

Maritime Tacit Knowledge Attrition and Operational Continuity Vulnerability in Multigenerational Shipping Workforces

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ABSTRACT

The shipping industry faces operational continuity vulnerabilities due to the lack of tacit knowledge of senior seafarers in a multigenerational workforce. Differences in experience, communication, technology adaptation, and personnel rotation can hinder the transfer of knowledge critical to ship safety. This study aims to analyze the effect of maritime tacit knowledge attrition on the vulnerability of operational continuity of shipping organizations. An explanatory quantitative approach was used through a survey of 156 respondents, including ship officers, operational crews, fleet managers, and safety staff. Data were collected using a structured questionnaire and analyzed using descriptive statistics, reliability testing, multiple linear regression, and moderation analysis. The results show that weak cross-generational mentoring, lack of experience documentation, and Data were collected using a structured questionnaire and analyzed using descriptive statistics, reliability testing, multiple linear regression, and moderation analysis. to emergency decision-making, ship-land coordination, and safety compliance. These findings underscore the importance of knowledge management to strengthen the succession of competencies and operational resilience of sustainable shipping.

INTRODUCTION

The shipping industry is a strategic sector for archipelagic countries because it plays a role in maintaining inter-island connectivity, logistics distribution, human mobility, and the sustainability of the national supply chain. In practice, the success of shipping operations is determined not only by the ship's feasibility, the sophistication of navigation technology, and compliance with safety regulations, but also by the quality of the human resources operating the system. Setiawan and Sudja (2021) emphasized that the competence of marine human resources is an important factor in strengthening Indonesia's maritime competitiveness. In this context, the tacit knowledge of senior seafarers—in the form of practical experience, safety intuition, the ability to read situations, and the ability to make decisions in emergency situations—becomes an organizational asset that is difficult to replace by written procedures.

The phenomenon of tacit knowledge loss is increasingly urgent to study as the shipping industry faces changing demographics of the workforce, accelerating digitalization, and demands for increased safety standards. Marsudi and Kristiawan (2025) show that the transformation of maritime human resource management systems through e-crewing emerged in response to the global seafarer shortage and the need for more integrated crew competency data management. However, the digitalization of crew management is not always able to capture the experience-based knowledge inherent in senior seafarers. Knowledge such as how to respond to bad weather, read the technical condition of ships, manage communications in high-pressure situations, and assess operational risks are often gained through long experience, not just through formal training.

At the local level, the urgency of this research is also related to the need to improve the quality of maritime education and training in Indonesia. Suprapti and Wahyuni (2025) emphasized the importance of maritime vocational education management from a human capital perspective, especially to build competence, critical thinking, and safety culture of prospective seafarers. Meanwhile, Bayan and Syamsiah (2025) show that learning technology and practical activities have an important role in improving the competence of marine transportation students at shipping vocational schools. The findings indicate that seafarers' competencies cannot be formed through explicit knowledge transfer alone, but require practice-based learning, interaction with experienced instructors, and ongoing reinforcement of field experience.

Previous studies have extensively discussed shipping safety and crew competence, but have not specifically placed tacit knowledge attrition as a source of operational continuity vulnerability. Riyadi (2025), for example, examines the quality management of sea transportation in relation to improving safety standards and passenger comfort. Arsy, Syamsiah, and Umar (2025) highlight the optimization of occupational safety and health training to prevent crew work accidents. Dipta, Gias, and Azmi (2025) also emphasized the importance of STCW-based safety training for ship crews. While relevant, these studies have focused more on formal training, safety standards, and the improvement of

technical competence, rather than on the mechanisms of the loss of senior operational experience in multigenerational shipping organizations.

The next research gap can be seen in the limited discussion of the relationship between the difference in the generation of the shipping workforce and the sustainability of operational knowledge transfer. Wahyuni, Kristiyanti, Mahendro, and Khoriyantun (2025) discuss the revitalization of Indonesian seafarers' competencies through the design of an integrated database, which emphasizes the importance of data mapping and seafarers' competencies. However, database-based approaches tend to be robust in documenting certifications, training histories, and administrative data, but are not necessarily capable of recording tacit knowledge such as situational assessments, safety habits, and problem-solving strategies on board. Thus, there is scientific space to examine how shipping organizations can maintain experience-based knowledge in the event of retirement, crew rotation, contract changes, or differences in communication styles between generations.

From an organizational perspective, the loss of tacit knowledge can create operational continuity vulnerabilities because it weakens the organization's ability to maintain quality decision-making, coordination, and response to disruptions. Gumay, Fahrisoni, and Muslim (2025) show that shipping companies assess cadets' performance not only from the mastery of technical knowledge, but also from work skills, discipline, communication, and readiness to face operational demands. This shows that maritime competence is multidimensional and heavily influenced by practical experience. If senior seafarers' experience is not systematically transferred to the next generation, organizations risk a gap in ability to handle emergency situations, maintain safety compliance, and ensure effective ship-land coordination.

Based on these backgrounds and gaps, this study aims to analyze how the loss of maritime tacit knowledge affects the vulnerability of operational continuity in the multigenerational shipping workforce. Narratively, this study is directed to explain the relationship between cross-generational mentoring intensity, documentation of operational experience, personnel rotation, and informal knowledge transfer on the ability of shipping organizations to maintain safety, work coordination, and operational effectiveness. Such focus is important because the sustainability of shipping operations depends not only on the availability of crew members, but also on the continuity of critical knowledge inherited through work experience.

The theoretical contribution of this research lies in the development of the study of maritime knowledge management by linking the concepts of tacit knowledge, multigenerational workforce, seafarer competence, and operational continuity vulnerabilities in a single analytical framework. In practical terms, this research can provide a basis for shipping companies, maritime vocational education institutions, and regulators to design knowledge retention strategies through structured mentoring, operational experience documentation, post-incident evaluation, practice-based learning, and competency succession systems. Thus, this research is expected not only to enrich the academic discourse on maritime human resources, but also to help solve real problems in the form of

loss of critical experience that can disrupt the sustainability of shipping operations.

LITERATURE REVIEW

Maritime Tacit Knowledge as a Hard-to-Replace Operational Asset

In the shipping industry, tacit knowledge is not just in the form of technical understanding written into procedures. This knowledge also includes navigational intuition, experience dealing with weather conditions, operational risk reading, interagency coordination, onboard work habits, and the ability to make quick decisions in abnormal situations. This kind of knowledge is often inherent in senior sailors, ship officers, or crew members who have worked in a particular company's routes, types of ships, and cultures. Studies on tacit knowledge transfer show that tacit knowledge tends to move through direct interaction, socialization, involvement in work activities, and intergenerational learning, not just through formal documents (Munir, 2022). In the context of shipping, this means that the loss of senior seafarers, weak mentoring, or too rapid crew turnover can reduce the operational memory of ships and companies.

Tacit knowledge attrition can occur when work experience is not documented, not inherited, or not internalized by the next generation of crew members. This issue is important because the safety, efficiency, and operational accuracy of ships are highly dependent on the competence of the crew as the main implementers of operations at sea. Studies on crew skills in the use of navigation equipment show that crew skills have a strong positive influence on shipping safety (Jayanti & Noreng, 2023). These findings reinforce the view that formal technical competencies need to be complemented by practical experience and situational knowledge formed through working hours on board.

Knowledge Sharing as a Mechanism to Prevent Knowledge Loss

Knowledge sharing serves as the main mechanism to prevent the loss of tacit knowledge in shipping organizations. Research by Hendrawan, Sasongko, and Pramono (2022) shows that knowledge sharing affects shipping safety behavior with a significance value of $P = 0.00$. This means that the better the practice of sharing knowledge, the stronger the safety behavior in shipping activities. These findings are relevant to research on maritime tacit knowledge attrition because knowledge sharing can serve as a bridge between individual experiences and the sustainability of organizational knowledge.

In maritime education and training, knowledge sharing has also been proven to be influenced by personal factors such as locus of control, goal orientation, and self-efficacy. Rohman and Susanto (2024) found that these three factors have a statistically significant effect on knowledge sharing in laboratory lecturers and simulators of the Makassar Shipping Science Polytechnic. Although the context is in a shipping education institution, these findings remain relevant for the ship's work environment because the success of knowledge transfer is strongly influenced by individual beliefs, learning goals, and willingness to share experiences with others.

Multigenerational Workforce and the Challenges of Knowledge Transfer

The modern cruise workforce is made up of generations, ranging from senior crew members with long experience to young crew who are more adaptive to digital technology. This multigenerational condition can be a strength if the organization is able to manage knowledge transfer systematically. However, differences in communication styles, learning preferences, career orientation, and work discipline can hinder the inheritance of tacit knowledge. Prabowo and Nadia (2025) explained that the multigenerational workforce involves Baby Boomers, Generation X, Millennials, and Generation Z who work together in one organizational environment. The study also emphasizes that intergenerational dynamics affect organizational performance and require a more adaptive human resource management strategy.

In the context of shipping, the generation gap can have a direct impact on operational continuity. Senior seafarers typically have practical experience of routes, port risks, weather, ship character, working relationships, and problem solving in the field. In contrast, young seafarers tend to be closer to digital systems, modern navigation technologies, and data-driven procedures. If these two groups are not connected through mentoring, briefing, debriefing, or cross-generational teamwork, then operational knowledge can be disconnected. As a result, shipping companies not only lose labor, but also lose the working memory needed to maintain operational consistency.

Crew Competencies and Operational Continuity Vulnerabilities

The competence of the crew is an important factor in maintaining operational continuity. The Jayanti and Noreng (2023) study shows that the skill of the crew in the use of navigation equipment has a positive effect on shipping safety. These results confirm that the technical capabilities of the crew cannot be separated from the safety and smooth operation of the ship. If tacit knowledge is reduced, then the crew's ability to understand the field situation, read risk signs, and use equipment appropriately also has the potential to decrease.

The competency aspect is also seen in the Samekto (2025) study on green shipping training for ship crews. The research shows that structured training can improve crew knowledge of energy efficiency regulation, technical skills in the use of energy-efficient technologies, and more efficient operational behaviors. These findings are relevant because they show that training can be a formal instrument to reduce the risk of knowledge loss, especially when technology, regulations, and operational standards are constantly changing.

Crew Change, Safe Manning, and the Risk of Operational Knowledge Loss

Crew change is a routine process in the shipping industry, but it has direct implications for operational continuity. If crew changes do not run as scheduled, are not competency-based, or are not accompanied by adequate knowledge transfer, then the ship may face operational disruptions. Nisa, Dahri, Yudianto, and Rakhman (2025) found that the mechanism of crew change that is not in accordance with the provisions of safe manning can affect ship operations and work safety. The study also showed that there were obstacles such as a lack of

competent replacement crews, mismatch of position positions, and administrative constraints.

Similar findings can be seen in the research of Panggayuh, Sianturi, Yudianto, and Nofandi (2025), which shows that the crew change process has a significant effect on the smooth operation of foreign ships at PT Pertamina Trans Kontinental Balikpapan. The study found an R square value of 0.644, which means that the crew change process explains 64.4% of the variation in the smooth operation of the ship. Thus, crew change is not only an administrative issue, but also part of the continuity of knowledge and operational stability of the shipping company.

Work Stress, Organizational Support, and Crew Operational Resilience

Operational continuity vulnerabilities can also arise from the psychological state of the crew. Samekto (2024) explained that the crew profession faces typical work demands, such as social isolation, long working hours, and a challenging physical environment. The study found that work stress had a negative and significant effect on crew performance, while organizational support had a positive and significant effect on performance. In the context of tacit knowledge attrition, work stress can weaken the willingness of the crew to share experiences, decrease concentration, and accelerate the intention to quit work.

Organizational support becomes important because tacit knowledge transfer requires a safe, trusting, and open work environment. If the senior crew feels unappreciated, or the young crew feels that they are not given a learning space, then knowledge sharing will be weakened. This condition can increase operational continuity vulnerability because knowledge is only stored in certain individuals and does not turn into the collective knowledge of the organization.

Turnover Intention and Risk of Memory Loss of Maritime Organizations

The attrition of tacit knowledge is closely related to turnover intention. When experienced crew members leave the company without a knowledge transfer process, the organization loses practical experience that is not easily replaced by new recruitment. Samekto (2025) found a significant negative relationship between job satisfaction and turnover intention in national commercial ship crews. The higher the job satisfaction of seafarers, the lower their tendency to leave the profession or company. The research also emphasizes the importance of a supportive social work environment, recognition of performance, and a clear career path to retaining quality crews.

In this study, turnover is not only seen as a loss of labor, but also as a loss of operational knowledge. Senior crew members carry memories of unwritten procedures, adjustments to field conditions, crisis coordination, and safety practices formed from long experience. If a company does not have a retention, mentoring, experience documentation, and succession planning mechanism, then turnover can increase the vulnerability of operational continuity.

Synthesis of Research Gaps

Indonesian literature in 2021–2025 has discussed a lot about knowledge sharing, shipping safety, crew competence, crew change, safe manning, work

stress, job satisfaction, and a multigenerational workforce. However, studies that specifically link maritime tacit knowledge attrition to operational continuity vulnerability in the context of multi-generational shipping workforces are still limited. Existing studies generally discuss variables separately, such as knowledge sharing for safety, crew change for smooth operations, or job satisfaction for turnover intention. Therefore, this research has a new position because it integrates tacit knowledge loss, multigenerational dynamics, and operational continuity vulnerabilities in a single research model.

Conceptually, this research can be placed on the intersections of knowledge management, shipping human resource management, maritime safety, and operational sustainability. The novelty of the research lies in how to see knowledge attrition not just as an individual problem, but as an organizational risk that can affect safety, efficiency, safe manning compliance, and smooth ship operations. Thus, this research is important to strengthen mentoring policies, intergenerational knowledge transfer, ongoing training, and operational experience documentation systems in shipping companies.

Research Hypothesis

H1: Maritime tacit knowledge attrition has a positive effect on operational continuity vulnerability in shipping companies.

H2: Knowledge sharing has a negative effect on maritime tacit knowledge attrition.

H3: Knowledge transfer between generations has a positive effect on tacit retention of maritime knowledge.

H4: The effectiveness of crew change has a negative effect on operational continuity vulnerability.

H5: Organizational support weakens the influence of maritime tacit knowledge attrition on operational continuity vulnerability.

H6: Training and competency development of crew has a negative effect on operational continuity vulnerability.

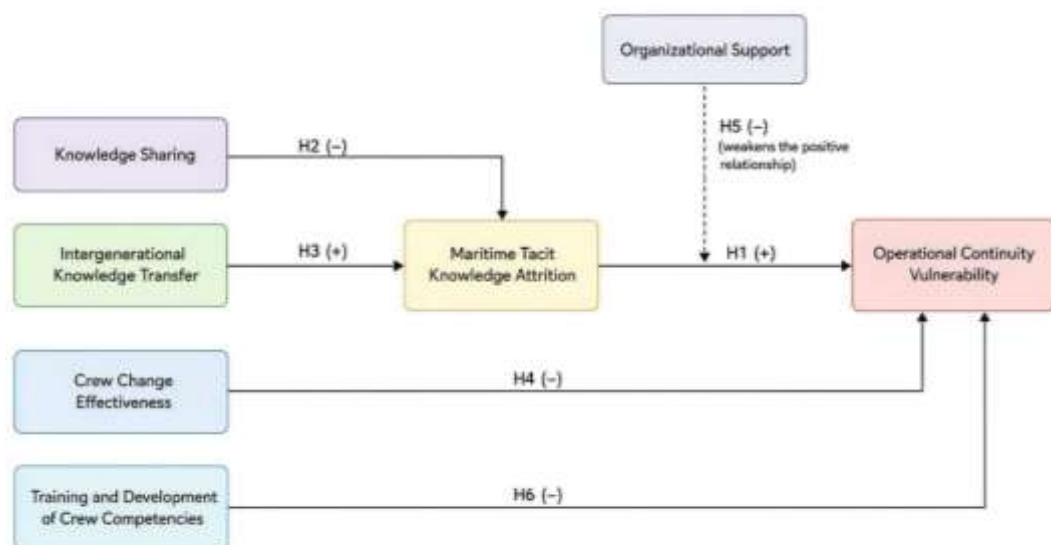


Figure 1. Conceptual Framework

METHODOLOGY

Types of Research

This research is an explanatory quantitative research. This type of research is used to explain the influence of intervariables in a measurable manner, especially the effect of maritime tacit knowledge attrition on operational continuity vulnerability in shipping companies.

Research Approach

The quantitative approach is used because the research data is in the form of numbers and is statistically analyzed. This approach is suitable for testing hypotheses, measuring the relationship between variables, and obtaining objective results based on respondents' answers.

Research Design

The research design used was a cross-sectional survey. Data was collected once through a questionnaire to 156 respondents consisting of ship officers, operational crews, fleet managers, and safety staff. Respondents were selected using purposive sampling techniques because they had direct experience related to knowledge transfer, crew change, safety, and continuity of shipping operations (Creswell & Creswell, 2022; Saunders et al., 2023).

Data Collection Techniques

Data were collected using a structured questionnaire with a five-point Likert scale, ranging from strongly disagree to strongly agree. The questionnaire items were compiled based on research variables, namely maritime tacit knowledge attrition, knowledge sharing, intergenerational knowledge transfer, crew change effectiveness, organizational support, crew training, maritime tacit knowledge retention, and operational continuity vulnerability. The preparation of the instrument refers to the principle of questionnaire design that is clear, relevant, and in accordance with the research construct (Taherdoost, 2022). Validity is tested through item-total correlation, while reliability is tested using Cronbach's alpha with a minimum limit of 0.70.

Data Analysis Techniques

Data were analyzed using descriptive statistics, reliability tests, multiple linear regression, and moderation tests. Descriptive statistics are used to describe the tendency of respondents' answers to each variable. Multiple linear regression was used to test the influence of independent variables on dependent variables, while moderation tests were used to test the role of organizational support in weakening the influence of maritime tacit knowledge attrition on operational continuity vulnerability. The analysis was conducted using IBM SPSS Statistics and PROCESS Macro Model 1.

RESEARCH RESULTS

Descriptive Statistics

The results of descriptive statistics showed that all variables were analyzed based on 156 respondents. The operational continuity vulnerability

variable has an average value of 3.460 with a standard deviation of 1.019. This value indicates that operational continuity vulnerabilities are at a fairly high trend. The maritime tacit knowledge attrition variable had an average value of 3.433 with a standard deviation of 1.050. This condition suggests that the loss of maritime tacit knowledge is also on a fairly high trend.

Table 1. Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
MTKA	156	1,00	5,00	3,433	1,050
KS	156	1,00	5,00	3,264	1,077
TPAG	156	1,00	5,00	3,247	1,039
RTKM	156	1,00	5,00	3,300	1,021
ETC	156	1,00	5,00	3,122	1,059
OS	156	1,00	5,00	3,122	1,096
TPK	156	1,00	5,00	3,269	1,065
OCV	156	1,00	5,00	3,460	1,019

Reliability Test

The results of the reliability test showed that all variables had a Cronbach's Alpha value above 0.70. Thus, all instruments were declared reliable and suitable for further analysis.

Table 2. Reliability Test

Variable	Number of Items	Cronbach's Alpha	Remarks
MTKA	4	0,890	Reliable
KS	4	0,898	Reliable
TPAG	4	0,882	Reliable
RTKM	4	0,872	Reliable
ETC	4	0,890	Reliable
OS	4	0,892	Reliable
TPK	4	0,877	Reliable
OCV	4	0,879	Reliable

Multiple Linear Regression Results

The results of multiple linear regression showed that the main model had an R-Square value of 0.356. This means that maritime tacit knowledge attrition, crew change effectiveness, and crew training were able to explain 35.6% of the variation in operational continuity vulnerability. The rest is explained by other variables outside the research model.

Table 3. Model Summary Regresi Linear Berganda

Model	R	R Square	Adjusted R Square	F	Sig.
OCV's main regression	0,596	0,356	0,343	27,963	<0.001

The results of the coefficient test showed that maritime tacit knowledge attrition had a positive effect on operational continuity vulnerability. Meanwhile, the effectiveness of crew change and crew training has a negative effect on operational continuity vulnerability.

Table 4. Regression Coefficient Test Results

Variable	B	Std. Error	Beta	t	Sig.
MTKA	0,473	0,063	0,487	7,479	<0.001
ETC	-0,233	0,063	-0,242	-3,709	<0.001
TPK	-0,218	0,062	-0,228	-3,497	<0.001

H2 and H3 Test Results

The results of the H2 test show that knowledge sharing has a negative effect on maritime tacit knowledge attrition. The coefficient value of -0.394 indicates that the better the knowledge sharing, the lower the rate of maritime tacit knowledge loss.

The results of the H3 test showed that intergenerational knowledge transfer had a positive effect on the retention of maritime tacit knowledge. The coefficient value of 0.570 indicates that the stronger the intergenerational knowledge transfer, the higher the tacit retention of maritime knowledge.

Table 5. H2 and H3 Test Results

Hypothesis	Variable Relationships	B	t	Sig.	Remarks	
H2	KS → MTKA		-0,394	-5,487	<0.001	Accepted
H3	TPAG → RTKM	0,570		8,844	<0.001	Accepted

Moderation Test Results

The results of the moderation test showed that the interaction between maritime tacit knowledge attrition and organizational support had a negative effect on operational continuity vulnerability. The value of the interaction coefficient was -0.148 with a significance value of 0.006. These results show that organizational support weakens the influence of maritime tacit knowledge attrition on operational continuity vulnerability.

Table 6. Moderation Test Results

Variable	B	Std. Error	t	Sig.
MTKA centered	0,470	0,062	7,593	<0.001
ETC	-0,243	0,062	-3,938	<0.001
TPK	-0,242	0,062	-3,883	<0.001
OS centered	0,028	0,061	0,459	0,647
MTKA × OS	-0,148	0,053	-2,785	0,006

DISCUSSION

The results of the study show that maritime tacit knowledge attrition has a positive effect on operational continuity vulnerability in shipping companies. The value of the regression coefficient of 0.473 with a significance of <0.001 indicates that the higher the loss of maritime tacit knowledge, the higher the vulnerability of operational continuity. These findings confirm that senior seafarers' experience is an important asset that cannot be easily replaced by written procedures, navigation technology, or formal administrative systems. Tacit knowledge includes safety intuition, risk reading skills, experience in dealing with bad weather, understanding of the character of ships, and decision-making skills in emergency situations. This is in line with Eklund (2024), who asserts that tacit

knowledge in critical safety systems is difficult to formalize, but it greatly determines the quality of workers' responses in routine and non-routine situations.

The results of the study also show that knowledge sharing has a negative effect on maritime tacit knowledge attrition. A coefficient value of -0.394 with a significance of <0.001 indicates that the better the practice of knowledge sharing, the lower the loss of maritime tacit knowledge. These findings reinforce the concept of knowledge management that places knowledge sharing as the primary mechanism for transforming individual experiences into organizational knowledge. In the context of shipping, knowledge sharing can be done through mentoring, briefing, debriefing, case discussions, simulations, and post-operative evaluations. These results are in line with Soon and Teh (2025), who explain that knowledge management orientation can support the performance of shipping companies. Thus, knowledge sharing cannot be seen as an additional activity, but needs to be part of the safety culture and operational work system.

Intergenerational knowledge transfer was shown to have a positive effect on the retention of maritime tacit knowledge with a coefficient of 0.570 and a significance of <0.001 . These findings show that the stronger the cross-generational learning process, the higher the organization's ability to retain experiential knowledge. In a multigenerational shipping workforce, senior crew members have extensive field experience, while younger crews are more adaptive to digital technologies and modern work systems. If these two groups are connected through mentoring and work mentoring, companies can maintain the continuity of operational knowledge. Pereira et al. (2024) affirm that knowledge transfer during generational changes is important because experienced workers bring knowledge that is difficult to replace when they leave the organization. Therefore, shipping companies need to build a knowledge succession system that not only records certificates and training, but also captures practical experience that arises in real work situations.

The effectiveness of crew change and crew training has also been shown to have a negative effect on operational continuity vulnerability. The effectiveness of crew change has a coefficient of -0.233, while crew training and competency development has a coefficient of -0.218 with a significance of <0.001 . These results show that orderly crew turnover, accompanied by clear handovers, can reduce the risk of operational disruptions. Conversely, weak crew changes can lead to a loss of information about the ship's condition, risk record, and previous operating experience. Training also plays an important role as it helps crews update technical competencies, understand safety procedures, and improve preparedness for emergencies. Martanto and Sijabat (2022) show that training and competence affect shipping safety performance. However, formal training still needs to be combined with simulations, case studies, and mentoring so that it does not stop at procedural understanding.

The results of the moderation test showed that organizational support weakened the influence of maritime tacit knowledge attrition on operational continuity vulnerability. The interaction coefficient of -0.148 with a significance of 0.006 indicates that the impact of tacit knowledge loss on operational vulnerability becomes lower when organizational support is strong. Organizational support can

be in the form of mentoring policies, experiential documentation systems, rewards for crew who share knowledge, a culture of safety, ongoing training, and leadership that encourages open communication. Theoretically, this research contributes by integrating the concepts of tacit knowledge attrition, multigenerational workforce, and operational continuity vulnerability in a single model. Practically, this study recommends shipping companies to build knowledge retention systems based on mentoring, handover, experience documentation, and practice-based training. However, because the data were collected through a cross-sectional self-reported survey, follow-up research needs to use original field data, a wider number of respondents, and a mixed method approach so that tacit forms of knowledge that are difficult to measure through questionnaires can be explored in more depth.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the study, it can be concluded that maritime tacit knowledge attrition has a positive effect on operational continuity vulnerability in shipping companies. This means that the higher the loss of maritime tacit knowledge, the greater the vulnerability of operational continuity that can arise in the form of emergency decision-making disruptions, weak ship-land coordination, and an increased risk of non-compliance with safety procedures. These findings suggest that the experience of senior sailors is an organization's strategic asset that cannot be completely replaced by written procedures, technology, or formal administrative systems.

This research also shows that knowledge sharing, intergenerational knowledge transfer, the effectiveness of crew change, organizational support, and crew training and competency development play an important role in reducing operational vulnerabilities. Good knowledge sharing practices can reduce tacit knowledge loss, while intergenerational knowledge transfer can strengthen retention of maritime work experience. In addition, an effective crew change process and continuous crew training are able to maintain information continuity, work readiness, and operational response. Organizational support also proves important because it can weaken the negative impact of the loss of tacit knowledge on the operational continuity of shipping companies.

Based on the findings, shipping companies are advised to build a more structured knowledge management system through cross-generational mentoring, documentation of operational experiences, clear handovers during crew changes, briefing and debriefing forums, and real-life case-based training on board. Further research is recommended using original field data with a wider number of respondents, involving different types of vessels and crew positions, and combining quantitative approaches with in-depth interviews. This approach is important so that tacit forms of knowledge that are difficult to measure through questionnaires can be explored in more detail and result in a stronger understanding of the operational resilience of shipping.

ADVANCED RESEARCH

Further research is recommended using broader field data from different shipping companies, vessel types, crew positions, and service periods. Advanced

research can also use a mixed method approach by combining quantitative surveys, in-depth interviews, and observations of work on board. This approach is important to explore forms of tacit knowledge that are difficult to measure through questionnaires, such as safety intuition, experience in dealing with emergencies, and operational decision-making patterns. In addition, subsequent research can add variables of safety culture, ship leadership, work stress, turnover intention, and digital documentation systems to expand understanding of shipping companies' operational resilience.

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