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The Influence of Safety Culture on Aviation Safety Through the Implementation of Safety Management System in Papua: Case Study of Safety Risk Management and Aircraft Crew Training

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Abstract: This research examines the influence of safety culture on aviation safety through the implementation of the Safety Management System (SMS) in Papua. The focus of this study is on safety risk management and crew training at airports in Papua, which face unique challenges such as extreme weather and difficult terrain. The research method used is quantitative analysis by collecting data through surveys and interviews. The results indicate that the implementation of a strong and effective safety culture can significantly improve aviation safety. Additionally, well-implemented SMS helps in identifying and managing risks and enhancing the quality of training and personnel qualifications. The study also emphasizes the importance of involving all stakeholders, including local communities, to create an environment that supports aviation safety. The implications of this research suggest the need for increased support and investment in infrastructure as well as continuous training to address operational challenges in Papua

Keywords: aircraft crew training, aviation safety, safety culture, safety management system, safety risk management

INTRODUCTION

Aviation safety is a crucial aspect of the aviation industry, with a global commitment to ensuring optimal standards. All airlines must comply with international rules such as those from ICAO and FAA, as well as national regulations such as Law No. 1 of 2009 and Government Regulation No. 3 of 2001. Aviation safety is determined through operating procedures and technical requirements. However, ICAO data shows that the highest global accident rate occurred in 2012, with 3.2 accidents per one million departures. In order to improve aviation safety, the Indonesian government issued Ministerial Regulation No. 21 of 2015 concerning Civil Aviation Safety. The Federal Aviation Administration identified three main factors causing accidents: weather conditions, aircraft factors, and human error. This is due to the low level of discipline of aviation personnel regarding safety culture (Umar & Anggraeni, 2020).

Human factor is also an important aspect in building an aviation safety culture (Fatonah et al., 2023). Professional human resources play a crucial role in enhancing aviation safety,

particularly within the air cargo sector (Bunahri, 2023). The dominant cause of aviation accidents in Indonesia is the human factor, with a percentage reaching 60% (Poerwanto & Mauidzoh, 2016). Human development, not technology, limits the technical characteristics of aircraft in the 21st century (Kozuba, 2011). In aircraft maintenance, human factors are widely used for the design of aircraft maintenance hangars, workshops, task cards, and the design of tools and equipment needed to improve maintenance performance (Sheikhalishahi et al., 2016). In the world of air transportation, its main task involves providing airport services and related services, as well as managing aspects of security, safety, and flight order at airports that have not been commercially operated. Papua, with its rapid development of transportation systems, requires good safety management at airports.

Increased airport activity affects the safety management system, with the main challenges being the lack of personnel and facilities that reduce the effectiveness of passenger supervision. Issues in terminal operations can significantly impact the performance and efficiency of airport activities, especially in air cargo services (Bunahri et al., 2023). Safety culture, which includes shared norms and values within an organization, is a key element in SMS, especially in Papua with its unique challenges. Complying with international standards such as ICAO and building a safety culture are proactive steps to address environmental and weather challenges in the area. Reducing the risk of accidents is the main goal of safety culture, which helps organizations in Papua, with its extreme weather conditions and difficult terrain, identify and manage risks more effectively. Safety culture integrates safety values into operational procedures and decision-making, increasing vigilance, accountability, and efficiency. It encourages reporting of incidents without fear of punishment, facilitates learning from mistakes, and corrects weaknesses in the SMS. Safety culture also focuses on equipment maintenance, training, and procedures that are appropriate to the work environment, and involves all stakeholders to support the safety system at Papua airports.

The implementation of the Safety Management System (SMS) significantly improves aviation safety in Papua by addressing its operational challenges. SMS helps airport staff identify and address risks, especially in diverse geographical and weather conditions, and implement appropriate preventive measures. The system also improves personnel qualifications and training to deal with extreme weather and difficult terrain. Incident data analysis allows for identification of areas for improvement and ongoing actions to enhance operational safety. The Safety Management System (SMS) ensures that the airport remains adaptive to changing conditions, regulations and technology through continuous performance monitoring. SMS engages all stakeholders, including airlines, authorities and the community, to create a cooperative and supportive working environment. In Papua, SMS enables the development of specific operational procedures, such as real-time weather monitoring and rapid response planning. In addition, SMS educates the local community and involves them in aviation safety efforts, making it a shared responsibility.

The implementation of safety culture and Safety Management System (SMS) faces major challenges from extreme physical environmental conditions, such as bad weather and difficult terrain, which affect employee attitudes and behavior in maintaining the health and safety of the organization (Choudhry et al., 2007). Culture in safety culture is used in industry because it is applied to organizations and safety (Glendon & Stanton, 2000). Limited resources and infrastructure, such as runway maintenance and air navigation, require greater support and investment to support an effective safety culture.

Personnel qualifications and training are critical in Papua, given the unique climate and environment; inadequate training can increase risks. Stakeholder engagement and understanding of local culture are also challenges, particularly in terms of communication and local values. Managing additional risks such as natural disasters and coordination between different organizations at the airport need to be addressed. A thorough understanding of these issues is crucial to building and maintaining an effective safety culture and improving overall

operational safety. Therefore, this study aims to determine how safety culture and safety management systems influence flight safety and are interconnected at Papua Airport.

METHOD

This research method uses an ex-post facto design with a quantitative approach to analyze numerical data through statistical techniques. The study was conducted at Sentani Jayapura Airport from January to March 2024, with a population including aviation security officers, apron movement control, and passenger service. The sample was taken by purposive sampling, namely the entire population of 40 people. Data collection techniques involve observation, documentation, and questionnaires that have been tested for validity and reliability. The data were analyzed using the path analysis method to identify direct and indirect influences between variables, as well as multiple linear regression analysis. In addition, a determination coefficient test, t-test, F-test, and Sobel test were carried out after the classical assumption test was carried out to ensure the validity of the analysis results.

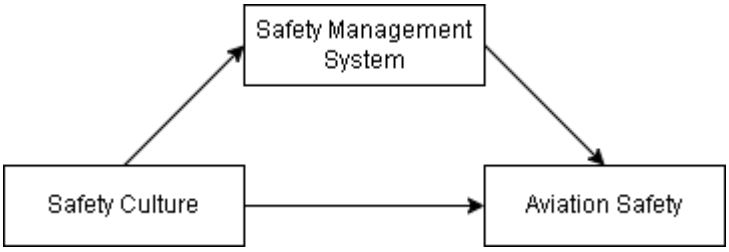

Figure 1. Research Design

RESULTS AND DISCUSSION

Descriptive Data

Table 1. Descriptive data on safety culture

	N	Minimum	Maximum	Mean	Std. Deviation
Commitment	30	1.00	5.00	4.4667	.86037
Truth	30	2.00	5.00	4.3000	.83666
Information	30	1.00	5.00	4.2000	1.03057
Vigilance	30	1.00	5.00	4.2000	1.12648
Adaptation	30	1.00	5.00	2.9000	1.34805
Attitude	30	1.00	5.00	3.6000	1.13259
Valid N (listwise)	30				

The results show that commitment, truth, information, and awareness in aviation safety culture have a high average with relatively consistent respondent perceptions. Commitment (average 4.4667) and truth (average 4.3000) reflect a good level of awareness. Information dissemination (average 4.2000) is considered quite good, although there are variations in perception. Alertness (average 4.2000) is also high but more varied. In contrast, adaptation (average 2.9000) and attitude (average 3.6000) are lower, indicating the need for improvement in these two aspects to strengthen safety culture.

Table 2. Descriptive data of safety management system

	N	Minimum	Maximum	Mean	Std. Deviation
Safety Policy and objectives	30	1.00	5.00	3.2667	1.31131
Safety risk management	30	1.00	5.00	3.9333	1.08066
Safety assurance	30	1.00	5.00	4.0000	1.05045
Safety promotion	30	1.00	5.00	2.4667	1.52527
Valid N (listwise)	30				

The data shows that safety policies (mean 3.2667) and safety risk management (mean 3.9333) are perceived positively by respondents, although there are variations in views that need to be considered. Safety assurance has the strongest and most uniform perception with a mean of 4.0000. However, safety promotion (mean 2.4667) is seen as less effective and requires significant improvement. Overall, although policies and risk management are running well, safety promotion needs to be improved to strengthen the aviation safety management system.

Table 3. Descriptive flight safety data

	N	Minimum	Maximum	Mean	Std. Deviation
Standard Safety Procedures	30	1.00	5.00	2.6000	1.42877
Safe Flight Criteria	30	1.00	5.00	3.8667	.97320
Inspection and Supervision	30	1.00	5.00	4.0667	.94443
Safety Incident Reporting	30	1.00	5.00	3.8667	1.33218
Training and Certification	30	1.00	5.00	3.6000	1.42877
Valid N (listwise)	30				

The data shows that safety procedures (mean 2.6000) were considered inadequate with significant variation in respondents' views, while flight safety criteria (mean 3.8667) and safety incident reporting (mean 3.8667) were viewed positively and consistently. Inspection and supervision were rated the highest (mean 4.0667), indicating a very good assessment. Safety training and certification (mean 3.6000) were also rated fairly good, although respondents' perceptions varied. Overall, improvements were needed in safety procedures and training, while other aspects were rated as being good.

Prerequisite Analysis Test

Table 4. Data Normality Test

		Unstandardized Residual
N		30
Normal Parametersa,b	Mean	.0000000
	Std. Deviation	2.82678104
Most Extreme Differences	Absolute	.108
	Positive	.082
	Negative	-.108
Test Statistics		.108
Asymp. Sig. (2-tailed)		.200c,d

a. Test distribution is Normal.

From the results of the normality test using Kolmogorov-Smirnov, a significance value of 0.200 (> 0.05) was obtained, which shows that the data is normally distributed and the research can be continued with the next prerequisite test.

Table 5. Heteroscedasticity Test

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2,650	2,081		1.273	.214
	Safety Culture	-.066	.101	-.147	-.652	.520
	Safety Management System	.076	.122	.141	.623	.538

a. Dependent Variable: ABS_RES1

Based on the results of the heteroscedasticity test through the Glejser test in table 4.5, it can be seen that sig. on each variable is worth more than 0.05. and it can be said that this indicates that there is no heteroscedasticity in the regression model in this study. and the independent variables can be stated not to experience heteroscedasticity.

Table 6. Test Multicollinearity

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Safety Culture	.713	1,402
	Safety Management System	.713	1,402

The Influence of Safety Culture on Safety Management System

The results of the linear regression testing carried out at this stage are as follows.

Table 7. R-Squared Value of Safety Culture

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.536a	.287	.261	2.87577

The results of the linear regression analysis showed a moderate correlation between safety culture and safety management system, with a correlation coefficient of 0.536. As much as 28.7% of the safety management system variable is influenced by safety culture, while 71.3% is influenced by other variables. After that, testing was carried out using the Anova F value.

Table 8. Anova Table of the Influence of Safety Culture on the Safety Management System

Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	93.106	1	93.106	11,258	.002b
	Residual	231,561	28	8,270		
	Total	324,667	29			

The results in the table above show that based on the F value, the result is 11,258 with a significant value of 0.002 (<0.05). It can be seen that safety culture has an influence on the safety management system.

Table 9. Research Hypothesis t-Test

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	3.207	3.161		1,014	.319
	Safety culture	.442	.132	.536	3.355	.002

The results of the t-test showed 3.335 (> 1.96), with a sig. value of 0.002 (< 0.05). This result can be said that safety culture has a positive influence on the safety management system. This result also shows that every 1 increase in safety culture will provide an increase of 0.442 in the safety management system. This result provides the conclusion that the alternative hypothesis is accepted and the null hypothesis is rejected. Safety culture has a significant influence on flight safety at Sentani Airport, Jayapura, because it creates an environment where compliance with safety procedures is a top priority. A positive safety culture increases compliance with safety procedures (Sidey-Gibbons & Sidey-Gibbons, 2019). Conversely, organizations with a strong safety culture tend to have lower incident and accident rates

(Reason & Hobbs, 2020). Every individual in the organization understands and complies with established protocols, so that the risk of accidents and incidents can be minimized.

Safety culture encourages ongoing training for employees to ensure understanding and implementation of best safety practices (Thomas & Sian, 2020). Effective and transparent communication between pilots, air traffic control and ground personnel is key to reducing miscommunication and preventing accidents in a safety culture (Stolzer et al., 2018). Incident and hazard reporting systems enable staff to report errors or potential risks without fear of retribution, helping to identify and mitigate risks before they become major problems. A proactive approach to risk management emphasizes early identification and management of potential hazards, including regular inspections and operational risk assessments. A positive safety culture encourages the reporting of safety issues without fear (Wiegmann & Shappell, 2021). When safety is considered a top priority, employee morale and performance improves, which in turn improves flight safety at Sentani Airport.

The Influence of Safety Management System on Aviation Safety

The results of the linear regression testing carried out at this stage are as follows.

Table 10. Safety Management System R-Squared Value

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.491a	.242	.214	3.60594

Based on the results of the linear regression analysis, the correlation coefficient value is 0.419 which is included in the category of moderate relationship strength. So there is a moderate relationship between the safety management system and flight safety. The determinant coefficient value of 0.242 means that 24.2% of flight safety variables are influenced by the safety management system, while 48.3% are influenced by other variables.

Table 11. Anova Table of the Effect of Safety Management System onSafetyFlight

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	115,922	1	115,922	8.915	.006b
	Residual	364,078	28	13.003		
	Total	480,000	29			

The results in the table above show that based on the F value, the result is 8.915 with a significant value of 0.000 (<0.05). It can be seen that the safety management system has an influence on flight safety.

Table 12. Research Hypothesis t-Test Table

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9,834	2,813		3.496	.002
	Safety Management System	.598	.200	.491	2.986	.006

The t-test results show a value of 2.986 (>1.96) with a significance of 0.006 (<0.05), indicating that the safety management system has a positive influence on flight safety, with every 1 increase in the safety management system increasing flight safety by 0.491. The alternative hypothesis is accepted and the null hypothesis is rejected. Safety culture also has a significant influence on SMS at Sentani Airport, Jayapura, because it supports the

implementation and effectiveness of SMS (Reason, 1997). A strong safety culture ensures that all members of the organization comply with SMS procedures, which is essential for identifying, evaluating, and controlling risks and appropriate preventive measures. Cultural aspects such as leadership and employee involvement greatly influence the success of SMS implementation (Guldenmund, 2000). Not only that,*Safety Culture*also influences how organizations understand and respond to risk (Pidgeon, 1998). He found that organizations with a good safety culture are more likely to proactively identify and address safety issues.*Safety Culture*which improves compliance with the safety policies and procedures set out in the SMS (Zohar, 2010).

A safety culture that supports ongoing training ensures employees have the knowledge and skills necessary to perform their tasks safely and builds safety awareness throughout the organization (Chen & Chen, 2020). Effective communication, which is an essential element of a safety culture, also plays a crucial role in supporting SMS. Having clear and open communication channels allows for quick and accurate information exchange between various parties involved, such as pilots, air traffic controllers and ground personnel. This reduces the risk of miscommunication that can lead to incidents or accidents. A safe incident reporting system, supported by a positive safety culture, allows for the identification and analysis of potential hazards for appropriate corrective action and supports a proactive approach to risk management. A strong safety culture also improves staff morale and performance, as employees feel that their safety is a priority, supporting the effectiveness and success of the Safety Management System at Sentani Airport, Jayapura.

The Influence of Safety Culture on Aviation Safety

Table 13. R-Squared Table

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.707a	.499	.481	2.92970

a. Predictors: (Constant), X

The results of the linear regression analysis show a correlation coefficient value of 0.707, which is included in the category of moderate relationships between safety culture and flight safety. The determination coefficient of 0.499 indicates that 49.9% of flight safety variables are influenced by safety culture, while 50.1% are influenced by other factors.

Table 14.Anova F test table of the effect of safety culture on aviation safety

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	239,673	1	239,673	27,924	.000b
	Residual	240,327	28	8,583		
	Total	480,000	29			

a. Dependent Variable: Y
b. Predictors: (Constant), X

The results in the table above show that based on the F value, the result is 27,924 with a significant value of 0.000 (<0.05). It can be seen that safety culture has an influence on flight safety.

Table 15. Research Hypothesis t-Test

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.218	3.221		.378	.708

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
X	.709	.134	.707	5.284	.000

a. Dependent Variable: Y

The t-test shows a value of 5.284 (> 1.96) with a significance of 0.000 (< 0.05), indicating that safety culture has a positive influence on flight safety, with every 1 increase in the safety management system increasing flight safety by 0.707. The alternative hypothesis is accepted and the null hypothesis is rejected. The Safety Management System (SMS) has a significant influence on flight safety at Sentani Airport, Jayapura, by providing a structured framework to proactively identify and manage risks (McDonald et al., 2000). Safety assurance in SMS ensures that safety systems and procedures are functioning properly through regular monitoring and analysis, and ensures compliance with aviation safety regulations (Stolzer et al., 2021). This includes safety audits, inspections and data analysis to identify areas for improvement, thereby increasing the quantity and quality of safety reports, enabling organizations to address safety issues more quickly (Li & Harris, 2019).

Promoting safety through effective training and communication ensures that all employees have the knowledge and skills necessary to perform their duties safely. A strong safety culture is also encouraged, so that employees feel safe to report incidents and potential hazards without fear of retribution. By effectively identifying and managing risks, SMS can improve operational efficiency (O'Connor & O'Dea, 2021). Overall, SMS enables Sentani Airport to manage flight safety proactively and systematically. By implementing comprehensive safety policies and procedures, managing risks effectively, monitoring safety performance, and promoting a positive safety culture, SMS directly contributes to improving flight safety at the airport.

The Influence of Safety Culture on Aviation Safety Mediated by the Safety Management System

Based on the Beta and Standard Error values, the safety culture coefficient (X) on the safety management system (M) and the influence of the safety management system (M) on flight safety (Y) are as follows:

- a = 0.536: Coefficient of direct effect of safety culture on safety management system.
- b = 0.491: Coefficient of direct effect of safety management system on flight safety.
- Sa = 0.132: Standard Error of a.
- Sb = 0.200: Standard Error of b.

By entering the values of a, b, Sa, and Sb into the Sobel test equation, Sab = 0.121 is obtained. To calculate the t count of the indirect effect of safety culture (X) on flight safety (Y) through the safety management system (M), the formula t count = ab / Sab is used. From this calculation, the t count is 2.230, greater than 1.96, and the p-value is 0.025, which is less than 0.05. This shows that the safety management system positively mediates the effect of safety culture on flight safety. These results can be verified with the Sobel Test Calculator, which produces a t count of 2.230, in accordance with manual calculations.

Input:			Test statistic:	Std. Error:	*p*-value:
a	0.442	Sobel test:	2.2302605	0.11851351	0.02573015
b	0.598	Aroian test:	2.17690351	0.12141834	0.02948777
s_a	0.132	Goodman test:	2.2877436	0.11553567	0.02215246
s_b	0.200	Reset all	Calculate		

Figure 2. Sobel test

The Sobel test showed a t-value of 2.23 (> 1.96) and a p-value of 0.025 (< 0.05), indicating that the safety management system mediates the effect of safety culture on flight safety. The safety culture at Sentani Airport strongly influences flight safety through SMS, with the entire organization prioritizing safety and adhering to established procedures. In addition, the safety culture encourages ongoing training and effective communication among all team members. Ongoing training helps in updating employee knowledge and skills in handling emergency situations and adhering to the latest safety procedures set by SMS. Open and clear communication ensures that safety information is disseminated quickly and accurately throughout the organization, so that every team member has a good understanding of the actions to be taken in a given situation.

Incident and hazard reporting systems are also an integral part of a positive safety culture. At Sentani Airport, employees feel safe to report incidents or hazards without fear of retribution. This allows for early identification and thorough analysis of potential hazards that could threaten flight safety. Thus, the safety culture strengthens the implementation and effectiveness of the SMS by enabling more proactive and effective risk management. Overall, flight safety at Sentani Airport is strongly influenced by the safety culture in place, which acts as a link between individuals and the safety practices structured in the SMS. A strong safety culture increases risk awareness, ensures compliance with safety procedures, and encourages active participation from all members of the organization, which in turn improves overall flight safety.

CONCLUSION

The conclusion of the research results shows that a strong safety culture at Sentani Airport, Jayapura, has a significant influence on flight safety. This culture ensures compliance with safety procedures, encourages continuous training, effective communication, and incident reporting without fear of retribution, and facilitates proactive risk management. The Safety Management System (SMS) strengthens the safety culture by systematically identifying and controlling risks, monitoring safety performance, and implementing clear safety policies. Collaboration between safety culture and SMS improves overall flight safety by strengthening compliance, training, and communication, and minimizing the risk of incidents and accidents. Recommendations for Sentani Airport Management include improving infrastructure, using advanced technology for surveillance, regular training, and implementing a comprehensive SMS with an emphasis on reporting culture and compliance with safety standards. For further research, it is recommended to analyze specific risks, evaluate the effectiveness of SMS, compare practices with other airports, and study factors that influence safety culture at the airport.

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