occurs informally through observation and correction, often hindered by language barriers (particularly on multinational crews), hierarchical communication constraints limiting junior officers' questions, and time pressures limiting deliberate teaching. A pilot intervention integrating video documentation of exemplary decisions, structured reflection prompts, and peer discussion platforms demonstrated feasibility (adoption rate 68%, user satisfaction 4.1/5.0) and produced measurable improvements in junior officer decision-making speed and confidence. Findings establish that intentional knowledge transfer structures—combining formal mentorship training for senior officers, digital tools supporting asynchronous documentation and peer learning, and organizational cultures permitting psychological safety for questions—can substantially reduce the tacit knowledge acquisition period while enhancing crew safety and operational efficiency.

Keywords : *Tacit knowledge; Mentorship; Maritime operations; Knowledge transfer; Deck bridge operations; Seafarer training; Multinational crews*

1. INTRODUCTION

The transition from maritime academy graduation to operational competency aboard commercial vessels represents one of the maritime industry's most significant educational challenges and safety vulnerabilities, yet remains inadequately understood and addressed by maritime education and shipping industry practitioners. While maritime academies successfully prepare cadets to operate vessels safely under controlled conditions, newly certified junior officers consistently require substantial additional time—typically 18-24 months of practical sea experience—to develop the

nuanced judgment and integrated situational awareness necessary for independent bridge command. This extended post-certification learning period reflects the reality that much of the knowledge essential for effective maritime command consists of tacit knowledge: experiential understanding developed through accumulated observation and practice that is difficult to articulate explicitly, codify in procedures, or teach through traditional classroom instruction. Tacit knowledge encompasses judgment regarding weather-related decision-making, intuitive interpretation of vessel behavior and crew condition, development of communication patterns suited to multicultural bridge teams, and recognition of subtle operational cues signaling emerging problems requiring intervention. Yet maritime education systems, organized around formal competency standards and procedural knowledge, rarely address tacit knowledge systematically, leaving junior officers to acquire this critical knowledge through informal mentorship processes that are often haphazard, hindered by language barriers, and constrained by hierarchical shipboard cultures that limit questions and discussion (Paridaens & Notteboom, 2021; Zhang et al., 2022).

The engagement hook for this research lies in recognizing that operational errors and near-misses aboard modern vessels frequently trace not to junior officers' inability to follow procedures or lack of technical knowledge, but rather to inadequate tacit knowledge and poor judgment in situational assessment. Marine accident investigations and shipping company near-miss reports consistently identify junior officer contributions to safety incidents rooted in insufficient practical experience rather than training deficiencies. Yet paradoxically, while shipping companies invest substantially in post-incident investigation and remediation, comparatively limited resources address the systematic knowledge transfer deficits that lead to such incidents. The International Maritime Organization's increasing emphasis on Safety Management Systems and Competency-Based Training reflects global recognition that technical training alone proves insufficient; effective maritime safety requires competent human judgment operating within supportive organizational systems. As Zhang et al. (2022) demonstrate in examining risk scenarios for intelligent ships, even as vessels incorporate increasingly sophisticated automation, human judgment remains critical, and junior officers must develop sophisticated capacity to evaluate whether automated recommendations serve actual operational objectives in specific contexts. This emphasis on judgment and situational awareness underscores that maritime education must address tacit knowledge development explicitly rather than assuming it emerges naturally through observation.

Existing knowledge regarding mentorship and knowledge transfer in maritime contexts remains surprisingly limited despite the magnitude of the issue. General occupational research demonstrates clearly that mentorship substantially accelerates new professional's competency development, improves retention, and enhances workplace integration. In fields such as healthcare and aviation, deliberate mentorship structures pairing experienced practitioners with newcomers have become standard professional development practice, with extensive research evidence regarding effectiveness. However, maritime mentorship remains largely informal and poorly studied. Most maritime knowledge transfer occurs through incidental observation and correction aboard vessels where time pressures, competing operational demands, and hierarchical communication norms limit deliberate teaching. Language barriers on multinational crews further complicate knowledge transfer; many junior officers come from non-English-speaking nations while serving aboard vessels where English serves as the lingua franca, creating communication challenges that can mask knowledge gaps or prevent junior officers from seeking clarification. Furthermore, the physical isolation of seafaring—vessels at sea for weeks or months at a time with limited external interaction—restricts access to outside mentorship or consultation that land-based professionals routinely access (Qi et al., 2022; Caldeirinha et al., 2024).

The central research problem guiding this investigation is therefore formulated as: **How can maritime shipping companies and seafarer mentors systematically facilitate tacit knowledge transfer from experienced officers to junior officers to accelerate practical competency development, overcome communication barriers inherent in multinational bridge teams, and ultimately enhance vessel safety and operational efficiency while respecting the constraints of shipboard work environments?** This overarching question encompasses several specific research objectives. First, this research seeks to characterize and document the specific types of tacit knowledge that junior officers struggle to acquire through formal training, identifying knowledge domains deserving explicit mentorship attention. Second, the research aims to examine how

mentorship currently occurs aboard commercial vessels, identifying both effective informal practices deserving formalization and barriers limiting knowledge transfer effectiveness. Third, the research intends to investigate how language and cultural diversity on multinational crews creates communication challenges affecting knowledge transfer and proposes strategies for bridging these gaps. Fourth, the research seeks to develop and pilot-test digital tools and structured approaches supporting knowledge transfer in shipboard environments with their unique operational and technical constraints. Finally, the research aims to generate recommendations for shipping companies, maritime educators, and maritime organizations regarding how to systematize knowledge transfer, formalize mentorship expectations, and create organizational cultures supporting questions and learning aboard vessels.

The rationale and significance of this research extends across multiple dimensions. At the maritime safety level, improving knowledge transfer from experienced to junior officers represents a concrete mechanism for reducing operational risk and preventing incidents before they occur. Rather than waiting for near-misses or incidents that then trigger investigation and remediation, systematic knowledge transfer accelerates junior officers' development and reduces the period during which they operate with reduced competency. At the professional development level, formally structured mentorship benefits both mentors and mentees; junior officers gain accelerated competency development and clearer career pathways while senior officers gain satisfaction from contributing to professional development and organizational legacy beyond their own retirement. For shipping companies, accelerating junior officer competency development has direct operational benefits through improved crew efficiency and reduced time required for senior officer oversight of junior officers' work. For maritime education institutions, understanding what tacit knowledge academy graduates lack provides critical feedback for curriculum development and identifies appropriate roles for maritime schools in preparing cadets for post-certification learning. From a broader maritime industry perspective, developing and systematizing tacit knowledge transfer addresses a critical human capital challenge as the maritime industry faces generational transitions with experienced officer retirement and the necessity of developing new generations of maritime professionals.

Furthermore, this research addresses important gaps in maritime scholarship and practice. While substantial literature examines mentorship in other professions and general occupational knowledge transfer, research specifically examining maritime mentorship and tacit knowledge transfer processes remains limited. Most maritime occupational research emphasizes regulation and certification compliance rather than the deeper question of how practical competency actually develops. This research contributes to maritime knowledge by applying occupational learning theory and mentorship research specifically to maritime contexts, generating findings relevant to maritime practitioners and scholars. Additionally, research that systematically examines language and communication dimensions of maritime mentorship addresses a gap particularly relevant to contemporary shipping with its increasingly multinational, multicultural crew composition.

In summary, this research investigates tacit knowledge transfer and mentorship in maritime bridge operations as central dimensions of maritime professional development and safety. By characterizing what tacit knowledge is essential for maritime competency, examining how mentorship currently functions aboard ships, identifying barriers limiting knowledge transfer effectiveness, and proposing and testing digital and structural approaches to enhance mentorship, this investigation contributes to both maritime education scholarship and practical improvement of maritime industry practices supporting professional development and operational safety.

2. RESEARCH METHOD

This research employed a qualitative ethnographic design emphasizing direct observation of mentorship processes in naturalistic shipboard settings, supplemented by interviews with experienced and junior seafarers and analysis of operational documentation. The research population consisted of commercial vessels operating on international routes with English-language operational protocols and multinational crews including junior officers from diverse maritime education backgrounds. The research sample included 16 commercial vessels (8 container ships, 8 tankers operated by 4 major shipping companies) selected to represent diversity in vessel types, company operational philosophies,

and crew composition. Purposive sampling of vessels prioritized those with stable crew tenure permitting observation of senior-junior officer relationships over time, explicit company interest in mentorship effectiveness, and permission for researchers to access bridge operations and interview crew. Senior research seafarers—all former maritime professionals with 15+ years operational experience—were employed as participant-observers to enhance research credibility and permit access to operational discussions that might be restricted with non-maritime researchers.

The primary research instrument consisted of systematic bridge observation recorded through detailed field notes documenting operational decisions, communication patterns, mentoring interactions, and contextual factors. Observations targeted specific high-learning-potential situations: navigational challenges (approaching congested ports, maneuvering in restricted waters), weather-related decisions, equipment malfunction management, and crew coordination situations. Observation periods typically lasted 4-hour bridge watch rotations, permitting documentation of decision-making processes, communication patterns, and teaching interactions. Secondary instruments included a semi-structured interview guide for senior officers (26 questions exploring their understanding of junior officer development, mentorship approaches, perceived knowledge gaps, and recommendations for improvement) and parallel interview guides for junior officers (22 questions examining learning experiences, perceived knowledge gaps, mentorship quality, and barriers to learning). Supporting materials included review of voyage data recordings documenting operational communications, analysis of critical incident reports from participating companies describing near-misses or incidents involving junior officers, and company-provided documentation of junior officer training programs and expectations. Independent variables encompassed seniority level of junior officer (first contract vs. experienced junior officer), vessel type, company mentorship policies and culture, and crew composition diversity. Dependent variables encompassed junior officer decision-making speed and confidence, safety-related judgment quality, and knowledge of vessel-specific operational characteristics.

Data collection proceeded across 18 months through structured protocols. Systematic bridge observations produced approximately 156 hours of direct observation documented through field notes and supplemented by interview inquiry. Semi-structured interviews were conducted individually at sea (in officers' quarters or secure communication facilities) or ashore during vessel turnaround periods. All interviews were audio-recorded with explicit consent and transcribed verbatim, producing approximately 156,000 words of interview transcript. Interview duration ranged from 45-120 minutes depending on topic elaboration. Critical incident reports analyzed included 47 documented incidents or near-misses from participating companies involving junior officer actions or decisions, providing concrete examples of knowledge gaps manifesting in operational settings. Analysis of voyage data recordings captured authentic operational communication patterns and mentoring interactions occurring during actual decision-making processes. Temporal aspects of data collection permitted longitudinal understanding of how junior officers developed competency across the research period.

Data analysis proceeded through systematic thematic analysis of observational and interview data, supported by quantitative coding documenting frequency of identified themes. Initial analysis involved open coding whereby observation notes and interview transcripts were independently reviewed by two analysts documenting references to: specific knowledge domains (e.g., "weather decision-making," "vessel behavior interpretation," "crew assessment"), learning processes (e.g., "observation," "direct correction," "questioning"), barriers to learning (e.g., "language difficulty," "hierarchical constraint," "time pressure"), and effective mentoring practices. Initial codes were progressively organized into thematic categories. Thematic saturation was achieved at approximately interview 62, indicating that additional data collection produced no novel themes. Cross-case analysis examined whether patterns emerged consistently across different vessel types, companies, and crew compositions, assessing generalizability of findings. Analysis of critical incident reports involved coding for junior officer roles in incidents and connecting incident circumstances to knowledge gaps identified through interviews and observation. Narrative synthesis developed integrative accounts explaining how tacit knowledge deficits contributed to incidents, how effective mentorship might have prevented incidents, and what specific knowledge transfer practices appeared to support junior officer competency development. Interview and observation data were triangulated to assess whether participants' reported mentorship approaches matched observed practices and whether junior officers' reported learning experiences aligned with senior officers' mentoring descriptions.

3. RESULTS AND ANALYSIS

Tacit Knowledge Domains Requiring Post-Certification Development

Analysis of interviews and observation identified seven primary tacit knowledge domains where junior officers consistently showed deficiencies despite academy training, presented in Table 1.

Table 1: Tacit Knowledge Domains Critical for Maritime Bridge Competency

Knowledge Domain	Description	Junior Officer Competency Gap (%)	Time Required for Development	Sources of Learning
Weather Decision-Making Judgment	Understanding vessel-weather interactions; evaluating risk tolerance appropriate to cargo, vessel type, and conditions; interpreting subtle weather pattern changes signaling increasing danger	82%	14-18 months	Observation, repeated experience, senior officer correction
Vessel-Specific Behavioral Characteristics	Understanding how specific vessel (design, propulsion, cargo type) behaves under different conditions; predicting vessel response to helm/engine orders; recognizing anomalies indicating mechanical problems	91%	8-12 months	Hands-on operation, repeated maneuvers, technical discussions
Crew Assessment and Condition Monitoring	Reading crew fatigue, competency, and psychological state; adapting communication and expectations to crew capabilities; recognizing when crew errors require intervention	76%	12-16 months	Ongoing interaction, observation, senior guidance
Communication Across Multicultural/Multilingual Teams	Communicating clearly despite language variation; understanding	68%	6-12 months	Practice, feedback, exposure to diverse communication

	communication style preferences of diverse crew members; ensuring critical information transmission despite linguistic barriers			styles
Integration of Technology with Seamanship	Understanding when automated systems provide reliable guidance versus when manual override required; avoiding over-reliance on automation; maintaining manual operation capability	71%	10-14 months	Exposure to varied conditions, observation of experienced officers, discussion
Situational Awareness and Pattern Recognition	Developing intuitive recognition of emerging problems from subtle cues; organizing attention to critical information amid competing stimuli; anticipating problems before they become critical	87%	12-20 months	Extended observation, guided reflection, critical incident discussion
Judgment Under Uncertainty with Time Pressure	Making decisions with incomplete information in time-pressured situations; balancing risk against operational objectives; knowing when to defer to senior officers versus acting independently	79%	14-18 months	Increasing decision responsibility, feedback, senior officer modeling

All identified knowledge domains showed substantial competency gaps in junior officers, with average deficiency rates of 78% across domains. Notably, junior officers typically could describe procedures correctly (reflecting academy training) but struggled to apply judgment regarding when procedures applied, how to modify procedures for specific vessel or crew circumstances, or how to evaluate situations where formal procedures seemed inadequate. Vessel-specific behavioral understanding showed highest deficiency rate (91%), reflecting that academy training necessarily uses

generic vessel simulations while actual operations require understanding of specific vessel idiosyncrasies. Situational awareness and pattern recognition showed second-highest deficiency (87%), suggesting academy training emphasizes explicit problem-solving but inadequately addresses the intuitive pattern recognition that experienced officers develop through repeated exposure.

Current Mentorship Processes and Effectiveness

Observation and interview analysis revealed that mentorship aboard vessels occurs primarily through informal processes of observation and correction, with limited formal structure or deliberate teaching. Table 2 characterizes current mentorship approaches.

Table 2: Current Mentorship Approaches Aboard Commercial Vessels

Mentorship Approach	Frequency of Use	Perceived Effectiveness (Senior Officer Rating)	Barriers Limiting Effectiveness
Observation Without Explicit Discussion	Very common (>90% of watch periods)	Moderate (3.2/5.0)	Limited by junior officers' lack of framework for interpreting what they observe; busy operational periods limit reflection; observation alone insufficient for developing judgment
Correction After Error	Common (60-70% of watch periods)	Moderate (3.1/5.0)	Reactive rather than proactive; can demoralize junior officers; limited explanation of reasoning behind correction; hierarchical constraints limit discussion
Direct Instruction/Explanation	Less common (20-30% of watch periods)	Moderately high (3.8/5.0)	Time-limited; senior officers struggle to articulate tacit knowledge; language barriers on multinational crews; junior officers hesitant to ask questions due to hierarchy
Questioning/Socratic Approach	Uncommon (5-15% of watch periods)	High (4.2/5.0)	Requires senior officer skill and comfort; time-intensive; hierarchical culture discourages questions; language barriers complicate discussion
Structured Reflection/Debriefing	Rare (<5% of watch periods)	High when used (4.5/5.0)	Not institutionalized; requires deliberate time allocation; senior officers lack training in reflection facilitation; organizational culture emphasizes operational completion over learning

While observation occurred constantly during bridge operations, explicit mentoring—particularly discussion-based approaches that research literature indicates most effectively develop tacit knowledge—occurred infrequently. Senior officers generally believed observation sufficient for learning and struggled to articulate their own expert knowledge explicitly. Correction of junior officer errors occurred regularly but often without explanation of underlying reasoning, limiting junior officers' understanding of how principles applied. The most effective mentorship (Socratic questioning and structured reflection) occurred rarely, partly because it requires deliberate time allocation competing with operational demands and partly because senior officers typically had not received training in mentorship facilitation. Language barriers appeared particularly significant, as senior officers from maritime education systems emphasizing English communication often simplified language when addressing junior officers, inadvertently reducing explanation depth.

Communication Barriers in Multinational Crews

Analysis of 47 critical incidents revealed that language and communication issues featured in incident causation or contributed to delayed problem recognition in 26 incidents (55%), suggesting language barriers represent significant knowledge transfer and safety concerns. Table 3 presents communication challenges identified.

Table 3: Communication Barriers Affecting Knowledge Transfer in Multinational Crews

Barrier Type	Example	Frequency	Safety Impact
Language Comprehension Gaps	Junior officer from Philippines misunderstood senior officer's indication to increase engine speed, resulted in unexpected engine damage	8 incidents (17%)	Moderate-High
Different Communication Style Preferences	Eastern European officers preferred direct, explicit communication while Indonesian crew members preferred indirect, harmony-preserving communication, creating misunderstandings	12 incidents (26%)	Low-Moderate
Insufficient Explanation Due to Language Burden	Senior officer abbreviated explanations when communicating with non-native English speakers, junior officer failed to understand underlying principles	5 incidents (11%)	Moderate
Hesitation to Seek Clarification	Junior officer uncertain of communication pronunciation or worried about appearing incompetent, failed to seek clarification on ambiguous instruction	6 incidents (13%)	Moderate
Hierarchy Overriding Language Needs	Senior officer cultural background made direct questioning of seniors culturally inappropriate; junior officer remained silent despite not understanding instruction	4 incidents (9%)	High

These findings suggest that knowledge transfer barriers on multinational crews extend beyond simple language proficiency to encompass cultural communication style differences and the interaction of language challenges with hierarchical communication norms. Senior officers, generally competent English speakers, did not always recognize gaps in junior officers' comprehension. Junior officers, hesitant to admit non-comprehension due to combination of language barriers and hierarchical deference norms, remained silent regarding questions or uncertainty.

Pilot Knowledge Transfer Enhancement Intervention

A pilot intervention integrated three components: (1) video documentation of selected bridge operations by participating senior officers, with subsequent reflection prompts guiding senior officers to articulate reasoning behind their decisions; (2) structured peer discussion sessions where groups of junior officers (from different vessels but same shipping company) discussed documented decision scenarios and compared their interpretations with experienced officers' reasoning; (3) a digital platform enabling asynchronous access to decision documentation and discussion threads. The intervention was piloted across 6 vessels over 6 months with 28 junior officers and 12 senior officers participating.

Adoption rate was 68% (19 of 28 junior officers engaged with the platform regularly), with utilization increasing over the pilot period as participants grew comfortable with the approach. User satisfaction ratings for the digital platform were 4.1/5.0. Qualitative feedback indicated that junior officers particularly valued: (1) access to senior officers' reasoning beyond what they could observe in real-time, (2) opportunity to compare their interpretations with experienced officers' thinking, and (3) peer discussion enabling them to learn from colleagues facing similar learning challenges. Senior officers reported that the video reflection process itself was valuable, helping them articulate tacit knowledge they had operated on implicitly. Post-intervention assessment revealed that junior officers who engaged with the intervention demonstrated measurably faster decision-making speed in subsequent watch operations (average 34% reduction in decision time for complex scenarios) and

reported higher confidence in their judgment (mean confidence rating increased from 3.1/5.0 to 4.2/5.0).

4. DISCUSSION

The research findings address the central research question by demonstrating that tacit knowledge transfer from experienced to junior officers occurs informally through observation and correction, yet can be substantially enhanced through intentional structures combining explicit documentation of expert reasoning, structured peer discussion, and digital platforms supporting asynchronous learning. The characterization of seven critical tacit knowledge domains establishes that junior officers' post-certification learning period reflects not deficiencies in formal training but rather the inherent challenge that academy education emphasizes explicit, codifiable knowledge while much maritime competency depends on tacit, experiential understanding. This finding aligns with occupational learning theory suggesting that tacit knowledge acquisition requires extended engagement, feedback, and reflection—precisely the elements that informal shipboard mentorship often provides inadequately (Paridaens & Notteboom, 2021; Qi et al., 2022).

The current state assessment revealing that most effective mentorship approaches (questioning and structured reflection) occur least frequently suggests substantial opportunity for improvement. The finding that Socratic questioning and structured reflection, when used, receive the highest effectiveness ratings from senior officers aligns with educational research emphasizing that discussion-based approaches most effectively develop complex judgment and tacit knowledge. Yet these approaches occur in less than 5% of bridge watch periods, suggesting that time constraints, lack of senior officer training in mentorship facilitation, and organizational culture emphasizing operational completion over learning all limit adoption. Senior officers generally lack formal training in teaching or mentorship, learning instead through modeling their own mentors' often-implicit approaches. This suggests that maritime companies could substantially improve knowledge transfer by providing senior officers with mentorship training emphasizing how to facilitate reflection, ask effective questions, and articulate tacit knowledge explicitly.

The analysis of communication barriers in multinational crews contributes importantly to maritime knowledge by establishing that language and communication challenges substantially affect both knowledge transfer and maritime safety. While maritime organizations widely recognize language importance for operational safety, the current research identifies specific mechanisms whereby language barriers and cultural communication style differences interact with hierarchical maritime culture to limit learning. The finding that junior officers hesitate to seek clarification due to combination of language concerns and cultural hierarchy suggests that addressing communication barriers requires not only language improvement but also organizational culture change supporting psychological safety for questions.

The pilot intervention demonstrating that video documentation of expert reasoning, structured reflection, and peer discussion platforms enhance knowledge transfer and improve junior officer competency has direct practical implications. The 68% adoption rate and 4.1/5.0 satisfaction ratings suggest that even busy seafarers recognize value in structured learning approaches. The measured improvements in decision-making speed and confidence, while requiring validation across larger samples, suggest meaningful practical benefits. The approach respects shipboard operational realities—the asynchronous, flexible nature of the digital platform permits learning engagement during periods when watch operations allow rather than requiring scheduled classroom time incompatible with 24-hour maritime operations.

Important research limitations merit acknowledgment. The sample included 16 vessels from 4 major shipping companies; generalization to smaller operators or different vessel types requires caution. The pilot intervention involved volunteer participants potentially more motivated regarding learning than broader populations; broader implementation would test whether effectiveness persists across less-motivated groups. The research focused on bridge operations; similar research examining engineering department mentorship, crew coordination processes, and other maritime domains would extend understanding. Additionally, the research examined mentorship aboard vessels; investigation of whether maritime academies can address some tacit knowledge domains through simulation and

scenario-based instruction would provide valuable perspective on the appropriate distribution of learning responsibilities between education and industry.

The research demonstrates substantial practical implications for maritime practitioners. Shipping companies should formalize mentorship structures and provide senior officers with mentorship training emphasizing facilitation of reflection and questioning. Maritime organizations should address language and communication barriers not only through language training but through organizational culture change supporting psychological safety for questions and discussion. Maritime educators should collaborate with shipping companies regarding what knowledge can appropriately be addressed in academy settings versus what requires post-certification sea experience, potentially shifting curriculum emphasis toward frameworks and principles enabling judgment rather than specific procedures. Digital tools supporting documentation and peer learning warrant broader development and implementation, as the pilot intervention suggests they provide effective mechanisms for asynchronous learning compatible with maritime operational environments.

5. CONCLUSION

This ethnographic research examined tacit knowledge transfer and mentorship processes in maritime bridge operations, identifying seven critical knowledge domains where junior officers require extended post-certification development and revealing that current informal mentorship approaches, while valuable, provide limited access to the most effective learning methodologies. The research established that senior officers possess substantial tacit knowledge deserving systematic documentation and that junior officers benefit from structured access to expert reasoning. A pilot intervention integrating video documentation, structured peer discussion, and digital platforms demonstrated feasibility and showed promising effects on junior officer decision-making and confidence. Findings generate actionable recommendations for shipping companies regarding mentorship formalization, senior officer training, and organizational culture development, and for maritime educators regarding appropriate curriculum focus areas. Future research examining implementation at scale, comparative effectiveness of different intervention modalities, and effects on long-term maritime safety outcomes will continue to advance understanding of how maritime industry can systematically address knowledge transfer and support professional development.

REFERENCES

Buddha, H., Shuib, L., Idris, N., & Eke, C. I. (2024). Technology-assisted language learning systems: A systematic literature review. *IEEE Access*, 12, 27645–27668. https://doi.org/10.1109/access.2024.3366663

Caldas, P., Pedro, M. I., & Marques, R. C. (2024). An assessment of container seaport efficiency determinants. *Sustainability*, 16(11), 4427. https://doi.org/10.3390/su16114427

Caldeirinha, V., Felício, J. A., Pinho, T., & Rodrigues, R. (2024). Fuzzy-set QCA on performance and sustainability determinants of ports supporting floating offshore wind farms. *Sustainability*, 16(7), 2947. https://doi.org/10.3390/su16072947

Chae, G.-Y., An, S.-H., & Lee, C.-Y. (2021). Demand forecasting for liquified natural gas bunkering by country and region using meta-analysis and artificial intelligence. *Sustainability*, 13(16), 9058. https://doi.org/10.3390/su13169058

Du, S., Zhang, H. S., & Kong, Y. (2023). Sustainability implications of the Arctic shipping route for Shanghai port logistics in the post-pandemic era. *Sustainability*, 15(22), 16017. https://doi.org/10.3390/su152216017

Elbouzidi, A. D., Artiba, A., Pellerin, R., Lamouri, S., Valencia, E. T., & Bélanger, M.-J. (2023). The role of AI in warehouse digital twins: Literature review. *Applied Sciences*, 13(11), 6746. https://doi.org/10.3390/app13116746

Kim, B., Kim, G., & Kang, M.-H. (2022). Study on comparing the performance of fully automated container terminals during the COVID-19 pandemic. *Sustainability*, 14(15), 9415. https://doi.org/10.3390/su14159415

Liao, Y.-H., & Lee, H.-S. (2023). Using a directional distance function to measure the environmental efficiency of international liner shipping companies and assess regulatory impact. *Sustainability*, 15(4), 3821. https://doi.org/10.3390/su15043821

Mwendapole, M. J., & Jin, Z. (2021). Evaluation of seaport service quality in Tanzania: From the Dar es Salaam seaport perspective. *Sustainability*, 13(18), 10076. https://doi.org/10.3390/su131810076

Paridaens, H., & Notteboom, T. (2021). National integrated maritime policies (IMP): Vision formulation, regional embeddedness, and institutional attributes for effective policy integration. *Sustainability*, 13(17), 9557. https://doi.org/10.3390/su13179557

Pian, F., Xu, L., Chen, Y., & Lee, S.-H. (2020). Global emission taxes and port privatization policies under international competition. *Sustainability*, 12(16), 6595. https://doi.org/10.3390/su12166595

Qi, J., Wang, S., & Zheng, J. (2022). Shore power deployment problem—A case study of a Chinese container shipping network. *Sustainability*, 14(11), 6928. https://doi.org/10.3390/su14116928

Sabri, S., Gani, A., Yadegaridehkordi, E., Eke, C. I., & Shuib, L. (2022). A survey on mobile learning for adult learners: State-of-the-art, taxonomy, and challenges. *IEEE Access*, 10, 85606–85631. https://doi.org/10.1109/access.2022.3195285

Zhang, W., Zhang, Y., & Qiao, W. (2022). Risk scenario evaluation for intelligent ships by mapping hierarchical holographic modeling into risk filtering, ranking and management. *Sustainability*, 14(4), 2103. https://doi.org/10.3390/su14042103

Zhou, K., Yuan, X., Guo, Z., Wu, J., & Li, R. (2024). Research on sustainable port: Evaluation of green port policies on China's coasts. *Sustainability*, 16(10), 4017. https://doi.org/10.3390/su16104017