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The Influence of Interfunctional Collaboration on Management Traffic by Operations through AOCC Performance at Ngurah Rai Airport

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Abstract: I Gusti Ngurah Rai International Airport in Bali is one of the busiest airports in Indonesia, serving over 19 million passengers in 2023. With an average of 390 aircraft movements per day and a high proportion of international wide-body flights, the airport faces increasing operational complexity. Challenges such as limited apron space, slot overlaps, and fragmented coordination among stakeholders often result in delays and reduced passenger satisfaction. This study aims to analyse the influence of interfunctional collaboration on traffic operation management performance through the roles of AOCC service quality and performance. Using a quantitative descriptive approach, the study involves 150 respondents selected through stratified random sampling. Primary data were collected via questionnaires, supported by secondary data such as operational reports and previous research. Data analysis was conducted using Structural Equation Modeling (SEM) with SmartPLS 4.0. These findings demonstrate that the implementation of A-CDM and a well-performing AOCC plays a crucial role in supporting airport operational resilience. Strengthened coordination, data-driven resource allocation, and integrated monitoring systems under A-CDM collectively contribute to better management operations by Traffic, improving not only operational efficiency but also overall passenger experience at Ngurah Rai Airport.

Keywords: AOCC, Management operation by traffic, Interfunctional collaboration, Operational efficiency, I Gusti Ngurah Rai Airport.

INTRODUCTION

Airports play a crucial role in supporting the smooth operation of air transportation around the world. As the number of passengers and flight frequencies continue to rise, maintaining operational efficiency and service quality becomes increasingly complex. Modern airports are required to improve their capacity and efficiency while upholding high service standards. One strategy that many airports globally have adopted to address these challenges is the implementation of Airport Collaborative Decision Making (A-CDM) and MOT.

I Gusti Ngurah Rai Airport is one of the busiest airports in Indonesia. Located in Bali, the country's main tourism hub, this airport serves as the primary gateway for international tourists entering Indonesia. According to data from Injourney Airports, in 2023 Ngurah Rai Airport recorded the movement of over 19 million passengers, with more than 40% consisting of international travelers.

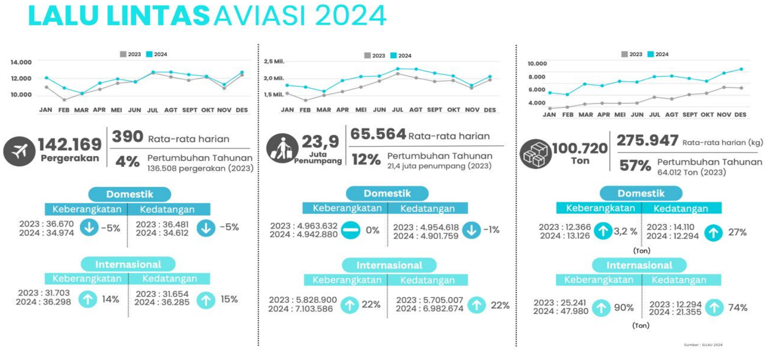

Fig. 1. Traffic at I Gusti Ngurah Rai Airport

Based on the 2024 aviation traffic data shown in the infographic, Bali Airport has demonstrated a significant and consistent positive growth trend compared to 2023, reflecting recovery and increased air transport activities in the post-pandemic period.

However, with an average of 390 aircraft movements per day and the dominance of wide-body international aircraft, operational capacities such as apron and taxiways are becoming increasingly limited. This situation creates the potential for overlapping flight slots, takeoff and landing queues, and delays in aircraft turnaround ground time. Coordination among stakeholders, such as airport authorities, airlines, ground handling, immigration, customs, and security authorities, has not yet reached optimal levels. This fragmentation becomes a barrier when quick decision-making is needed (for example, during delays or slot changes), which in turn affects on-time performance and the passenger experience.

Currently, the airport does not manage resource allocation (gates, conveyor belts, check-in counters, waiting areas, aprons) based on dynamic traffic patterns. In fact, Bali's tourist traffic is seasonal (peak-high season) and highly fluctuating. The system's unpreparedness in anticipating operational disruptions such as bad weather, international flight delays, or slot shifts results in schedule backlogs and a decline in customer satisfaction. MOT is needed to provide data-driven prediction and mitigation systems. Based on the issues described above, there were 90 passenger complaints recorded at I Gusti Ngurah Rai Airport between August 2024 and January 31, 2025.

In addition, the success of A-CDM is highly dependent on adequate technological infrastructure. The utilization of real-time data and advanced communication systems is a key element in ensuring that all stakeholders can effectively share information. Research by Aditya Dwi Sanjaya (2021) emphasizes the importance of harmonization between Air Traffic Flow Management (ATFM) and A-CDM to enhance flight operational efficiency. This harmonization can reduce aircraft waiting times and improve the quality of flight services, which are the primary objectives of A-CDM implementation (Putri, 2016).

Although A-CDM has been implemented at several major airports in Indonesia, including Ngurah Rai Airport, there are still several challenges that must be addressed to achieve optimal results. One of the main issues is the lack of effective integration and coordination among various stakeholders. For instance, there are cases where airlines and ground handling service providers do not always share real-time information, leading to delays in decision-making and flight operations

Although international studies have explored A-CDM effectiveness in improving on-time performance and collaborative decision-making, research specifically analyzing the relationship between interfunctional collaboration, AOCC performance, and MOT-based operational outcomes in Indonesia remains scarce. Moreover, prior literature tends to focus on technical and procedural improvements, while empirical investigation into soft-coordination mechanisms, stakeholder synergy, and AOCC-centered service quality in high-traffic Southeast Asian airports is still insufficient. Most research also emphasizes A-CDM implementation in European and North American hubs, leaving a contextual gap in understanding its adaptation and performance in emerging aviation environments.

Thus, this study provides a novel contribution by examining how interfunctional collaboration influences AOCC service quality and performance, and how these factors subsequently affect traffic-driven operational management at a major Indonesian international airport. The findings are expected to enrich the body of knowledge in aviation management and offer practical insights for strengthening collaborative strategies in Indonesian airports undergoing post-pandemic growth and operational modernization.

Conceptually, this study aims to examine the impact of AOCC performance on the quality of airport operational services and to explore the mediating role of interfunctional collaboration on the quality of airport operational services. Through this research, it is expected to contribute significantly to the development of more effective collaborative strategies at airports in Indonesia, which will ultimately enhance the quality of services and the operational efficiency of air transport as a whole.

METHOD

This study employs a descriptive quantitative approach to illustrate and analyze the relationships between variables related to the implementation of Airport Collaborative Decision Making (A-CDM) and the management of the Airport Operations Control Center (AOCC) at I Gusti Ngurah Rai International Airport, Bali.

The population in this study includes all parties involved in airport operations, particularly those who interact directly with A-CDM and AOCC, such as airline representatives, airport authorities, and service providers. The sampling technique used is probability sampling with a stratified random sampling method (Khaidir Ali Fachreza et al., 2024)., ensuring representation from each respondent group.

The sample size is determined using the formula from Hair et al. (2010), which recommends using 5 to 10 times the number of indicators. In this study, with 30 indicators, the calculation of 5 × 30 results in a total sample of 150 respondents.

The primary data source consists of data collected through questionnaires, while secondary data include airport documents, journals, and relevant previous studies. Data analysis is conducted using the Structural Equation Modeling (SEM) method with the assistance of SmartPLS 4.0 software. The analysis includes testing the outer model to assess validity and reliability, as well as the inner model to examine the relationships between variables and test the research hypotheses.

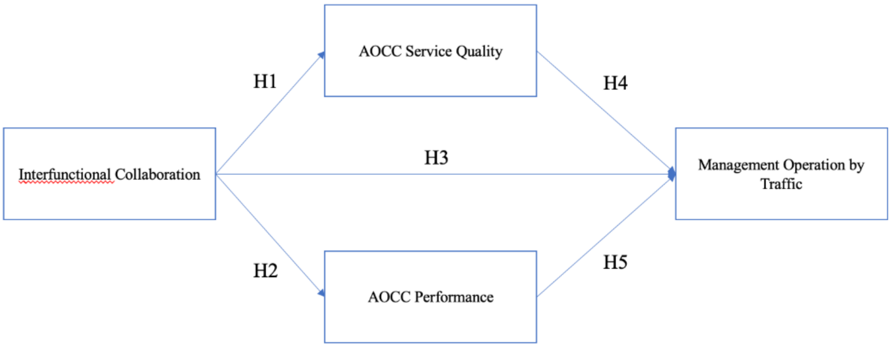

Fig. 2. Research Framework

Based on previous research related to this study, this study formulates nine hypotheses as follows:

H1: Interfuntional Collaboration has a positive effect on AOCC Service Quality.
H2: Interfunctional Collaboration has a positive effect on AOCC Performance.
H3: Interfunctional Collaboration has a positive effect on Management Operation by Traffic.
H4: AOCC Service Quality has a positive effect on Management Operation by Traffic.
H5: AOCC Performance has a positive effect on Management Operation by Traffic.

Based on previous research and relevant theoretical frameworks, this study establishes a set of measurement indicators used to assess each construct in the research model. These indicators are designed to capture the dimensions of Interfunctional Collaboration, AOCC Service Quality, AOCC Performance, and Management Operation by Traffic, reflecting various operational, coordination, and service aspects within the airport context. The complete list of indicators is presented as follows:

Table 1. Questionnaire indicators

Variables		Indicator	Source
Interfuntional Collaboration (X1)	X1.1	AOCC actively collaborates with airlines and ground handling agents to enhance operational efficiency	PM 41 (2023)
	X1.2	AOCC has an effective communication system with airlines and ground handling agents to address operational challenges	
	X1.3	AOCC implements a data-sharing system with external partners to improve flight coordination	
	X1.4	AOCC ensures that flight data is updated in real time and accessible to relevant stakeholders	
	X1.5	AOCC ensures optimal coordination among internal units in managing flight operations	
	X1.6	AOCC conducts regular meetings among internal units to discuss service improvement	
	X1.7	Operational decisions at AOCC are made through discussions involving all relevant units	
	X1.8	AOCC applies a transparent reporting mechanism in the decision-making process	
AOCC Service	Z1.1	Passenger and baggage inspections are conducted quickly and efficiently	PM 41 (2023)

Quality (Z1)	Z1.2	Security screening processes run optimally without causing long queues	
	Z1.3	Check-in and boarding services are completed within a reasonable time	
	Z1.4	AOCC collaborates with airlines to accelerate the boarding process	
	Z1.5	Flight information systems are easy for passengers to access and understand	
	Z1.6	Assistance services are available for passengers requiring additional support	
	Z1.7	Public facilities such as waiting seats, restrooms, and lounges are available and function properly	
	Z1.8	Passenger service areas are designed to provide maximum comfort	
	Z1.9	Additional facilities such as prayer rooms, nurseries, restaurants, lounges, charging stations, and internet services function properly	
	Z1.10	Value-added facilities are available and accessible for passenger use	
	Z1.11	The domestic terminal capacity is sufficient to accommodate passenger volume	
	Z1.12	The international terminal capacity adequately supports smooth operational processes	
AOCC Performance (Z2)	Z2.1	Supporting equipment for aircraft movement is available and functions optimally	PM 41 (2023)
	Z2.2	The “On-Time Performance Caused by Airlines” indicator reaches its maximum target	
	Z2.3	AOCC effectively minimizes flight delays	
	Z2.4	Public facilities such as waiting areas and check-in counters are available and in good condition	
	Z2.5	Flight information facilities are available and easily accessible to passengers	
	Z2.6	The cleanliness of airport areas is regularly maintained	
	Z2.7	AOCC cooperates with relevant parties to ensure a clean and comfortable airport environment	
	Z2.8	Lighting throughout terminal areas and passenger access routes functions properly	
	Z2.9	Boarding gates and check-in areas operate effectively and are fully functional	
	Z2.10	Gate, check-in, and immigration services are performed quickly and accurately	
	Z2.11	Security checks are conducted in accordance with domestic flight safety standards	
	Z2.12	Security checks are conducted in accordance with international flight safety standards	
Management Operation by Traffic (Y)	Y1	AOCC manages aircraft movements (take-off and landing) efficiently to minimize delays	Janić (2019)
	Y2	AOCC optimizes the use of runways and aprons to reduce aircraft queues	

	Y3	AOCC ensures that flight schedules are properly coordinated and do not overlap	
	Y4	AOCC effectively handles operational congestion (e.g., aircraft queues on the apron)	
	Y5	AOCC has effective procedures to manage operational emergencies	
	Y6	AOCC can quickly allocate resources to overcome operational bottlenecks	
	Y7	AOCC involves all stakeholders (airlines, ground handling, etc.) in decision-making related to aircraft traffic	
	Y8	AOCC ensures that aircraft traffic information is communicated quickly and accurately to all stakeholders	
	Y9	AOCC facilitates effective coordination among operational units to support traffic management	
	Y10	AOCC responds promptly and effectively to operational changes (such as delays or adverse weather)	
	Y11	AOCC has a fast communication system to inform stakeholders about situational changes	
	Y12	AOCC can quickly adjust operational schedules in response to unexpected situations	

RESULTS AND DISCUSSION

The measurement model testing in this study was conducted to ensure that the variables Interfunctional Collaboration (X1), AOCC Service Quality (Z1), AOCC Performance (Z2), and Management Operation by Traffic (Y) are measured with both validity and reliability. Validity was assessed through convergent validity, indicated by an Average Variance Extracted (AVE) value of ≥ 0.5, and discriminant validity, evaluated by comparing the square root of AVE with the inter-construct correlations to confirm that each construct is conceptually distinct. Reliability was measured using composite reliability (CR), with a threshold value of CR ≥ 0.7, to ensure the internal consistency of the indicators within each construct. This assessment of the measurement model is a critical prerequisite before proceeding with the analysis of direct and indirect relationships among the variables in the proposed structural model.

Validity Test Result

Convergent validity testing was conducted using SmartPLS 4 with the Partial Least Squares (PLS) algorithm approach. An indicator is considered valid if it has a loading factor value of ≥ 0.70, indicating that the indicator strongly represents the measured construct.

Table 1 Results of Validity Testing

Variable	Indicators	Loading Factors	Description
Interfunctional Collaboration (X1)	X1.1	0.821	Valid
	X1.2	0.753	
	X1.3	0.841	
	X1.4	0.831	
	X1.5	0.790	
	X1.6	0.782	

	X1.7	0.819	
	X1.8	0.811	
AOCC Service Quality (Z1)	Z1.1	0.870	Valid
	Z1.2	0.845	
	Z1.3	0.785	
	Z1.4	0.880	
	Z1.5	0.857	
	Z1.6	0.799	
	Z1.7	0.816	
	Z1.8	0.815	
	Z1.9	0.771	
	Z1.10	0.761	
	Z1.11	0.821	
	Z1.12	0.833	
AOCC Performance (Z2)	Z2.1	0.822	Valid
	Z2.2	0.837	
	Z2.3	0.849	
	Z2.4	0.846	
	Z2.5	0.818	
	Z2.6	0.860	
	Z2.7	0.828	
	Z2.8	0.799	
	Z2.9	0.831	
	Z2.10	0.874	
	Z2.11	0.846	
	Z2.12	0.853	
Management Operation by Traffic (Y)	Y1	0,885	Valid
	Y2	0,922	
	Y3	0,908	
	Y4	0,945	
	Y5	0,932	
	Y6	0,865	

Based on the results of the convergent validity test presented in the table, all indicator values for each latent variable exhibit strong loading factors, exceeding the minimum threshold of 0.70. This indicates that all indicators are valid measures of their respective constructs:

The Interfunctional Collaboration (X1) variable is measured using eight indicators, all of which show loading factors ranging from 0.753 to 0.841. These results confirm that each item is strongly correlated with the latent construct, demonstrating that the indicators contribute meaningfully to measuring collaboration across airport functions. The relatively consistent values also indicate stability in the measurement of this construct.

The AOCC Service Quality (Z1) construct consists of twelve indicators, with loading factors between 0.761 and 0.880. These values indicate a high level of internal consistency and accuracy in measuring service quality dimensions within the AOCC. The indicators exhibit strong correlations with the underlying construct, validating their appropriateness in assessing service-related perceptions and performance in the AOCC context.

The AOCC Performance (Z2) variable is represented by twelve indicators as well, showing robust loading factor values ranging from 0.799 to 0.874. These strong coefficients reflect high reliability and validate that each item effectively captures the key aspects of AOCC performance. The consistency across all items demonstrates the quality of the instrument used to assess this variable.

The Management Operation by Traffic (Y) construct is measured by six indicators, all of which demonstrate exceptionally high loading factors, ranging from 0.865 to 0.945. These values confirm that each indicator is a highly valid reflection of the latent variable. The strong convergence of these items suggests that the operational management based on traffic dynamics is well captured through these measurements.

Overall, these results confirm that all observed indicators are valid showing that all indicators have loading values greater than 0.7 (> 0.7), which confirms their validity. To further assess convergent validity, the Average Variance Extracted (AVE) was utilized as an additional measure. AVE reflects the proportion of variance captured by the indicators relative to the variance due to measurement error. A construct is considered to have good convergent validity when its AVE value is greater than 0.50 (> 0.50). The following section presents the AVE values obtained for each construct in this research.

Table 2AVE Value of Research Variables

Variable	Average Variance Extracted (AVE)
X1	0.650
Z1	0.676
Z2	0.704
Y	0.769

Furthermore, the high level of validity and reliability achieved across all constructs ensures that the subsequent structural analysis in the PLS-SEM model can be interpreted accurately and confidently. This methodological robustness not only strengthens the statistical credibility of the findings but also enhances their practical relevance. In the operational context of the AOCC at Ngurah Rai Airport, reliable and valid instruments enable decision-makers to identify which collaborative, service quality, or performance factors most strongly influence traffic management efficiency, thereby supporting data-driven strategies for improving airport operations.

Reliability Test Result

Reliability testing evaluates the internal consistency of the research instrument to ensure stability and trustworthiness in repeated measurements. This study employs Cronbach's Alpha and Composite Reliability as the main indicators. A construct is considered reliable if Cronbach's Alpha > 0.6 (exploratory) or > 0.7 (confirmatory), and Composite Reliability > 0.7 (Ghozali, 2016). The results of both indicators are presented as follows.

Table 2 Results of Realibility Testing

Variable	Cronbach's alpha	Composite reliability (rho_c)
X1	0.923	0.937
Z1	0.956	0.961
Z2	0.962	0.966
Y	0.973	0.976

Based on the reliability test results in Table 4.2, all constructs in this study, Interfunctional Collaboration (X1), AOCC Service Quality (Z1), AOCC Performance (Z2), and Management Operation by Traffic (Y), have Cronbach's Alpha and Composite Reliability values above 0.7. This indicates that all indicators within each construct exhibit high internal consistency and meet the reliability criteria. Therefore, the instruments used in this study are considered reliable and suitable for further analysis.

R^2 Test Result

The coefficient of determination (R^2) represents the proportion of variance in the dependent variable that can be explained by the independent variables within the model. According to Hair et al. (Hair et al., 2014), R^2 is derived by squaring the correlation coefficient. To assess the explanatory power of the model, the R^2 value can be interpreted as follows: a value above 0.67 indicates a strong level of explanatory power, a value between 0.33 and 0.67 reflects a moderate level, while a value between 0.19 and 0.33 suggests a weak level of influence. The following model summary table presents the R^2 values for each dependent construct in the study.

Table 3 Results of Coefficient of Determination (R^2)

Variable	R-square	R-square adjusted	Result
Y	0.509	0.499	Moderate
Z1	0.134	0.128	Weak
Z2	0.141	0.135	Weak

The Management Operation by Traffic (Y) variable has an R-square value of 0.509 and an adjusted R-square of 0.499. These values indicate that approximately 50.9% of the variance in Y can be explained by the combined influence of Interfunctional Collaboration (X1), AOCC Service Quality (Z1), and AOCC Performance (Z2). According to the commonly used criteria (Hair et al., 2010), an R-square between 0.33 and 0.67 is considered moderate, suggesting that the model has a reasonably strong predictive capability for this outcome variable.

The AOCC Service Quality (Z1) variable has an R-square value of 0.134 and an adjusted R-square of 0.128, meaning that only 13.4% of its variance is explained by the independent variable(s). Similarly, AOCC Performance (Z2) shows an R-square of 0.141 and an adjusted R-square of 0.135, which indicates that 14.1% of the variance in Z2 is explained by the model. These values fall below 0.33, which is generally categorized as weak explanatory power.

The relatively low R-square values for Z1 and Z2 suggest that there are external factors not yet included in the model that may influence AOCC Service Quality and AOCC Performance. These could include aspects such as the level of supporting technology, inter-agency coordination mechanisms, leadership style, or the prevailing work culture within the airport environment. Despite these limitations, the structural results remain credible because the instruments used in this study have been proven valid and reliable. The use of well-validated indicators minimizes measurement error, thereby improving the accuracy of the structural estimations and ensuring that the relationships tested in the PLS-SEM model can be interpreted with a higher level of confidence.

Hypothesis Testing Result

This section outlines the final stage of analysis, which involves evaluating the regression coefficients to examine the significance of relationships between variables. Hypothesis testing is conducted at a 5% significance level, where a hypothesis is accepted if the t-statistic exceeds

1.980 and the p-value is below 0.05 (Hair et al., 2014). A significant regression coefficient indicates a meaningful relationship between the tested variables, thereby supporting the proposed hypothesis.

The hypothesis testing results were obtained through data analysis using Partial Least Squares (PLS) with SmartPLS version 4.1.0.0. The output of this analysis is visualized in the path diagram shown in Figure 4.2, which illustrates the relationships among variables as evaluated through the PLS approach.

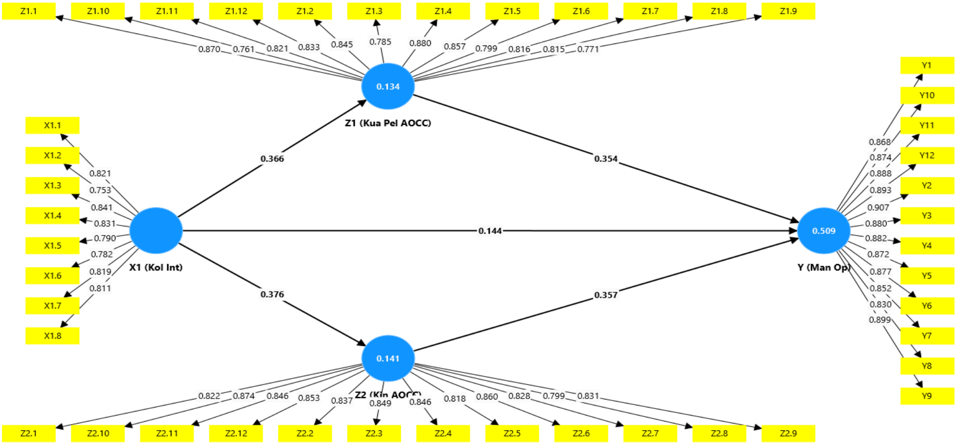

Fig 3. Path Diagram

The table below presents the regression coefficient values for each independent variable in relation to the respective dependent variable being tested.

Table 4 Results of Direct Hypothesis Testing

Hypothesis	Path	Original sample (O)	T statistics	P values	Result
H1	X1 -> Z1	0.366	4.738	0.000	Acceptable
H2	X1 -> Z2	0.376	5.433	0.000	Acceptable
H3	X1 -> Y	0.144	2.45	0.014	Acceptable
H4	Z1 -> Y	0.354	4.071	0.000	Acceptable
H5	Z2 -> Y	0.357	4.159	0.000	Acceptable

Hypothesis 1

The path coefficient for H1 is 0.366, with a T-statistic of 4.738 and a p-value of 0.000, indicating that the relationship is statistically significant. This result suggests that stronger collaboration across airport-related functions significantly improves the quality of services provided by the AOCC. Coordination among stakeholders such as airlines, ground handlers, immigration, and customs ensures better alignment in operational execution, which enhances service responsiveness and reliability.

According to de Barros et al., (2007), inter-agency coordination is critical in improving service quality at major airports, especially under high traffic conditions. Their study highlights how structured communication protocols contribute to reduced delays and increased passenger satisfaction.

Hypothesis 2

H2 has a path coefficient of 0.376, with a T-statistic of 5.433 and a p-value of 0.000, confirming a statistically significant effect. This indicates that better interfunctional collaboration positively influences AOCC performance, such as timeliness in decision-making, resource allocation, and disruption response. When departments work cohesively, operational bottlenecks are reduced, leading to enhanced system performance.

A study by Corrigan et al., (2015) confirms that cross-functional collaboration enhances performance through faster information sharing and joint planning, especially in complex operational environments like airports.

Hypothesis 3

The path coefficient for H3 is 0.144, with a T-statistic of 2.45 and a p-value of 0.014, indicating a statistically acceptable relationship. Although the effect size is smaller than the previous hypotheses, it still shows that collaboration among airport units has a direct, positive impact on traffic-based operational management. This implies that even without mediation, strong collaboration can improve flow efficiency and responsiveness to traffic fluctuations. According to Graham (2014), operational integration across departments is a key factor in managing traffic-intensive environments, especially in peak seasons, where coordination minimizes delays.

Hypothesis 4

With a path coefficient of 0.354, a T-statistic of 4.071, and a p-value of 0.000, H4 is statistically significant. This finding confirms that better service quality within the AOCC contributes to more effective and efficient traffic operations at the airport. High-quality services, including timely information flow, accurate resource deployment, and responsive handling of disruptions, directly enhance traffic management outcomes. Khudhair et al., (2021) found that service quality within airport control functions significantly affects operational flow and on-time performance, especially in congested terminals.

Hypothesis 5

The path coefficient is 0.357, with a T-statistic of 4.159 and a p-value of 0.000, indicating that this relationship is also strongly supported. This result illustrates that higher AOCC performance such as real-time monitoring, adaptive response to delays, and integrated scheduling directly improves the airport’s ability to manage traffic efficiently. It highlights the central role of AOCC in operational execution. According to Idris & Hansman, (2000), real-time performance of airport control systems significantly enhances operational efficiency and reduces turnaround times.

CONCLUSION

This study aims to analyze the influence of Interfunctional Collaboration on Traffic-Based Operations Management, considering the mediating roles of AOCC Service Quality and AOCC Performance at I Gusti Ngurah Rai International Airport, Bali. Based on the analysis using Structural Equation Modeling (SEM) with SmartPLS 4.0, it can be concluded that all proposed hypotheses are statistically significant and accepted.

The findings indicate that Interfunctional Collaboration has a direct and significant influence on both AOCC Service Quality and AOCC Performance, which subsequently contribute positively to the effectiveness of traffic-based operational management. Effective collaboration among key stakeholders, such as airlines, ground handling services, airport authorities, immigration, and security, proves essential in enhancing internal AOCC performance and improving the quality of services delivered to stakeholders within the airport ecosystem.

Moreover, both AOCC Service Quality and AOCC Performance are shown to play critical roles in supporting the efficiency and effectiveness of airport operations. These results reflect that strengthening service quality and operational control center performance not only improves internal coordination but also has a direct impact on flight movement management, slot allocation, and overall passenger experience.

In conclusion, Interfunctional Collaboration showed a notable effect on AOCC Service Quality (36.6%) and AOCC Performance (37.6%), this research highlights the importance of implementing collaborative strategies and reinforcing the strategic role of AOCC as a central hub for airport operations management. The findings provide empirical evidence supporting the integration of collaborative and data-driven approaches to enhance operational efficiency and service excellence at major airports in Indonesia, particularly amid the dynamic and complex post-pandemic traffic growth.

However, this study is limited to a single airport case and uses a cross-sectional design, restricting generalization and temporal insight. Future research could extend the model to multiple airports, adopt longitudinal analysis, or include technological and digital integration factors to better capture collaboration dynamics in complex operational environments.

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