APPROACH: Jurnal Teknologi Penerbangan
Vol.9, 2 (Oktober, 2026), pp. 89-98
ISSN: 2548-8090; E-ISSN: 2548-8104,

CCTV UTILIZATION IN APRON MOVEMENT CONTROL AND AIRSIDE SAFETY COMPLIANCE: A QUANTITATIVE STUDY AT JUANDA INTERNATIONAL AIRPORT

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ARTICLE INFO

Keywords:

Closed-Circuit Television (CCTV), Apron Movement Control (AMC), procedural compliance, operational safety, airside.

Article history:

Received
Revised
Accepted

ABSTRACT

Previous studies have primarily focused on the role of Closed-Circuit Television (CCTV) in airport security and operational monitoring, while empirical evidence regarding its influence on personnel compliance with airside operational safety procedures remains limited. This study addresses this gap by examining the effect of CCTV utilization by the Apron Movement Control (AMC) unit on operational safety compliance at Juanda International Airport, Surabaya. A quantitative associative approach was employed using questionnaire data collected from 47 AMC personnel. The data were analyzed using SPSS through validity and reliability tests, classical assumption tests, simple linear regression, and hypothesis testing. The findings indicate that CCTV utilization and operational safety compliance were both rated high, with mean scores of 4.34 and 4.31, respectively. Regression analysis revealed a significant positive effect of CCTV utilization on compliance ($p < 0.001$), with a regression coefficient of 0.824 and a coefficient of determination (R^2) of 0.777. These findings demonstrate that optimizing CCTV utilization significantly improves personnel compliance and provides empirical evidence that CCTV serves not only as a surveillance system but also as an effective operational safety management tool, supporting safer and more efficient airside airport operations.

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1. INTRODUCTION

Juanda International Airport in Surabaya is one of Indonesia's strategic airports, playing a vital role in ensuring the smooth operation and safety of air transportation, particularly in East Java and the surrounding regions. The high volume of aircraft and passenger traffic makes Juanda Airport one of the busiest airports

in terms of operational activity, making aviation safety a critical factor in the management of airport operations. As an airport serving both domestic and international flights, Juanda International Airport must meet aviation safety standards established by the government and international aviation organizations. The implementation of aviation safety systems covers various aspects, including airport infrastructure readiness, the suitability of airside and landside facilities, human resource competence, and compliance with standard operating procedures(Ahmad, 2021; Firlej, 2025; Peraturan Menteri Perhubungan 37 Tahun 2021). All of these aspects aim to minimize the risk of aviation accidents or incidents.

Airports are high-risk operational environments because they involve the simultaneous movement of aircraft, operational vehicles, support equipment, and personnel, particularly in the airside area (Keke & Candra Susanto, 2019; Sugiarti, 2017; *Undang-Undang Nomor 1 Tahun 2009*, 2009). One area requiring intensive supervision is the apron, as various aviation operations take place there. Therefore, effective supervision is necessary to ensure airport safety and operational efficiency. The Apron Movement Control (AMC) Unit is responsible for monitoring and controlling activities on the airside to ensure all operations proceed in accordance with safety procedures. In practice, on-site monitoring may face several challenges, such as limited observation range and high operational activity levels. To support these tasks, the airport utilizes Closed-Circuit Television (CCTV) technology as a tool for operational monitoring.

Previous studies have mainly discussed the role of CCTV as a security and surveillance tool or its contribution to monitoring apron activities and maintaining operational order. However, empirical evidence examining how CCTV utilization by the Apron Movement Control (AMC) unit influences personnel compliance with airside operational safety procedures remains limited. Most existing studies emphasize surveillance effectiveness or airport security performance without quantitatively measuring the relationship between CCTV utilization and compliance with operational safety regulations, particularly in the context of Indonesian international airports.

The novelty of this study lies in its empirical examination of CCTV utilization as a factor influencing compliance with airside operational safety procedures from the perspective of the Apron Movement Control (AMC) unit. Unlike previous studies that primarily evaluated CCTV as a monitoring or security system, this research quantitatively analyzes its contribution to procedural compliance using validated indicators and regression analysis based on data collected from AMC personnel at Juanda International Airport. The findings provide empirical evidence that CCTV functions not only as a surveillance device but also as an operational safety management tool that significantly improves compliance with airside safety procedures

The use of CCTV enables real-time monitoring of activities, documentation of incidents, and identification of safety procedure violations. The presence of CCTV is expected to enhance the effectiveness of monitoring and support personnel compliance with operational safety procedures. However, based on observation results, several instances of non-compliance with operational procedures were still identified, indicating that the effectiveness of CCTV utilization requires further review.(Bahri, 2025). Therefore, this study aims to examine whether the utilization of CCTV by the Apron Movement Control (AMC) unit influences personnel compliance with operational safety procedures in the airside area of Juanda International Airport, Surabaya.

2. METHODS

This study used a quantitative approach with an associative design. The population comprised all 54 AMC personnel at Juanda International Airport Surabaya. Using the Slovin formula with a 5% margin of error, a sample of 47 respondents was obtained through simple random sampling. Simple Random Sampling is a probability sampling technique in which every member of the population has an equal and independent chance of being selected as a sample. The selection process is carried out randomly, ensuring that each

population element has the same probability of inclusion (Cresswell, 2020). Data were collected using a Likert-scale questionnaire (1–5) consisting of 20 items: 10 items measuring CCTV utilization (variable X) and 10 items measuring compliance (variable Y)(Firmansyah et al., 2021; İnal et al., 2017)The questionnaire is designed to determine the extent of the impact or consequences resulting from the issues observed at the study site by asking respondents questions related to the issues under investigation. The questionnaire was developed by the researchers based on previous studies and relevant literature on CCTV utilization and operational safety compliance, followed by content validation by an AMC officer, an AMC supervisor, and an academic expert to ensure the relevance and clarity of the items. Before the main survey, a pilot test was conducted with 30 non-sample respondents, and only questionnaire items that met the validity (r-count > r-table, $p < 0.05$) and reliability (Cronbach's Alpha > 0.70) criteria were included in the final questionnaire distributed to 47 AMC personnel. Indicators for variable X included frequency of use, ease of use, perceived benefits, effectiveness, and operational efficiency. Indicators for variable Y included adherence to SOP, discipline, safety awareness, responsibility, and response to supervision (Ginting et al., 2019; Safitri et al., 2025).

Tabel 1. Likert Scale Ratings

No	Symbol	Description	Score
1.	SS	Strongly Agree	5
2.	S	Agree	4
3.	N	Neutral	3
4.	TS	Disagree	2
5.	STS	Strongly Disagree	1

Source: (Moonlight et al., 2022, 2023)

The instrument was validated through content validity (expert judgment by AMC officer, supervisor, and academic expert) and empirical validity (trial on 30 non-sample respondents). An item was considered valid if r-count > r-table (0.361) and Sig. < 0.05. Reliability was measured using Cronbach's Alpha with a threshold >0.70. Data analysis included descriptive statistics, classical assumption tests (normality, linearity, heteroscedasticity), simple linear regression, coefficient of determination (R^2), and t-test for hypothesis testing, all conducted using SPSS (Mardiatmoko, 2020; Rosita et al., 2021).

3. FINDINGS AND DISCUSSION

3.1 Findings

Based on the validity test conducted, all indicators of variable X obtained a calculated r value above the critical r value (0.288) and a significance level below 0.05. A similar pattern was observed for variable Y, where all indicators had a calculated r > 0.288 and a significance level < 0.05. Thus, it can be concluded that all indicators for both variables are valid and suitable for use in this study.

Meanwhile, the reliability test yielded a Cronbach's Alpha value of 0.909 for variable X and 0.920 for variable Y. Both values exceed the minimum threshold of 0.80, indicating that all items in variables X and Y possess high reliability. Overall, the research instruments for variables X and Y have been proven to be valid and reliable.

Tabel 2. Summary of Validity Test Results (Variable X)

Variabel	Indikator	Rhitung	>Rtabel	Sig	<0.05	Ket.
	X1	0.785	0.288	0.00	0.05	Valid
	X2	0.818	0.288	0.00	0.05	Valid
	X3	0.769	0.288	0.00	0.05	Valid
	X4	0.853	0.288	0.00	0.05	Valid
	X5	0.617	0.288	0.00	0.05	Valid
Variabel X	X6	0.648	0.288	0.00	0.05	Valid
	X7	0.628	0.288	0.00	0.05	Valid
	X8	0.648	0.288	0.00	0.05	Valid
	X9	0.769	0.288	0.00	0.05	Valid
	X10	0.853	0.288	0.00	0.05	Valid

Tabel 3. Summary of Validity Test Results (Variable Y)

Variabel	Indikator	Rhitung	>Rtabel	Sig	<0.05	Ket.
	Y1	0.817	0.288	0.00	0.05	Valid
	Y2	0.836	0.288	0.00	0.05	Valid
	Y3	0.753	0.288	0.00	0.05	Valid
	Y4	0.760	0.288	0.00	0.05	Valid
	Y5	0.762	0.288	0.00	0.05	Valid
Variabel Y	Y6	0.810	0.288	0.00	0.05	Valid
	Y7	0.771	0.288	0.00	0.05	Valid
	Y8	0.635	0.288	0.00	0.05	Valid
	Y9	0.753	0.288	0.00	0.05	Valid
	Y10	0.760	0.288	0.00	0.05	Valid

The mean scores for each indicator ranged from 4.25 to 4.43. This indicates that, in general, respondents tended to agree with the statements regarding the use of CCTV. Indicator X1 recorded the highest mean score of 4.4255, indicating that the majority of respondents utilize CCTV. Meanwhile, the lowest mean score was found in indicator X7 at 4.2553, yet it still falls within the "agree" category on the 4-point Likert scale.

The median value for all indicators is 4.00, reinforcing the tendency that respondents give positive ratings regarding the use of CCTV. The mode is also dominated by 4.00, with some indicators such as X4 and X10 having a mode of 5.00, indicating a tendency for respondents to select "strongly agree." The standard deviation values ranged from 0.58 to 0.75, indicating relatively low data dispersion, meaning respondents' answers tended to be consistent. The minimum value of 3.00 and maximum of 5.00 indicate that respondents' answers fell within the "somewhat agree" to "strongly agree" categories.

Tabel 4. Descriptive Statistics of CCTV Utilization (Variable X)

Statistics

		X01	X02	X03	X04	X05	X06	X07	X08	X09	X10
N	Valid	47	47	47	47	47	47	47	47	47	47
	Missing	0	0	0	0	0	0	0	0	0	0
Mean		4.4255	4.2766	4.3404	4.3191	4.2766	4.3830	4.2553	4.3830	4.3404	4.3191
Median		4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000
Mode		4.00	4.00[a]	4.00	5.00	4.00	4.00	4.00	4.00	4.00	5.00
Std. Deviation		.58028	.71329	.59988	.75488	.61510	.60982	.60678	.60982	.59988	.75488
Minimum		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Maximum		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

a. Multiple modes exist. The smallest value is shown

The mean scores ranged from 4.23 to 4.38, indicating that, in general, respondents tended to agree with the statements in variable Y. Indicator Y5 has the highest mean value of 4.3830, while the lowest mean values are found in indicators Y3 and Y9 at 4.2340; however, all remain in the high category.

The median value across all indicators is 4.00, indicating that the majority of respondents answered in the "agree" category. The mode is dominated by the number 4.00, with one indicator—Y8—having a mode of 5.00, suggesting that some respondents tended to choose "strongly agree." The standard deviation values range from 0.60 to 0.74, indicating that the level of data dispersion is relatively small. This means that respondents' answers tend to be consistent or homogeneous. Additionally, the minimum value of 3.00 and the maximum of 5.00 indicate that the range of respondents' answers falls within the "somewhat agree" to "strongly agree" categories.

Tabel 5. Descriptive Statistics of CCTV Utilization (Variable Y)

Statistics

		Y01	Y02	Y03	Y04	Y05	Y06	Y07	Y08	Y09	Y10
N	Valid	47	47	47	47	47	47	47	47	47	47
	Missing	0	0	0	0	0	0	0	0	0	0
Mean		4.3617	4.3404	4.2340	4.3617	4.3830	4.2766	4.3191	4.2553	4.2340	4.3617
Median		4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000
Mode		4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.00	4.00	4.00
Std. Deviation		.64016	.59988	.59756	.60525	.57306	.68214	.66288	.73627	.59756	.60525
Minimum		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Maximum		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

The normality test aims to determine whether the data used follow a normal distribution. In this study, the normality test was conducted using the Kolmogorov-Smirnov test via SPSS software. The data are considered to follow a normal distribution if the significance value is greater than 0.05; conversely, if the significance value is less than 0.05, the data are deemed non-normal.

Tabel 6. Results of the Kolmogorov-Smirnov Normality Test

		Unstandardized Residual
N		47
Normal Parameters[a,b]	Mean	0,0000000
	Std. Deviation	2,73702712
Most Extreme Differences	Absolute	0,128
	Positive	0,073
	Negative	-0,128
Test Statistic		0,128
Asymp. Sig. (2-tailed)		.511[c]

Based on the results of the normality test shown in the table above, a significance value of 0.511 was obtained. Since this value exceeds 0.05, it can be concluded that the data for all variables are normally distributed.

A linearity test was conducted to determine whether the relationship between the independent variable—CCTV usage by AMC units—and the dependent variable—compliance with airside operational safety procedures—is linear. This test was performed as a prerequisite for linear regression analysis.

Based on the results of the data analysis presented in the ANOVA table. It is known that the significance value (Sig.) in the linearity row is 0.000, and the significance value in the Deviation from Linearity row is 0.404. The significance value for linearity is less than 0.05, while the significance value for Deviation from Linearity is greater than 0.05.

Tabel 7. Linearity Test Results

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Kepatuhan Prosedur Keselamatan * Pemanfaatan CCTV	Between Groups	(Combined)	826,152	14	59,011	7,898	0,000
		Linearity	720,633	1	720,633	96,453	0,000
		Deviation from Linearity	105,518	13	8,117	1,086	0,404
	Within Groups		239,082	32	7,471		
	Total		1065,234	46			

This indicates that there is a linear relationship between the variable of CCTV utilization by AMC units and compliance with airside operational safety procedures, and that there is no significant deviation from linearity. Thus, the model satisfies the assumption of linearity and can proceed to linear regression analysis.

The heteroscedasticity test aims to determine whether the regression model exhibits heteroscedasticity, a condition in which the variance of the residuals is not constant across all values of the independent variables. In this study, the heteroscedasticity test was conducted using a regression method with the absolute value of the residuals as the dependent variable (ABS_RES).

Tabel 8. Results of the Heteroscedasticity Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1,845	2,392		-0,771	0,445
	Pemanfaatan CCTV	0,089	0,055	0,236	1,627	0,111

It is known that the significance value (Sig.) for the variable "CCTV utilization by AMC units" is 0.111, which is greater than the significance level of 0.05. This indicates that the independent variable does not have a significant effect on the absolute residuals. Thus, there is no evidence of heteroscedasticity in this regression model. This means that the residual variance is constant and satisfies one of the classical assumptions in linear regression analysis.

Simple Linear Regression and Hypothesis Testing: The regression equation was Y = 7.413 + 0.824X. The positive coefficient (0.824) means that each one-unit increase in CCTV utilization increases compliance by 0.824 units. The coefficient of determination (R^2) was 0.777.

Tabel 9. Simple Linear Regression Results

Coefficients[a]					
	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std.Error	Beta	t	Sig
1 (Constant)	7,413	3,704		2,002	0,051
Pemanfaatan CCTV	0,824	0,085	0,822	9,701	0,000

A simple linear regression test was conducted to determine the extent of the independent variables' influence on the dependent variable. Based on the results of the simple linear regression test shown in the table above, the following regression equation was obtained:

Y = a + bx (1)

Y = 7, 413 + 0,824x

The interpretation of this regression equation is as follows:

1. The constant value of 7.413 indicates that if the value of the independent variable X (CCTV utilization by AMC units) is zero, then the predicted value for the dependent variable Y (compliance with airside operational safety procedures) is 7.413 units.

2. The regression coefficient for variable X, which is 0.824, indicates that every one-unit increase in CCTV utilization will result in an increase in compliance with airside operational safety procedures of 0.824 units.

3. A positive regression coefficient indicates a positive relationship between the use of CCTV by AMC units and compliance with airside operational safety procedures. This means that the more effectively CCTV is utilized, the higher the level of compliance with airside operational safety procedures.

To determine the extent to which variable X influences variable Y in a simple linear regression analysis, the coefficient of determination (R^2) can be used as a reference. This value is obtained from the Model Summary table in the SPSS output, as shown in the following figure.

Tabel 10. Model Summary Output

Model Summary[b]										
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.822[a]	0,777	0,769	2,767	0,777	94,105	1	45	0,000	2,070

Based on the SPSS output in the Model Summary table, the R-squared value was found to be 0.777. This means that 77.7% of the variation in operational safety procedure compliance can be explained by the variable "CCTV usage by AMC units," while the remaining 22.3% is explained by other factors outside the scope of this study.

3.2 Discussion

The findings indicate that CCTV utilization at Juanda International Airport is already high, and it significantly improves compliance with operational safety procedures. This aligns with previous research by , which found a strong correlation between AMC surveillance via CCTV and orderliness in the make-up area. The regression coefficient of 0.824 shows a strong positive influence, meaning that better CCTV use directly increases adherence to safety rules(Susilo et al., 2024)(Astanta et al., 2023)

The significant influence of CCTV utilization on compliance with operational safety procedures can be attributed to its ability to strengthen continuous monitoring and increase personnel awareness that operational activities are being observed in real time. CCTV enables the Apron Movement Control (AMC) unit to monitor aircraft movements, operational vehicles, equipment, and personnel simultaneously across the apron, overcoming the limitations of direct field observation. As a result, personnel are more likely to comply with established safety procedures because potential violations can be detected and documented promptly. This finding is consistent with the positive regression coefficient (0.824) and the significant t-test result ($p < 0.001$), indicating that improved CCTV utilization is associated with higher levels of operational safety compliance. Moreover, CCTV functions not only as a surveillance tool but also as a preventive mechanism that encourages disciplined behavior and reinforces adherence to Standard Operating Procedures (SOP).

The relatively high coefficient of determination ($R^2 = 0.777$) suggests that CCTV utilization represents one of the dominant factors affecting compliance with operational safety procedures among AMC personnel at Juanda International Airport. This high explanatory power may be explained by the extensive integration of CCTV into daily apron monitoring activities, where surveillance supports rapid identification of unsafe behaviors and operational irregularities. Furthermore, both the CCTV utilization variable and the compliance variable were rated in the high category by respondents, indicating consistent implementation of surveillance practices and safety procedures. Because the respondents consisted entirely of AMC personnel who routinely use CCTV during operational supervision, their perceptions closely reflect the relationship between surveillance effectiveness and procedural compliance, resulting in a strong statistical association. Nevertheless, the remaining 22.3% of unexplained variance indicates that other factors—such as weather conditions, human factors, organizational safety culture, training, and technical aspects of airport operations—may also influence compliance and should be examined in future studies.

These findings have important operational implications for airport safety management. First, airport operators should maximize CCTV utilization not only for monitoring aircraft parking positions and traffic movements but also as an active tool for supervising compliance with airside safety procedures. Second, AMC personnel should continuously monitor CCTV displays to identify unsafe behaviors, such as failure to use personal protective equipment, unsafe vehicle operations, or other violations occurring in the apron area. Third, airport management should ensure the reliability of the CCTV system through regular maintenance, improvement of image quality, and installation of additional cameras in blind-spot locations. Optimizing CCTV in this manner can enhance situational awareness, support faster operational decision-making, reduce the likelihood of safety violations, and ultimately strengthen the airport's Safety Management System (SMS). These implications are consistent with the study's recommendation that CCTV should serve a dual function as both an operational surveillance system and a proactive safety management instrument.

The results of this study are also consistent with several previous studies. A study by Ahmad (2021) indicates that there is a strong and significant correlation between AMC unit surveillance via CCTV and orderliness in the makeup area. Furthermore, the results indicate that minimizing the incidence of order violations in the makeup area can be achieved by conducting regular inspections by the AMC unit, as well as by increasing the number of personnel and enhancing the AMC unit's surveillance to monitor movement and maintain order in the makeup area.

Thus, the results of this study support previous theories and findings, while also underscoring the importance of utilizing surveillance technologies such as CCTV as a control mechanism in airside operations. The use of CCTV by AMC has proven not only to enhance the effectiveness of surveillance but also to play a crucial role in improving compliance with operational safety procedures.

4. CONCLUSION

Based on the research findings, the use of CCTV by the AMC unit on the airside of Juanda International Airport in Surabaya is relatively high, with an average score of 4.34 on a scale of 1–5, indicating that the use of CCTV has effectively contributed to supporting operational surveillance activities. Meanwhile, the effectiveness of CCTV in surveillance also falls into the high category, with an average of 4.31, and the analysis results show that the use of CCTV significantly influences personnel compliance with operational safety procedures. This means that the more extensively the AMC unit utilizes CCTV, the higher the compliance with operational safety procedures on the airside will become. Therefore, all stakeholders, particularly the AMC unit and ground handling personnel, should not merely rely on the presence of CCTV but also utilize it optimally and consistently as a preventive measure to ensure compliance with safety procedures, especially regarding vehicle and personnel movements in the apron area.

This study is limited by its focus on a single airport, Juanda International Airport, with a relatively small sample of 47 AMC personnel, which may limit the generalizability of the findings. Furthermore, the study employed a cross-sectional questionnaire-based design, so the results reflect respondents' perceptions at a single point in time rather than actual long-term operational behavior. Finally, only CCTV utilization was examined as the independent variable, while other factors that may influence operational safety compliance were not included in the research model.

The Apron Movement Control (AMC) Unit is advised to expand the use of CCTV, which has so far tended to focus solely on monitoring the positions and movements of aircraft at parking stands, into a more proactive tool for monitoring compliance with operational safety procedures on the apron. AMC personnel should not only ensure the safe movement of aircraft but also utilize CCTV screens to identify potential violations, such as the lack of personal protective equipment (PPE) or other hazardous activities in the apron area. With this shift in usage, CCTV can serve a dual purpose: as a parking stand traffic controller and as an effective safety monitor.

Recommendations:The management of Juanda International Airport in Surabaya is advised to conduct routine maintenance and improve the quality of the CCTV system, for example by increasing the number of cameras in hard-to-monitor areas (blind spots) and enhancing image quality to make it easier for AMC officers to identify violations of safety procedures.

Conflicts of Interest: The authors declare no conflict of interest. Zivana Shofi Alia Marsanda was responsible for the entire research process, including conceptualization, research design, data collection through questionnaires, data analysis using SPSS, interpretation of results, and drafting, reviewing, and finalizing the manuscript.

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