Economic and Business Horizon

ISSN: 2963-2765

Economic and Business Horizon
Volume: 05
Issue: 04
Year: 2026
Page: 375-388

Citation:
Arifin & Kusuma, E. A. (2026). Enhancing marine pilot team performance through competence, work environment, and operational leadership. *Economics and Business Horizon*, *5*(4), 375-388 .

Enhancing Marine Pilot Team Performance through Competence, Work Environment, and Operational Leadership

Arifin[1*], Emeralda Ayu Kusuma[1]

[1] Department of Management, Sekolah Tinggi Ilmu Ekonomi Indonesia Surabaya, Surabaya, Indonesia

[*] *Corresponding author: Arifin (pandulimadelta@gmail.com)*

Abstract

Marine pilotage is a safety-critical port operation that requires effective coordination among competent personnel, supportive working conditions, and operational leadership to ensure safe, timely, and reliable vessel movements. This study aims to examine the effects of competence and work environment on marine pilot team performance and to investigate the mediating role of operational leadership. A quantitative explanatory design was employed using a census of 55 personnel involved in the marine pilot work system at Semen Indonesia Tuban Port. Data were collected through structured questionnaires and analyzed using Partial Least Squares Structural Equation Modeling. The results indicate that competence, work environment, and operational leadership each have a positive and significant effect on marine pilot team performance. Furthermore, operational leadership serves as a partial mediator, strengthening the effects of competence and work environment on team performance while maintaining significant direct relationships. These findings demonstrate that reliable pilotage performance depends not only on competent personnel and supportive operational conditions but also on effective operational leadership that translates these resources into coordinated, safe, and efficient operational execution.

Keywords

Competence, Marine Pilot, Operational Leadership, Team Performance, Work Environment.

1. Introduction

Maritime transportation plays a strategic role in global trade, industrial distribution, and supply-chain integration. UNCTAD (2024) reported that more than 80% of global trade volume is transported by sea, highlighting the importance of reliable port operations in maintaining economic continuity. For Indonesia, as an archipelagic country, efficient logistics distribution and industrial activities largely depend on ports' ability to manage vessel movements safely, punctually, and consistently. Within port operations, marine pilotage represents a safety-critical function that involves not only navigational expertise but also the coordination of tugboat operations, radio communication, berth readiness, risk control, and compliance with operational procedures (Hetherington et al., 2006; Chauvin et al., 2013; Xi et al., 2025).

This study focuses on Semen Indonesia Tuban Port, an industrial port that supports the distribution of cement products and bulk materials. Operational data indicate a substantial increase in pilotage activities, from 972 vessel movements in 2024 to 1,384 movements in 2025. Cargo volume also increased from 5,646,837 tons to 5,726,367 tons during the same period. This operational growth has increased coordination complexity because pilotage teams must synchronize vessel movements, tugboat availability, berth allocation, inter-unit communication, and safety control within limited operational windows. Such conditions demonstrate that maintaining operational reliability requires not only technical procedures but also effective management of human and organizational factors (Nahrgang et al., 2011; Bakker & Demerouti, 2017).

Despite established operational procedures, several performance issues remain. Internal evaluation data show that 18–22% of pilotage activities experienced delays, with an average delay duration of 35–60 minutes. Safety records also identified 9–12 near-miss events and 2–3 minor incidents, while 5–8 service complaints were reported regarding delayed services, field coordination problems, and inconsistent procedural implementation. Furthermore, performance achievement remained below operational targets, with punctuality reaching 87% compared with the 95% target, procedural compliance reaching 92% compared with the 100% target, and productivity reaching 90% compared with the 100% target. These conditions indicate that performance in high-risk operational environments is influenced not only by technical systems but also by employee competence, work conditions, and leadership mechanisms that guide operational execution (Clarke, 2012; Kelloway et al., 2017; Payne et al., 2025).

Marine pilot team performance cannot be explained solely by technical competence; it is also shaped by the work environment and operational leadership. Competence reflects the knowledge, skills, experience, decision-making ability, and safety awareness required for high-risk operations (Becker, 1964; Crook et al., 2011). Meanwhile, the work environment provides organizational resources that enable employees to manage complex job demands through adequate support, coordination, and working conditions (Bakker & Demerouti, 2017; Latifah, 2024). Operational leadership further plays a critical role in directing work behavior, strengthening coordination, ensuring procedural compliance, and improving safety performance in risk-intensive industries (Clarke, 2012; Kelloway et al., 2017).

However, several research gaps remain. Previous studies by Qalati et al. (2022) and Zhenjing et al. (2022) have predominantly examined leadership as a direct predictor of performance, while its role as a mechanism that transforms employee competence and work-system support into operational performance remains underexplored. Existing performance studies by Cui and Mo (2025) have largely focused on manufacturing, service, healthcare, construction, and general maritime crews, whereas empirical research on marine pilotage teams in industrial ports

remains limited. Third, mediation studies have mostly emphasized psychological mechanisms such as commitment, job satisfaction, motivation, organizational citizenship behavior, self-efficacy, and safety climate, while the mediating role of operational leadership in high-risk port operations has received limited attention.

To address these gaps, this study introduces operational leadership as a mediating mechanism linking competence and work environment to marine pilot team performance. The novelty of this research lies in positioning operational leadership as a transformation process that converts individual capability and organizational support into safe, timely, coordinated, and reliable operational outcomes. This study aims to examine the effects of competence and work environment on marine pilot team performance and to test the mediating role of operational leadership. The findings contribute theoretically by extending human resource management and safety-performance literature in high-risk operational contexts. Practically, this study provides insights for port managers in developing strategies to strengthen competence, improve work environments, and enhance operational leadership to achieve safer, more efficient, and reliable pilotage services.

2. Literature Review and Hypothesis Development

2.1. The Effect of Competence

Competence refers to the integrated knowledge, skills, experience, judgment, and behavioral capabilities that enable individuals to perform tasks effectively. Based on Human Capital Theory, competence represents a productive resource that improves work quality, reliability, and organizational outcomes (Becker, 1964). In high-risk operations, competence extends beyond formal education and technical certification, encompassing non-technical skills such as situational awareness, communication, decision-making under pressure, teamwork, and safety discipline (Flin et al., 2008; Salas et al., 2015). Maritime safety research further highlights that human and organizational factors, including communication effectiveness and decision quality, significantly influence operational safety outcomes (Hetherington et al., 2006; Chauvin et al., 2013). Recent studies by Barasa et al. (2025) support this perspective by demonstrating that competence, safety equipment, and training contribute to safety climate in Indonesian shipping companies, while Xi et al. (2025) show that safety culture influences ship officers' safety behavior. Therefore, in marine pilotage operations, competent personnel are essential for interpreting navigational conditions, anticipating risks, coordinating with operational units, and responding effectively to dynamic situations.

Leadership effectiveness is not determined solely by formal authority but also by the interaction between leader behavior, follower characteristics, and task conditions (Fiedler, 1967). Contingency Leadership Theory suggests that follower competence influences how leadership functions are performed, as capable team members enable more effective delegation, coordination, and decision-making. Similarly, Functional Leadership Theory views leadership as a process of fulfilling team needs through direction, monitoring, coordination, feedback, and problem-solving (Morgeson et al., 2010). In marine pilotage contexts, competence strengthens operational leadership by reducing uncertainty, improving risk-based decision-making, and supporting accurate task execution. Thus, competent personnel not only contribute directly to performance but also enhance the effectiveness of operational leadership within high-risk maritime systems (Ajith et al., 2025).

H1: Competence has a positive and significant effect on marine pilot team performance.
H2: Competence has a positive and significant effect on operational leadership.

2.2. The Effect of Work Environment

The work environment encompasses physical, technical, social, and procedural conditions that shape task execution and operational outcomes. The Job Demands-Resources (JD-R) framework explains that high job demands, including workload, time pressure, and risk exposure, may reduce performance, whereas job resources such as reliable equipment, effective communication, safety support, and coordination systems enhance employee and team effectiveness (Nahrgang et al., 2011; Bakker & Demerouti, 2017). Empirical evidence from Zhenjing et al. (2022) further confirms that the workplace environment significantly influences employee performance through various mechanisms. In marine pilotage operations, the work environment involves weather and water conditions, tugboat readiness, radio communication, navigational facilities, berth coordination, workload management, and safety support. Unlike conventional workplaces, these operational conditions directly determine the team's ability to perform vessel movements safely, accurately, and on schedule.

The work environment also influences the effectiveness of operational leadership. Safety Leadership Theory highlights that leaders shape safety behavior through communicating priorities, enforcing standards, providing feedback, and managing risks (Zohar, 2010; Clarke, 2012). However, leadership effectiveness is highly dependent on operational conditions, as inadequate communication systems, limited equipment readiness, excessive workload, or weak coordination can constrain leadership actions. Payne et al. (2025) further demonstrate that effective safety leadership requires adaptive leadership approaches based on situational demands. This perspective is particularly relevant to marine pilotage, where leadership practices must respond to variations in vessel traffic, weather conditions, vessel characteristics, and field constraints. Therefore, the work environment functions not only as a contextual factor but also as an enabling mechanism that shapes how operational leadership is implemented and how performance is achieved.

H3: Work environment has a positive and significant effect on marine pilot team performance.
H4: Work environment has a positive and significant effect on operational leadership.

2.3. The Effect of Operational Leadership on Team Performance

Operational leadership refers to the capability of field-level leaders to direct, coordinate, monitor, and control daily operations to ensure safety, punctuality, and procedural compliance. Unlike strategic leadership, which focuses on long-term organizational direction, operational leadership is embedded in task execution. It emphasizes pre-operation briefings, field supervision, cross-unit coordination, emergency response, risk management, and performance evaluation. In high-risk operational environments, leadership effectiveness depends on the ability to adapt behaviors to changing conditions. Zhao et al. (2022) and Mahmud et al. (2023) found that safety leadership positively influences safety climate and employee safety participation, while Omidi et al. (2023) demonstrated that safety leadership and safety climate contribute to safety compliance and safety outcomes. These findings indicate that leadership plays a critical role in translating safety priorities into operational practices.

Recent studies further emphasize the adaptive nature of operational leadership. Payne et al. (2025) argue that effective safety leadership requires a multifaceted and situational approach because different operational conditions demand different leadership behaviors. Similarly, Ajith et al. (2025) highlight that operational-level leaders are essential in adaptive crisis management because they transform organizational strategies into practical field actions. Therefore, operational

leadership should be understood not merely as a supervisory function but as an adaptive coordination capability that enables teams to respond effectively to uncertainty, manage risks, and achieve reliable performance in dynamic and high-risk work systems.

H5: Operational leadership has a positive and significant effect on marine pilot team performance.

2.4. Operational Leadership as a Mediator Variable

High Reliability Organization (HRO) theory suggests that reliable performance in complex and high-risk systems depends on operational awareness, avoidance of oversimplification, commitment to resilience, and reliance on expertise (Weick & Sutcliffe, 2015). These principles indicate that resources alone do not guarantee reliability; rather, competence and supportive work systems must be transformed through processes that promote coordination, learning, vigilance, and disciplined execution. Supporting this view, Dwyer et al. (2023) found that the implementation of HRO principles requires more than formal safety commitments, as it involves concrete organizational practices, leadership involvement, communication routines, learning mechanisms, and operational discipline. Therefore, within marine pilotage operations, HRO provides a practical framework for understanding how competence and work environment are translated into reliable team performance through operational leadership.

Previous mediation studies in performance research have largely emphasized psychological and attitudinal mechanisms. For instance, Zhenjing et al. (2022) examined commitment and achievement-striving as mediators in the relationship between workplace environment and performance, Qalati et al. (2022) identified organizational citizenship behavior as a mediator between transformational leadership and employee performance, and Cui and Mo (2025) demonstrated the mediating role of safety self-efficacy in the relationship between supportive leadership and safety behavior. Although these studies provide valuable insights, they provide limited explanation of how operational performance emerges in field-based technical systems. Drawing on HRO theory and empirical evidence from Dwyer et al. (2023), this study positions operational leadership as a functional mediator that transforms individual competence and work-system conditions into coordinated, safe, and reliable marine pilotage performance.

H6. Operational leadership mediates the effect of competence on marine pilotage team performance.
H7. Operational leadership mediates the effect of work environment on marine pilotage team performance.

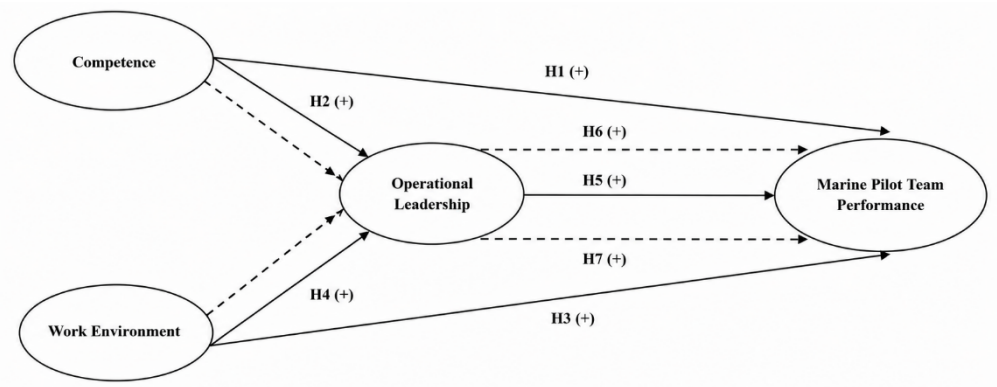

Figure 1. Conceptual Framework

Figure 1 illustrates that competence and work environment directly influence marine pilot team performance and indirectly affect it through operational leadership. The structural model indicates that operational leadership functions as a mediating variable linking competence and work environment with team performance. This suggests that improvements in employee competence and the quality of the work environment contribute to stronger operational leadership practices. In turn, effective operational leadership enhances coordination, decision-making, and the execution of pilotage operations, leading to better team performance. The model demonstrates that both direct organizational factors and the indirect influence of operational leadership shape marine pilot team performance.

3. Methods

This study employed a quantitative explanatory research design to examine the direct and indirect relationships among latent variables, including competence, work environment, operational leadership, and marine pilotage team performance. The research was conducted at Semen Indonesia Tuban Port, an industrial port that supports vessel movements, cargo handling, and the distribution of cement-related products. The unit of analysis was defined as the marine pilotage work system rather than individual pilots alone because pilotage performance is generated through an integrated operational process involving multiple actors. These actors include pilot officers, tugboat operators, Very High Frequency (VHF) communication operators, jetty personnel, safety officers, motor pilot operators, and administrative support staff who collectively contribute to safe, efficient, and reliable vessel operations.

The study population consisted of all personnel involved in the marine pilotage work system at Semen Indonesia Tuban Port. Due to the relatively small population size and the direct involvement of all personnel in pilotage operations, this research applied a census sampling technique. The total number of respondents was 55 personnel, comprising 2 chief pilots, 4 VHF communication operators, 27 tugboat operators, 6 jetty masters, 6 safety officers, 2 motor pilot operators, and 8 administrative support personnel. The inclusion of administrative and safety personnel was methodologically justified because their roles contribute to operational documentation, compliance monitoring, safety control, and coordination mechanisms that support overall pilotage performance. Primary data were collected through a structured questionnaire using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was developed based on the dimensions of each construct, while secondary operational data, including vessel movements, cargo volume, delays, near-miss events, minor incidents, complaints, and performance realization, were used to strengthen the empirical context of the study.

Data analysis was performed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS. The PLS-SEM approach was selected because the proposed model involved multiple latent constructs, mediation relationships, and a limited sample size derived from a specific operational setting. Furthermore, the objective of this study was to explain and predict performance relationships within the marine pilotage system rather than to test covariance-based model fit. The analysis followed the procedures recommended by Hair et al. (2022), including evaluation of the measurement model, structural model, and mediation effects.

The measurement model was assessed through convergent validity, discriminant validity, and internal consistency reliability. Convergent validity was evaluated using outer loadings and Average Variance Extracted (AVE), while reliability was assessed through composite reliability and Cronbach's alpha values. Discriminant validity was examined using the Heterotrait-Monotrait Ratio (HTMT) and Fornell-Larcker criterion. The structural model was evaluated using coefficient of

determination (R^2), predictive relevance, path coefficients, t-statistics, and p-values obtained through bootstrapping procedures. Finally, mediation analysis was conducted to examine the indirect effects of competence and work environment on marine pilot team performance through operational leadership, with the mediation type determined using the Variance Accounted For (VAF) approach.

4. Results

The respondent profile reflects the operational character of the pilotage work system. Most respondents were male (94.5%), aged 30-40 years (43.6%), educated at the senior high school or vocational school level (63.6%), employed on a contract basis (74.5%), married (74.5%), and had more than seven years of work experience (34.5%). Tugboat operators constituted the largest occupational group (49.1%), indicating that the empirical data primarily represent personnel who are directly engaged in vessel maneuvering and navigation support activities. This demographic composition suggests that the respondents possess substantial operational exposure and practical experience in daily pilotage operations, thereby providing relevant insights into competence, leadership, work environment, and team performance within the marine pilotage system. The respondent characteristics are consistent with the operational workforce required to ensure safe and efficient vessel movement at the port.

Table 1. Descriptive statistics of research constructs

Construct	Lowest Indicator	Highest Indicator	Mean	Category
Competence	4.20	4.33	4.247	Very High
Work Environment	4.18	4.42	4.320	
Operational Leadership	4.24	4.31	4.273	
Marine Pilot Team Performance	4.22	4.36	4.287	

Based on Table 1, all research constructs were perceived at a very high level, with mean scores ranging from 4.247 to 4.320. The work environment recorded the highest mean score (M = 4.320), indicating that respondents generally perceived operational conditions, facilities, safety support, and coordination as highly supportive of marine pilot activities. This was followed by team performance (M = 4.287) and operational leadership (M = 4.273), suggesting positive perceptions of leadership practices and overall operational performance. Competence had the lowest mean score (M = 4.247), although it remained within the very high category. Across all constructs, the difference between the lowest and highest indicator scores was relatively small, ranging from 4.18 to 4.42, reflecting consistent responses among participants. The lowest indicator was found in the work environment construct (4.18), while the highest indicator also belonged to the work environment construct (4.42). These findings indicate that respondents perceived competence, work environment, operational leadership, and marine pilotage team performance to be well established within the operational system of Semen Indonesia Tuban Port.

Table 2. Validity and Reliability

Construct	Outer Loading Range	AVE	Composite Reliability	Cronbach Alpha	Decision
Competence	0.771-0.861	0.646	0.901	0.862	Valid and Reliable
Work Environment	0.717-0.868	0.641	0.899	0.861	
Operational Leadership	0.807-0.939	0.742	0.935	0.913	
Marine Pilot Team Performance	0.778-0.896	0.669	0.910	0.875	

Based on Table 2, the measurement model demonstrated satisfactory validity and reliability across all constructs. The outer loading values ranged from 0.717 to 0.939, exceeding the recommended threshold of 0.70, indicating that all indicators adequately represented their respective latent constructs. The AVE values ranged from 0.641 to 0.742, all above the minimum criterion of 0.50, confirming good convergent validity. In terms of internal consistency, composite reliability values ranged from 0.899 to 0.935, while Cronbach's alpha values ranged from 0.861 to 0.913, both exceeding the recommended threshold of 0.70. Among the constructs, operational leadership demonstrated the strongest measurement properties, with the highest AVE (0.742), composite reliability (0.935), and Cronbach's alpha (0.913). These results indicate that all measurement scales are valid and reliable, supporting their suitability for subsequent structural model analysis.

Table 3. Direct Effect

Hypothesis	Path	Original Sample	t-statistic	p-value	Decision
H1	Competence →Marine Pilot Team Performance	0.316	2.088	0.037	Supported
H2	Competence → Operational Leadership	0.445	4.703	0.000	Supported
H3	Work Environment → Marine Pilot Team Performance	0.283	2.424	0.015	Supported
H4	Work Environment → Operational Leadership	0.570	7.245	0.000	Supported
H5	Operational Leadership → Marine Pilot Team Performance	0.434	3.048	0.002	Supported

Based on Table 3, all hypothesized direct relationships were positive and statistically significant, as evidenced by t-statistics greater than 1.96 and p-values below 0.05. Competence had a significant positive effect on marine pilot team performance ($\beta = 0.316$, $t = 2.088$, $p = 0.037$) and operational leadership ($\beta = 0.445$, $t = 4.703$, $p < 0.001$). Similarly, the work environment significantly influenced marine pilot team performance ($\beta = 0.283$, $t = 2.424$, $p = 0.015$) and operational leadership ($\beta = 0.570$, $t = 7.245$, $p < 0.001$). Furthermore, operational leadership exerted a significant positive effect on marine pilot team performance ($\beta = 0.434$, $t = 3.048$, $p = 0.002$). Among all direct relationships, the strongest effect was observed from work environment to operational leadership ($\beta = 0.570$), indicating that supportive operational conditions play a substantial role in strengthening leadership effectiveness within the marine pilot work system. This result suggests that improvements in the physical, organizational, and social aspects of the work environment are likely to enhance leaders' ability to coordinate personnel, allocate

resources, and maintain operational safety during pilotage activities. These findings confirm that competence and work environment function not only as direct determinants of team performance but also as important antecedents of effective operational leadership.

In addition, the standardized path coefficients indicate that operational leadership ($\beta = 0.434$) has a stronger direct influence on marine pilot team performance than competence ($\beta = 0.316$) and work environment ($\beta = 0.283$) individually. This finding implies that leadership serves as a critical mechanism for translating employee capabilities and favorable operational conditions into superior team performance. Although competence and work environment directly contribute to performance, their influence becomes more meaningful when accompanied by leadership practices that facilitate communication, coordination, problem-solving, and timely operational decision-making. The results demonstrate that reliable marine pilot team performance is achieved through the integration of competent personnel, a supportive work environment, and effective operational leadership, reflecting the interdependent nature of human resources and leadership within high-risk maritime operations.

Table 4. Indirect Effect

Hypothesis	Indirect path	Original Sample	t-statistic	p-value	VAF	Mediation
H6	Competence → Operational Leadership → Marine Pilot Team Performance	0.193	2.509	0.012	37.9%	Partial
H7	Work Environment → Operational Leadership → Marine Pilot Team Performance	0.247	2.730	0.006	46.6%	Partial

Based on Table 4, the mediation analysis indicates that operational leadership significantly mediates the relationship between competence, work environment, and marine pilotage team performance. The indirect effect of competence on team performance through operational leadership was positive and significant ($\beta = 0.193$, $t = 2.509$, $p = 0.012$), with a VAF of 37.9%, indicating partial mediation. Likewise, the indirect effect of work environment on team performance through operational leadership was positive and significant ($\beta = 0.247$, $t = 2.730$, $p = 0.006$), with a VAF of 46.6%, indicating partial mediation. Because the corresponding direct effects remained significant, operational leadership did not fully explain the relationships. However, it served as a complementary mechanism that strengthened the influence of competence and work environment on team performance. Moreover, the higher indirect effect and VAF value for the work environment pathway suggest that operational leadership plays a more substantial mediating role in translating supportive work conditions into improved marine pilotage team performance than in translating competence alone.

5. Discussion

The findings demonstrate that competence, work environment, and operational leadership significantly influence marine pilotage team performance. All direct hypotheses were supported, indicating that competence and work environment improve marine pilotage team performance while simultaneously strengthening operational leadership. Furthermore, operational leadership partially mediated the

relationships between competence and marine pilotage team performance as well as between work environment and marine pilotage team performance. These findings indicate that reliable pilotage performance is not determined solely by technical capability or favorable working conditions but is produced through the interaction of human capability, operational resources, and leadership processes within a high-risk operational system (Crook et al., 2011; Dwyer et al., 2023).

The positive effect of competence on marine pilotage team performance supports Human Capital Theory, which considers knowledge, skills, experience, and judgment as productive resources that enhance organizational performance (Becker, 1964; Crook et al., 2011). This finding is consistent with Christian et al. (2009), who reported that individual capability contributes to both safety and performance in high-risk occupations. Likewise, Hetherington et al. (2006) and Chauvin et al. (2013) emphasized that human and organizational factors are fundamental determinants of maritime operational safety. Recent studies further reinforce this argument. Barasa et al. (2025) found that competence and safety training strengthen the safety climate among ship crews. In contrast, Xi et al. (2025) demonstrated that safety-oriented competence promotes safe behavior among ship deck officers. The present study extends these findings by showing that competence contributes not only to operational safety but also to punctuality, productivity, and coordination, which collectively represent marine pilotage team performance. Moreover, competence significantly enhanced operational leadership, supporting Contingency Leadership Theory, which argues that leadership effectiveness depends on the alignment between leader behavior, follower capability, and task conditions (Fiedler, 1967). This finding also supports Functional Leadership Theory, which views leadership as a process of providing direction, coordination, monitoring, and problem solving to improve team effectiveness (Morgeson et al., 2010). Within the pilotage work system, technically competent personnel enable leaders to coordinate operations more effectively because they communicate operational information accurately and support timely risk-based decisions.

The findings also reveal that work environment significantly influences both operational leadership and marine pilotage team performance, with the strongest direct effect occurring between work environment and operational leadership. This result supports the JD-R framework, which proposes that adequate job resources enable employees to perform effectively under demanding work conditions (Nahrgang et al., 2011; Bakker & Demerouti, 2017). In marine pilotage operations, the work environment encompasses weather and water conditions, tugboat readiness, communication reliability, navigational facilities, workload, and inter-unit coordination. These operational conditions directly affect leaders' ability to organize vessel movements safely and efficiently. The finding is consistent with Lee and Jo (2023) and Payne et al. (2025), who argued that safety leadership is highly dependent on operational context, and with Zohar (2010), who emphasized that leadership effectiveness is closely associated with organizational safety conditions. Therefore, a supportive work environment not only facilitates operational execution but also strengthens the effectiveness of operational leadership.

The mediation analysis represents the primary theoretical contribution of this study. Operational leadership partially mediated the relationship between competence and marine pilotage team performance (VAF = 37.9%) and between work environment and marine pilotage team performance (VAF = 46.6%). Because the direct effects remained significant, the mediation is partial, indicating that competence and work environment continue to influence performance directly while their effects are strengthened through operational leadership. This finding differs from previous mediation studies by Qalati et al. (2022) and Cui and Mo (2025) that primarily employed psychological mechanisms, such as organizational citizenship behavior and safety self-efficacy. Instead, the present study demonstrates that

operational leadership functions as a practical coordination mechanism that converts competence and work environment into reliable marine pilotage team performance. This interpretation is consistent with HRO theory, which argues that reliability in complex and high-risk systems is achieved through continuous coordination, disciplined execution, sensitivity to operations, and adaptive leadership rather than through technical resources alone (Weick & Sutcliffe, 2015; Dwyer et al., 2023). Therefore, improving marine pilotage team performance requires an integrated managerial approach that simultaneously strengthens competence, work environment, and operational leadership to ensure safe, punctual, coordinated, and reliable port operations.

6. Conclusion

This study demonstrates that competence, work environment, and operational leadership have positive and significant effects on marine pilotage team performance at Semen Indonesia Tuban Port. Furthermore, operational leadership serves as a partial mediator in the relationships between competence and marine pilotage team performance and between work environment and marine pilotage team performance. These findings indicate that superior operational performance is not achieved solely through competent personnel or supportive working conditions but also through effective operational leadership that coordinates resources, manages operational risks, enforces safety procedures, and ensures the smooth execution of pilotage activities. The study contributes theoretically by extending Human Capital Theory, the JD-R Theory, and HRO Theory, demonstrating that operational leadership functions as a conversion mechanism through which competence and work environment are translated into reliable marine pilotage team performance in high-risk port operations.

From a practical perspective, the findings suggest that port management should adopt an integrated performance improvement strategy by simultaneously strengthening personnel competence, improving the operational work environment, and developing operational leadership capabilities. Nevertheless, this study has several limitations. It was conducted in a single industrial port with a relatively small census sample, which may limit the generalizability of the findings to other maritime settings. In addition, the cross-sectional research design does not capture changes in the relationships among the variables over time. Future research is therefore encouraged to examine multiple ports with different operational characteristics, employ longitudinal research designs, and incorporate additional variables, such as safety culture, safety climate, organizational resilience, or team communication, to provide a more comprehensive understanding of the factors influencing marine pilotage team performance.

References

Ajith, M. M., Lux, A. A., Bentley, T., & Striepe, M. (2025). Adaptive crisis management at the operational level: Responses to COVID-19 in the Australian resources sector. *Journal of Management & Organization*, *31*(4), 1909–1933. https://doi.org/10.1017/jmo.2024.62.

Bakker, A. B., & Demerouti, E. (2017). Job demands-resources theory: Taking stock and looking forward. *Journal of Occupational Health Psychology*, *22*(3), 273–285. https://doi.org/10.1037/ocp0000056.

Barasa, L., Simanjuntak, M., & Syafitra, B. W. (2025). Factors affecting the safety climate of the ship crew: Empirical evidence from shipping companies in Indonesia. *The Asian Journal of Shipping and Logistics*, *41*(2), 75–82. https://doi.org/10.1016/j.ajsl.2025.02.001.

Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. New York: Columbia University Press.

Chauvin, C., Lardjane, S., Morel, G., Clostermann, J. P., & Langard, B. (2013). Human and organisational factors in maritime accidents: Analysis of collisions at sea using HFACS. *Accident Analysis & Prevention*, *59*, 26–37. https://doi.org/10.1016/j.aap.2013.05.006.

Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, *94*(5), 1103–1127. https://doi.org/10.1037/a0016172.

Clarke, S. (2012). Safety leadership: A meta-analytic review of transformational and transactional leadership styles as antecedents of safety behaviours. *Journal of Occupational and Organizational Psychology*, *86*(1), 22–49. https://doi.org/10.1111/j.2044-8325.2012.02064.x.

Crook, T. R., Todd, S. Y., Combs, J. G., Woehr, D. J., & Ketchen, D. J. (2011). Does human capital matter? A meta-analysis of the relationship between human capital and firm performance. *Journal of Applied Psychology*, *96*(3), 443–456. https://doi.org/10.1037/a0022147.

Cui, L., & Mo, J. (2025). How does supportive leadership impact the safety behaviors of the new generation of construction workers? *Behavioral Sciences*, *15*(2), 110-119. https://doi.org/10.3390/bs15020110.

Dwyer, J., Karanikas, N., & Sav, A. (2023). Scoping review of peer-reviewed empirical studies on implementing high reliability organisation theory. *Safety Science*, *164*(1), 106-118. https://doi.org/10.1016/j.ssci.2023.106178.

Fiedler, F. E. (1967). *A theory of leadership effectiveness*. New York: McGraw-Hill.

Flin, R., O'Connor, P., & Crichton, M. (2008). *Safety at the sharp end: A guide to non-technical skills*. Aldershot: Ashgate.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). Thousand Oaks: Sage Publications.

Hetherington, C., Flin, R., & Mearns, K. (2006). Safety in shipping: The human element. *Journal of Safety Research*, *37*(4), 401–411. https://doi.org/10.1016/j.jsr.2006.04.007.

Kelloway, E. K., Nielsen, K., & Dimoff, J. K. (Eds.). (2017). *Leading to occupational health and safety: How leadership behaviours impact organizational safety and wellbeing*. Hoboken: Wiley.

Latifah, M. (2024). The effect of adaptive leadership on employee performance and organizational sustainability. *Economic and Business Horizon*, *3*(3), 96–101. https://doi.org/10.54518/ebh.3.3.2024.509.

Lee, D. Y., & Jo, Y. (2023). The job demands-resource model and performance: The mediating role of employee engagement. *Frontiers in Psychology*, *14*(1), 11-24. https://doi.org/10.3389/fpsyg.2023.1194018.

Mahmud, I., Kalsum, U., & Abbas, B. (2023). How work commitment, work discipline, and workload mediate the relationship between organizational culture and employee performance?: empirical evidence in land office of Southeast Sulawesi Province. *Economic and Business Horizon*, *2*(1), 12–23. https://doi.org/10.54518/ebh.2.1.2023.155.

Morgeson, F. P., DeRue, D. S., & Karam, E. P. (2010). Leadership in teams: A functional approach to understanding leadership structures and processes. *Journal of Management*, *36*(1), 5–39. https://doi.org/10.1177/0149206309347376.

Nahrgang, J. D., Morgeson, F. P., & Hofmann, D. A. (2011). Safety at work: A meta-analytic investigation of the link between job demands, job resources, burnout, engagement, and safety outcomes. *Journal of Applied Psychology*, *96*(1), 71–94. https://doi.org/10.1037/a0021484.

Omidi, L., Karimi, H., Pilbeam, C., Mousavi, S., & Moradi, G. (2023). Exploring the relationships among safety leadership, safety climate, psychological contract of safety, risk perception, safety compliance, and safety outcomes. *Frontiers in Public Health*, *11*(2), 123-135. https://doi.org/10.3389/fpubh.2023.1235214.

Payne, M., Roache, D., Subero, J., & Zhang, G. P. (2025). How safety leadership styles impact safety performance: A case study. *Journal of Safety Research*, *93*(2), 214–228. https://doi.org/10.1016/j.jsr.2025.02.006.

Qalati, S. A., Zafar, Z., Fan, M., Sánchez Limón, M. L., & Khaskheli, M. B. (2022). Employee performance under transformational leadership and organizational citizenship behavior: A mediated model. *Heliyon*, *8*(11), 110-122. https://doi.org/10.1016/j.heliyon.2022.e11374.

Salas, E., Shuffler, M. L., Thayer, A. L., Bedwell, W. L., & Lazzara, E. H. (2015). Understanding and improving teamwork in organizations: A scientifically based practical guide. *Human Resource Management*, *54*(4), 599–622. https://doi.org/10.1002/hrm.21628.

UNCTAD. (2024). *Review of maritime transport 2024*. Retrieved on March 1, 2026, from https://unctad.org/publication/review-maritime-transport-2024.

Weick, K. E., & Sutcliffe, K. M. (2015). *Managing the unexpected: Sustained performance in a complex world* (3rd ed.). Hoboken, NJ: Wiley.

Xi, Y., Wang, Z., Hu, S., Han, B., & Yin, J. (2025). The effect of safety culture on the safety behavior of ship deck officers: Empirical evidence from shipping industry. *Frontiers in Marine Science*, *12*(1), 15-29. https://doi.org/10.3389/fmars.2025.1599455.

Zhao, L., Yang, D., Liu, S., & Nkrumah, E. N. K. (2022). The effect of safety leadership on safety participation of employee: A meta-analysis. *Frontiers in Psychology*, *13*(1), 18-27. https://doi.org/10.3389/fpsyg.2022.827694.

Zhenjing, G., Chupradit, S., Ku, K. Y., Nassani, A. A., & Haffar, M. (2022). Impact of employees workplace environment on employees performance: A multi-mediation model. *Frontiers in Public Health*, *10*(2), 89-99. https://doi.org/10.3389/fpubh.2022.890400.

Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis & Prevention*, *42*(5), 1517–1522. https://doi.org/10.1016/j.aap.2009.12.019.