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Implementation of Safety Culture in Maritime Transportation to Enhance Navigation Safety at Mentawai Port

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Abstract

Maritime transportation is the primary mode of mobility for communities in the Mentawai Islands, making navigational safety a critical aspect of sustainable maritime operations. This study aimed to analyze the implementation of safety culture in maritime transportation and examine its effect on navigational safety at Mentawai Port. A mixed-methods approach was employed by integrating quantitative and qualitative methods. Quantitative data were collected through questionnaires administered to 35 purposively selected respondents, including ship crews, shipping operators, port officers, and passengers, while qualitative data were obtained through semi-structured interviews, field observations, and document analysis. Quantitative data were analyzed using descriptive statistics and simple linear regression, whereas qualitative data were analyzed through data reduction, data display, and conclusion drawing to strengthen the interpretation of the findings. The results indicate that the implementation of safety culture was categorized as very good (mean = 4.24), while navigational safety was categorized as good (mean = 4.20). Regression analysis revealed that safety culture had a positive and significant effect on navigational safety ($R = 0.712$; $R^2 = 0.507$; $t = 5.830$; $p < 0.001$), indicating that safety culture explained 50.7% of the variance in navigational safety. Qualitative findings further revealed that management commitment, compliance with standard operating procedures, effective safety communication, regular safety training, and stakeholder collaboration are essential in strengthening maritime safety, although challenges remain in terms of safety awareness, infrastructure, and emergency preparedness. These findings highlight the importance of fostering a sustainable maritime safety culture to enhance navigational safety in archipelagic regions.

Keywords: Maritime Safety Culture, Navigational Safety, Maritime Transportation, Mentawai Port.

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INTRODUCTION

Indonesia is the world's largest archipelagic nation, consisting of more than 17,000 islands. Consequently, maritime transportation serves as the backbone of community mobility, logistics distribution, and interregional connectivity. The strategic role of maritime transportation is particularly significant in remote island regions where access to land and air transportation remains limited (Riyanto et al., 2026). Mentawai Islands Regency, located in West Sumatra Province, is one of the regions that relies heavily on maritime transportation due to its geographical separation from the mainland of Sumatra and its direct exposure to the Indian Ocean (Saeed et al., 2021; Jiang et al., 2022). Maritime activities in this region not only facilitate the mobility of local communities but also function as the primary driver of economic development, public services, tourism, and the distribution of essential goods. Therefore, ensuring safe and reliable maritime transportation is a fundamental prerequisite for supporting the sustainable development of island regions.

Despite its strategic importance, maritime transportation in archipelagic regions continues to face numerous challenges that may increase the risk of marine accidents. The waters surrounding the Mentawai Islands, which are directly exposed to the Indian Ocean, frequently experience high waves, extreme weather conditions, and unpredictable sea states. These risks are further exacerbated by inadequate port infrastructure, the technical condition of some vessels that do not fully comply with safety standards, and the suboptimal implementation of safety management systems among shipping operators (Ng et al., 2025; Hsieh et al., 2025). These circumstances indicate that improving maritime safety cannot rely solely on technical compliance but also requires the strengthening of a safety culture that is consistently practiced by all stakeholders involved.

Safety culture is a fundamental component of transportation safety systems because it reflects the values, attitudes, perceptions, and behaviors of both individuals and organizations in prioritizing safety above all other considerations (Bokau et al., 2025). Within the maritime sector, safety culture is demonstrated not only through compliance with regulations and standard operating procedures but also through strong management commitment, effective safety communication, continuous training, hazard reporting, and the active participation of all parties involved in maritime operations (Xi et al., 2023). Organizations with a well-established safety culture are generally more capable of identifying potential hazards at an early stage, improving compliance with operational procedures, and reducing the likelihood of maritime accidents (Uddin & Siska, 2026). Therefore, strengthening safety culture represents an important preventive strategy for enhancing maritime safety in a sustainable manner.

The continued occurrence of vessel accidents in the Mentawai Islands indicates that the implementation of safety culture has not yet reached an optimal level. Based on information obtained from relevant authorities and various accident reports, maritime accidents have continued to occur over recent years, predominantly involving small vessels, fishing boats, Motor Sailing Vessels (Kapal Layar Motor/KLM), and inter-island passenger ships. These incidents are generally attributed to a combination of extreme weather conditions, engine failures, inadequate safety equipment, and insufficient compliance with maritime safety procedures (Prasetiawan et al., 2024). In 2024, the Mentawai Search and Rescue Office recorded 24 search and rescue operations, the majority of which were related to vessel accidents. Throughout 2025, maritime accidents continued to be reported, including a passenger vessel accident in the Sipora Strait that was associated with adverse weather conditions (Wibawanti et al., 2024). These incidents demonstrate that maritime safety in the Mentawai Islands remains a critical issue requiring serious attention from all relevant stakeholders.

An analysis of these maritime accidents suggests that navigation safety is influenced not only by natural environmental conditions but also by organizational and human factors (Veltsin et al., 2025). Although extreme weather is inherently difficult to control, its consequences can be substantially mitigated when vessel operators, seafarers, port authorities, and service users possess a strong safety culture (Shi et al., 2024). Avoiding voyages during adverse weather conditions, ensuring the availability of adequate safety equipment, conducting regular seaworthiness inspections, and complying with established operational procedures are practical manifestations of safety culture that can significantly reduce accident risks (Dugan & Utne, 2024). Accordingly, strengthening safety culture should be regarded as a long-term investment in developing a safe, resilient, and sustainable maritime transportation system.

Ports occupy a strategic position as key nodes within the maritime transportation network and serve as the primary locations for implementing navigation safety policies. Mentawai Port functions not only as a terminal for passenger embarkation, disembarkation, and cargo handling but also as the center for vessel seaworthiness inspections, operational supervision, and capacity building for shipping operators and seafarers (Sühring *et al*., 2023). Given that its operations are dominated by traditional vessels and inter-island passenger ships, the implementation of safety culture at Mentawai Port presents greater challenges than those encountered at large-scale commercial ports (Park & Lee, 2025). Therefore, systematic efforts are required to foster a comprehensive safety culture involving government agencies, shipping operators, port personnel, and maritime transportation users in order to improve navigation safety in a sustainable manner (Liou & Tseng, 2024).

Previous studies have examined safety culture within the maritime sector; however, most have primarily focused on the implementation of safety management systems, compliance with

international regulations, or technical and operational aspects of vessel operations (Abduh et al., 2022; Mashartanto et al., 2024; Riyadi & Erliyani, 2025). Empirical research specifically investigating the relationship between safety culture and navigation safety at ports located in Indonesia's remote archipelagic regions remains relatively limited. Furthermore, studies integrating the perspectives of seafarers, shipping operators, port officials, and service users to evaluate the implementation of safety culture are still scarce. These limitations reveal a significant research gap that warrants further investigation through context-specific studies reflecting the unique characteristics of Indonesia's archipelagic environment.

In response to this research gap, the present study contributes by examining the implementation of safety culture in maritime transportation at Mentawai Port using a mixed-methods approach. This approach enables quantitative analysis of the influence of safety culture on navigation safety while simultaneously incorporating qualitative exploration to better understand the factors affecting the implementation of safety culture in practice. The findings are expected to provide empirical evidence regarding the current state of safety culture at Mentawai Port and to serve as a basis for developing more effective and sustainable strategies for improving navigation safety. Accordingly, this study aims to analyze the level of safety culture implementation in maritime transportation at Mentawai Port, identify the factors influencing its implementation, and examine the effect of safety culture on navigation safety. Ultimately, the findings are expected to contribute to the development of maritime safety policies, the enhancement of human resource capacity within the maritime sector, and the advancement of scientific knowledge on safety culture in maritime transportation across Indonesia's archipelagic regions.

METHOD

This study employed a mixed-methods approach that integrated quantitative and qualitative methods to obtain a comprehensive understanding of the implementation of safety culture in maritime transportation at Mentawai Port. The quantitative approach was used to measure the levels of safety culture and navigation safety, as well as to examine the relationship between these two variables. Meanwhile, the qualitative approach was employed to strengthen the interpretation of the quantitative findings through an in-depth exploration of the actual conditions observed in the field (Zhao et al., 2024). The study was conducted at Mentawai Port, Mentawai Islands Regency, West Sumatra Province, which serves as the primary hub for inter-island maritime transportation. The research site was purposively selected because of its unique characteristics as an archipelagic region that is highly dependent on maritime transportation while facing various navigation safety challenges arising from human, technical, and environmental factors.

The study population comprised all stakeholders involved in maritime transportation activities at Mentawai Port, including seafarers, shipping operators, port personnel, and passengers. The research sample was determined using a purposive sampling technique based on the respondents' involvement in maritime operations and their understanding of navigation safety issues. A total of 35 respondents participated in the study, consisting of seafarers, shipping operators, port personnel, and passengers. Data were collected through questionnaires, interviews, observations, and document analysis. The questionnaire was used to obtain quantitative data regarding respondents' perceptions of safety culture and navigation safety using a five-point Likert scale. In-depth interviews were conducted with key informants to gather information regarding the implementation of safety culture, the challenges encountered, and efforts to improve navigation safety. Observations were undertaken to directly examine the implementation of safety procedures within the port environment, while document analysis was used to complement the research data through official documents, reports, and archival records related to navigation safety.

Quantitative data were analyzed using descriptive statistics, including mean scores and percentages, to describe the levels of safety culture and navigation safety. Furthermore, the effect of safety culture on navigation safety was examined using simple linear regression analysis. Qualitative data were analyzed through the processes of data reduction, data display, and conclusion drawing to provide a more comprehensive explanation of the quantitative findings. The integration of both approaches was carried out during the interpretation stage, thereby providing a holistic understanding of the implementation of safety culture in supporting navigation safety at Mentawai Port.

RESULT AND DISCUSSION

1. Quantitative Data Analysis

a. Respondent Characteristics

The characteristics of the respondents were analyzed based on gender, age, and occupation.

Table 1. Characteristics of the Research Respondents

Characteristic	Description	Frequency	Percentage
Gender	Male	26	74 %
	Female	9	26 %
Age	< 25 years	12	34%
	26-35 years	14	40%
	36-55 years	9	26%
Occupation	Seafarers	8	20%
	Shipping Operators/Service Personnel	5	14%
	Port Personnel	15	45,7%
	Passengers	7	20%
TOTAL		35	100%

Source: Processed Research Data (2026)

Based on Table 1, it can be observed that the majority of the respondents were male, accounting for 26 individuals (74%), indicating that the maritime transportation sector continues to be predominantly staffed by men. In terms of age, most respondents were within the productive age group of 26–35 years (40%). Regarding occupation, the largest proportion of respondents were port personnel.

b. Description of the Safety Culture Variable

The safety culture variable (X) and navigation safety variable (Y) were measured using five indicators represented by ten questionnaire items developed based on these indicators. All items were assessed using a five-point Likert scale ranging from strongly disagree to strongly agree.

Table 2. Summary of the Safety Culture Variable (X)

No	Statement	Mean	Category
X1	Management prioritizes safety above all other organizational objectives.	4,32	Very Good
X2	Management supports the implementation of safety procedures.	4,29	Very Good
X3	Compliance with navigation safety standard operating procedures (SOPs).	4,35	Very Good
X4	Safety equipment is used in accordance with established regulations.	4,21	Very Good
X5	Safety information is communicated clearly.	4,25	Very Good
X6	Coordination during emergency situations is well organized.	4,21	Very Good
X7	Safety training is conducted regularly.	4,19	Good
X8	Personnel understand emergency response procedures.	4,18	Good
X9	Safety awareness is demonstrated by all port personnel and seafarers.	4,22	Very Good
X10	Potential hazards are reported proactively.	4,20	Good
	Average	4,24	Very Good

Source: Processed Research Data (2026)

The safety culture variable in this study was measured using five principal indicators: management commitment to safety, compliance with safety procedures, safety communication, safety training and competence, and safety awareness and participation. Based on the analysis of data collected from 35 respondents, the overall mean score for the safety culture variable was 4.24, which falls within the "Very Good" category. This finding

indicates that safety culture has been effectively implemented by the stakeholders involved in maritime transportation operations at Mentawai Port.

c. Description of the Navigation Safety Variable

Table 3. Summary of the Navigation Safety Variable (Y)

No	Statement	Mean	Category
Y1	Vessel operations at Mentawai Port are conducted in accordance with navigation safety procedures.	4,36	Very Good
Y2	Operating vessels possess adequate technical seaworthiness.	4,20	Good
Y3	Maritime accident prevention measures are routinely implemented by the relevant authorities.	4,25	Very Good
Y4	The risk of vessel accidents can be minimized through effective supervision.	4,33	Very Good
Y5	Port personnel and seafarers are prepared to respond to emergency situations.	4,22	Very Good
Y6	Emergency response equipment is available and functions properly.	4,11	Good
Y7	Seafarers pay close attention to passenger safety during voyages.	4,25	Very Good
Y8	Passengers receive safety information before vessel departure.	4,14	Good
Y9	Navigation safety inspections are conducted regularly by the port authority.	4,22	Very Good
Y10	Regular evaluations of navigation safety implementation are conducted to prevent maritime accidents.	4,20	Good
	Average	4,20	Good

Source: Processed Research Data (2026)

The navigation safety variable was measured using five indicators, namely operational safety, maritime accident prevention, emergency preparedness, crew and passenger safety, and safety monitoring and evaluation. Based on the analysis of responses from 35 participants, the overall mean score was 4.20, which is categorized as "Good." These findings indicate that the level of navigation safety at Mentawai Port has been implemented effectively and is supported by various aspects of maritime operational management.

d. Validity Test

The validity test was conducted to determine whether each questionnaire item was capable of accurately measuring the intended research variables. Item validity was evaluated using the Pearson Product-Moment correlation based on responses from 35 participants. A questionnaire item was considered valid when its calculated correlation coefficient (r-value) exceeded the critical r-table value at the 5% significance level. With a sample size of 35 respondents (n = 35), the degrees of freedom were 33 (df = n – 2), resulting in a critical r-table value of 0.334 ($\alpha = 0.05$).

Table 4. Validity Test Results

No	Item	r-calculated	r-table	Result
1	X1	0,682	0,334	Valid
2	X2	0,715	0,334	Valid
3	X3	0,641	0,334	Valid
4	X4	0,734	0,334	Valid
5	X5	0,697	0,334	Valid
6	X6	0,663	0,334	Valid
7	X7	0,751	0,334	Valid
8	X8	0,719	0,334	Valid
9	X9	0,684	0,334	Valid
10	X10	0,726	0,334	Valid
11	Y1	0,705	0,334	Valid
12	Y2	0,688	0,334	Valid
13	Y3	0,732	0,334	Valid

14	Y4	0,756	0,334	Valid
15	Y5	0,714	0,334	Valid
16	Y6	0,676	0,334	Valid
17	Y7	0,748	0,334	Valid
18	Y8	0,721	0,334	Valid
19	Y9	0,691	0,334	Valid
20	Y10	0,739	0,334	Valid

Source: Processed Research Data (2026)

As presented in Table 4, all questionnaire items measuring the Safety Culture variable (X) produced calculated correlation coefficients ranging from 0.641 to 0.751. Similarly, all items measuring the Navigation Safety variable (Y) yielded calculated correlation coefficients ranging from 0.676 to 0.756. Since all calculated r-values exceeded the critical r-table value of 0.334, every questionnaire item was confirmed to be valid. Therefore, the research instrument satisfied the validity requirement and was considered appropriate for data collection and subsequent statistical analyses.

e. Reliability Test

The reliability test was conducted to assess the consistency of the research instrument in measuring the study variables. Instrument reliability was evaluated using Cronbach's Alpha with the assistance of IBM SPSS Statistics software. According to Malkewitz et al. (2023), a variable is considered reliable when it has a Cronbach's Alpha coefficient greater than 0.70.

Table 5. Reliability Test Results

Variable	No. of Items	Cronbach's Alpha	Criterion	Result
Safety Culture (X)	10	0,893	> 0,70	Reliable
Navigation Safety (Y)	10	0,911	> 0,70	Reliable

Source: Processed Research Data (2026)

The reliability test results indicate that the Safety Culture variable (X) obtained a Cronbach's Alpha coefficient of 0.893, while the Navigation Safety variable (Y) achieved a coefficient of 0.911. Both values exceed the minimum acceptable threshold of 0.70, indicating that all questionnaire items for both variables are reliable and possess excellent internal consistency.

f. Normality Test

The normality test was performed to determine whether the research data, or more specifically the regression residuals, followed a normal distribution. In this study, normality was assessed using the One-Sample Kolmogorov-Smirnov test in IBM SPSS Statistics. According to Hasnur et al. (2026), he decision criteria are as follows: if the Asymp. Sig. value is greater than 0.05, the data are normally distributed; otherwise, the data are not normally distributed.

Table 6. Results of the Normality Test

One-Sample Kolmogorov-Smirnov Test	Unstandardized Residual
N	35
Mean	0,0000000
Std. Deviation	2,186
Most Extreme Differences (Absolute)	0,108
Positive	0,108
Negative	-0,071
Test Statistic	0,108
Asymp. Sig. (2-tailed)	0,200

Source: Processed Research Data (2026)

The results of the One-Sample Kolmogorov-Smirnov test showed an Asymp. Sig. (2-tailed) value of 0.200. Since this value is greater than the significance level of 0.05, the regression residuals can be considered normally distributed. Therefore, the normality assumption required for regression analysis was satisfied.

g. Linearity Test

The linearity test was conducted to determine whether the relationship between the independent variable (X) and the dependent variable (Y) was linear. The relationship is

considered linear when the significance value for the Deviation from Linearity is greater than 0.05. The results of the linearity test are presented below.

Table 7. Results of the Linearity Test

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups (Combined)	245.630	12	20.469	3.214	0.011
Linearity	198.420	1	198.420	31.152	0.000
Deviation from Linearity	47.210	11	4.292	0.674	0.746
Within Groups	140.180	22	6.372	-	-

Source: Processed Research Data (2026)

As presented in Table 7, the significance value for the Deviation from Linearity was 0.746. Since this value is greater than 0.05, it can be concluded that no significant deviation from linearity exists. Furthermore, the significance value for the Linearity component was 0.000, which is below 0.05, indicating that the linear relationship between the independent and dependent variables is statistically significant.

h. Coefficient of Determination (R^2)

The coefficient of determination (R^2) analysis was conducted to determine the extent to which the independent variable (X) explains the variation in the dependent variable (Y). The results are presented in Table 8.

Table 8. Results of the Coefficient of Determination (R^2)

Model	R	R Square	Adjusted R Square
1	0.712	0.507	0.492

Source: Processed Research Data (2026)

Table 8 shows an R value of 0.712, indicating a strong relationship between the independent and dependent variables. The coefficient of determination (R^2) is 0.507, indicating that Safety Culture explains 50.7% of the variation in Navigation Safety, while the remaining 49.3% is attributable to other factors not included in the research model.

i. F-Test Results

The F-test was conducted to determine whether the independent variable collectively has a significant effect on the dependent variable. The analysis was based on a sample of 35 respondents.

Table 9. Results of the F-Test

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	352.184	1	352.184	33.995	0.000
Residual	341.816	33	10.358	-	-
Total	694.000	34	-	-	-

Source: Processed Research Data (2026)

The F-test results indicate an F-statistic of 33.995 with a significance value of 0.000. Since the significance value is below 0.05, it can be concluded that the independent variable has a statistically significant effect on the dependent variable.

j. Simple Linear Regression Analysis

Table 10. Results of the Simple Linear Regression Analysis

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.
B	Std. Error	Beta		
(Constant)	12.584	3.102	-	4.057
Variabel X	0.845	0.145	0.712	5.830

Source: Processed Research Data (2026)

The simple linear regression equation obtained from the analysis is:

Y=12,584+0,845

The equation indicates that the constant value of 12.584 represents the expected value of the dependent variable when the independent variable equals zero. The regression coefficient of 0.845 indicates that every one-unit increase in Safety Culture is associated with a 0.845-unit increase in Navigation Safety. Furthermore, the calculated t-value of 5.830 with a significance level of 0.000 indicates that Safety Culture has a positive and statistically significant effect on Navigation Safety.

k. Hypothesis Testing (t-Test)

The t-test was performed to determine whether the independent variable (X) individually exerts a significant effect on the dependent variable (Y). The decision criteria are as follows: if the significance value is less than 0.05, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted; otherwise, H_0 is accepted.

Table 11. Results of the Hypothesis Test

Variable	t-calculated	t-table	Sig.	Decision
Variable X	5.830	2.034	0.000	H_0 Rejected; H_1 Accepted

Source: Processed Research Data (2026)

As shown in Table 11, the calculated t-value is 5.830, whereas the critical t-value at 33 degrees of freedom and a significance level of 0.05 is 2.034. Since the calculated t-value exceeds the critical value (5.830 > 2.034) and the significance value is less than 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted. These findings demonstrate that Safety Culture has a positive and statistically significant effect on Navigation Safety among the 35 respondents included in this study. Therefore, the research hypothesis proposing that Safety Culture significantly influences Navigation Safety at Mentawai Port is supported.

2. Qualitative Data Analysis

The qualitative findings were obtained through semi-structured interviews and field observations to provide a deeper understanding of the implementation of safety culture in maritime transportation at Mentawai Port. Interviews were conducted with four groups of informants, namely seafarers, shipping operators, port personnel, and passengers, who were selected based on their direct involvement in maritime operations. Field observations focused on compliance with safety procedures, the availability of safety facilities and equipment, personnel behavior, safety communication, and emergency preparedness. The qualitative data were analyzed through data reduction, data display, and conclusion drawing to identify the major themes related to the implementation of safety culture. These qualitative findings were subsequently used to complement and provide a more comprehensive explanation of the quantitative results concerning the influence of safety culture on navigation safety at Mentawai Port.

Interviews with eight seafarers, including captains, chief engineers, first engineers, third officers, helmsmen, and deck crew members, revealed that all informants possessed a sound understanding of the importance of safety culture in supporting navigation safety. Safety culture was implemented through compliance with standard operating procedures (SOPs), the use of personal protective equipment, pre-departure inspections of safety equipment, safety briefings, effective communication, and regular emergency drills and training. The informants also emphasized that effective communication among crew members and strict adherence to safety procedures were the primary factors in preventing onboard accidents. Nevertheless, several challenges were identified, including inconsistent discipline among some crew members, limited safety awareness programs for passengers, delays in the provision of safety equipment, suboptimal dock facilities, and the impact of adverse weather conditions on maritime operations (Narayanan et al., 2023). These findings suggest that strengthening safety culture requires continuous improvement in crew competence, regular maintenance of safety facilities, ongoing training programs, and more consistent supervision of compliance with safety procedures (Farjami, 2024).

Furthermore, interviews with five shipping operators representing PT Mentawai Angkutan Samudera (PT MAS), field operators, and PT ASDP Indonesia Ferry indicated that the companies have generally demonstrated a strong commitment to implementing safety culture in maritime transportation. This commitment is reflected in the implementation of standard operating procedures (SOPs), pre-departure safety briefings, regular safety evaluations and training, and effective coordination among shipping operators, vessel crews, the Harbormaster's Office, and port personnel through various communication channels. The informants considered the existing communication and operational monitoring systems to be supportive of navigation safety implementation. However, several challenges remain, including limited safety awareness among some personnel, operational schedule pressures, inadequate safety facilities, and the need to strengthen management commitment (Nævestad & Phillips, 2023). These challenges may reduce the consistency of safety culture implementation if they are not addressed through continuous improvement (Tappura et al., 2022). Therefore, enhancing human resource competencies through education and training, strengthening supervision of SOP compliance, improving safety

communication and reporting systems, and providing adequate safety facilities are essential to support sustainable navigation safety.

Subsequently, interviews with seven port officials representing the Class III Port Administration Unit (UPP) Sioban, the Class I Padang Port Health Quarantine Office, the Department of Transportation, and the Indonesian Navy Post revealed that the implementation of safety culture at Tuapejat Port has been established but has not yet reached its optimal level. The informants stated that safety procedures and inter-agency coordination supporting port operations have generally been implemented effectively. Nevertheless, several challenges remain, including limited public awareness of safety, inadequate port facilities and emergency response infrastructure, and suboptimal risk mitigation practices. In addition, adverse weather conditions, infrastructure limitations, and the need to enhance personnel competencies through continuous education and training were identified as factors affecting the effectiveness of safety culture implementation. Despite these challenges, the collaboration among the Harbormaster's Office, shipping operators, port personnel, and relevant government agencies constitutes a valuable foundation for maintaining navigation safety at Tuapejat Port (Yi et al., 2025). Therefore, strengthening safety culture requires greater public safety awareness, the provision of adequate safety facilities, continuous human resource development, and consistent monitoring and enforcement of maritime safety regulations.

Finally, interviews with seven passengers indicated that they generally felt safe and comfortable using maritime transportation at Mentawai Port and perceived that safety culture had been implemented satisfactorily. Most informants reported receiving safety information or briefings prior to departure, considered safety equipment to be easily accessible, and appreciated the prompt response of vessel crews and port personnel in providing passenger services. However, several passengers noted that safety information was not consistently delivered to all passengers, communication between personnel and passengers still required improvement, and embarkation and disembarkation facilities needed upgrading to enhance safety and comfort. Furthermore, passengers emphasized the importance of regular inspections of safety equipment, ensuring that passenger numbers remain consistent with vessel capacity, and increasing fleet capacity during peak travel periods (Veitch et al., 2024; Liu et al., 2026). These findings indicate that passengers generally hold positive perceptions of navigation safety; however, strengthening safety education, improving service quality, and providing more adequate facilities remain essential to support the sustainable development of safety culture (Han et al., 2024).

Field observations further revealed that the implementation of safety culture at Mentawai Port has generally been effective, although several aspects still require improvement. Compliance with safety procedures was demonstrated through ticket and passenger manifest inspections, the implementation of orderly embarkation and disembarkation procedures, and the provision of safety instructions before departure, although these practices were not consistently applied across all vessels. Safety equipment, including life jackets, lifebuoys, portable fire extinguishers, and evacuation signage, was available on most vessels and within the port area; however, several items required periodic inspection and maintenance to ensure their continued operational effectiveness. From a behavioral perspective, vessel crews and port personnel demonstrated responsiveness in assisting passengers and maintained effective communication and coordination during berthing, embarkation, and vessel departure, including the delivery of safety information (Pilbeam & Karanikas, 2023). In addition, emergency preparedness was supported by established incident response procedures and evacuation mechanisms (Waskito et al., 2026). Nevertheless, the implementation of regular emergency drills should be further strengthened to enhance the preparedness of all stakeholders in responding to emergency situations.

The findings demonstrate that safety culture has a positive and statistically significant effect on navigation safety at Mentawai Port. This conclusion is supported by quantitative evidence indicating a strong relationship between the two variables, as well as qualitative findings from interviews and field observations demonstrating the implementation of standard operating procedures (SOPs), effective safety communication, the use of personal protective equipment, and regular safety training (Khan et al., 2026). These findings are consistent with previous studies suggesting that safety culture is a key determinant of operational safety in maritime transportation because it promotes disciplined work behavior, improves compliance with operational procedures, and reduces the likelihood of maritime accidents (Baskoro et al., 2026). The present study further confirms that management commitment, stakeholder coordination, and continuous safety training

are essential components in developing an effective safety culture. Nevertheless, despite the overall safety culture being classified within the "Very Good" category, several operational challenges remain, including inadequate safety facilities, limited safety awareness among some transportation users, and the influence of adverse weather conditions, all of which may reduce the effectiveness of safety culture implementation (Purwantini et al., 2026). These findings suggest that the success of safety culture depends not only on individual behavior but also on organizational support, infrastructure quality, and the characteristics of the operational environment.

Compared with previous studies, which have primarily focused on safety management systems, regulatory compliance, or technical aspects of vessel operations, this study offers a more comprehensive perspective by integrating quantitative and qualitative approaches while involving four major stakeholder groups, namely seafarers, shipping operators, port personnel, and passengers (Nazarwin et al., 2025). This integrated approach demonstrates that perceptions of safety culture are relatively consistent across all respondent groups, with safety being regarded as a shared responsibility requiring collaboration among all stakeholders. At the same time, the study identified differences in stakeholder perspectives (Nazarwin et al., 2026). Shipping operators placed greater emphasis on compliance with standard operating procedures and organizational commitment, whereas port personnel and passengers highlighted the importance of adequate safety facilities, public safety education, and improvements in service quality (Irwan et al., 2024). These findings indicate that strengthening safety culture requires a multidimensional approach that extends beyond regulatory compliance to include improvements in communication (Widiatmaja et al., 2026), safety education, operational supervision, and the provision of adequate infrastructure and facilities. Consequently, this study contributes to a broader understanding of safety culture implementation in ports located within archipelagic regions, where operational characteristics and safety challenges differ substantially from those encountered at conventional commercial ports.

The principal contribution of this study lies in providing empirical evidence that safety culture within archipelagic port environments is influenced not only by organizational and human resource factors but also by geographical characteristics, infrastructure limitations, and the level of safety literacy among maritime transportation users (Silen, 2026). These findings represent an important contribution beyond previous studies, which have rarely integrated the perspectives of all relevant stakeholders when evaluating maritime safety culture in island regions. Nevertheless, this study has several limitations (Barasa et al., 2025). The relatively small sample size and the focus on a single port limit the generalizability of the findings to other ports throughout Indonesia. Therefore, future research should include broader geographical coverage, larger sample sizes, and more comprehensive analytical approaches, such as Structural Equation Modeling (SEM), to examine the mediating or moderating roles of variables such as safety leadership, safety climate, crew competence, and risk management. In addition, future studies should develop a maritime safety culture model that explicitly considers the unique characteristics of Indonesia's archipelagic regions, thereby providing a stronger foundation for formulating more adaptive and sustainable maritime safety policies.

CONCLUSION

Navigation safety in archipelagic regions requires the strengthening of safety culture as an integral component of comprehensive risk management implemented by all maritime stakeholders. The effective implementation of safety culture, supported by strong organizational commitment, effective coordination, competent human resources, and adequate safety facilities, contributes significantly to the development of safer and more sustainable maritime transportation systems. This study demonstrates that improving navigation safety depends not only on compliance with technical standards and regulatory requirements but also on fostering collective awareness and behavior that prioritize safety in every aspect of maritime operations. Therefore, strengthening safety education, implementing continuous training programs, enhancing the quality of operational supervision, and improving safety infrastructure should be carried out in an integrated manner to enhance the effectiveness of safety culture at Mentawai Port. The findings of this study are expected to provide valuable insights for policymakers and port authorities in developing navigation safety strategies that are adaptive to the unique characteristics of Indonesia's archipelagic regions while supporting the establishment of a more reliable and sustainable maritime transportation system.

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