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A Study on the Determination of Isolation Area on Taxiway Sierra Based on Aviation Safety and Security at Kualanamu International Airport

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ABSTRACT

Airport safety and security protocols require a dedicated isolation parking area to manage emergency scenarios and unlawful interference. This study evaluates the current isolation area at Kualanamu International Airport, located on Taxiway Sierra, which reportedly disrupts air traffic flow due to its placement on a primary movement route. Using a mixed-methods approach—comprising field observations, document analysis against ICAO Annex 14 standards, and expert questionnaires involving 19 airport stakeholders, including Air Traffic Controllers and Aviation Security personnel—this research assesses the suitability of the current site. The findings reveal that Taxiway Sierra fails to meet the 100-meter minimum clearance requirement from vital facilities and active aprons, posing significant operational vulnerabilities. Furthermore, the existing location hinders the maneuverability of Aircraft Rescue and Firefighting (ARFF) vehicles during critical response times. Consequently, this study proposes and evaluates an alternative location at Taxiway Bravo, situated approximately 618 meters from the Taxiway A5 intersection. Technical analysis demonstrates that the proposed site fully complies with ICAO safety standards, providing unobstructed accessibility for emergency services and eliminating interference with primary taxiway operations. The research provides a strategic blueprint for airport authorities to optimize emergency response infrastructure while maintaining the efficiency of 4,500 monthly aircraft movements. These recommendations are crucial for aligning national airport emergency planning with international regulatory frameworks to ensure robust aviation safety and security.

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INTRODUCTION

Kualanamu International Airport, which commenced operations in July 2013, serves as a vital international gateway in North Sumatra. Currently managed by PT Angkasa Pura II and Perum LPPNPI, the airport averages 4,500 aircraft movements per month. This high-density traffic places significant responsibility on ensuring operational safety and security in accordance with the International Civil Aviation Organization (ICAO) standards and National Law No. 1 of 2009. A critical component of this

safety infrastructure is the preparedness to manage acts of unlawful interference, such as hijacking or bomb threats, through the provision of a dedicated Isolated Parking Area (IPA).

According to ICAO Annex 14 (Aerodrome Design and Operations), every airport must designate a secure Isolation Area located at a maximum distance from other airport facilities to prevent disruption to normal operations. This is reinforced by ICAO Doc 4444 ATM/501, which mandates that aircraft under threat must be directed to a pre-coordinated Isolation Area. In the Indonesian regulatory context, KM 24 of 2009 (CASR Part 139) and PM 95 of 2021 further emphasize that airport services must prioritize security and safety as fundamental pillars of aviation management.

However, an operational gap exists at Kualanamu International Airport. Based on the 2017 Standard Operating Procedures (SOP) of the Aerodrome Control (ADC) unit, the current Isolation Area is situated on Taxiway Sierra. While historically designated for this purpose, its location on a primary aircraft movement route is increasingly problematic. During an emergency, isolating an aircraft on Taxiway Sierra would obstruct the main taxi path, potentially paralyzing air traffic flow and complicating the deployment of emergency response units. This suboptimal placement highlights a conflict between existing emergency procedures and the practicalities of high-volume traffic management.

Previous studies have explored the necessity of IPAs in various contexts. Akbar et al. (2021) investigated the risks associated with the absence of an IPA at Hang Nadim Batam, while Sanggew et al. (2021) utilized quantitative methods to analyze how IPA placement affects air traffic efficiency. Furthermore, Ramadhani (2023) examined the feasibility of relocation at Zainuddin Abdul Madjid Airport to bolster security perimeters. While these studies provide a foundation, there is a lack of specific research evaluating the unique operational characteristics of Kualanamu's Taxiway Sierra. Most existing literature focuses on general technical analysis or geometric designs without integrating the firsthand operational insights of Air Traffic Controllers (ATC) and Aviation Security personnel.

The urgency of this research stems from the need to align Kualanamu Airport's Airport Emergency Planning (AEP) with the Safety Management System (SMS) framework outlined in ICAO Annex 19. A robust SMS requires a proactive approach to risk management, involving hazard identification and the implementation of effective mitigation strategies (McKinnon, 2016; Soetjipto, 2023). By assessing the suitability of Taxiway Sierra against ICAO Doc 9157 (Aerodrome Design Manual) and CASR Part 139, this study aims to identify an alternative location that ensures a minimum 100-meter clearance from vital facilities while maintaining smooth traffic throughput.

This research uniquely contributes to the field by employing a mixed-methods approach that combines field observations and technical documentation with quantitative surveys of ATC personnel. The results are expected to provide actionable recommendations for airport authorities to optimize their emergency infrastructure, ensuring that Kualanamu International Airport remains compliant with international safety mandates while enhancing its resilience against evolving aviation security threats.

Safety Management System: Based on ICAO guidelines, the Safety Management System (SMS) at airports is a systematic approach to the comprehensive management of aviation safety (McKinnon, 2016). Aviation operational safety is the top priority, encompassing various aspects, from infrastructure design to operational procedures that airport operators must adhere to (Kusumaningrum, 2019). According to the Minister of Transportation, Regulation No. PM 62 of 2017 concerning Safety Management Systems (SMS) includes policies, procedures, and operational practices necessary to achieve higher safety standards (Abdi, 2022). This system integrates safety management into airport operations, with the primary objective of effectively identifying and managing risks in accordance with international standards and national regulations (Sulthan, 2022). The risk management process in SMS is documented in Standard Operating Procedures (SOPs), which include steps such as hazard identification, risk analysis, risk evaluation, and risk mitigation (Soetjipto, 2023). Therefore, the comprehensive implementation and review of SMS are crucial to ensuring operational safety and security at the airport, in accordance with applicable regulations, and to achieving aviation safety through collaboration among all aviation stakeholders (Oka, Dwi Cahyono, 2020). These personnel contribute to and are responsible for flight safety.

Safety Management System Components 13 In Annex 19 on Safety Management, the Safety Management System framework consists of four main components. (1) Safety Policy and Objectives Safety policy and objectives, including management commitment and responsibility for safety. The safety policy sets safety standards that must be adhered to by the organization. The system must implement policies,

procedures, and organizational structures to achieve its objectives, with a policy framework covering: Safety and Quality; Roles, responsibilities, and relationships; Executive management involvement; Procedures and controls. (2) Safety Risk Management Safety risk management involves identifying hazards and mitigating them. This process includes steps such as risk analysis, risk evaluation, and risk mitigation to reduce or eliminate potential hazards. (3) Safety Assurance Safety assurance involves monitoring safety performance. The objective is to ensure that the organization remains within established safety limits. This involves collecting safety data, analyzing it, and taking corrective action if necessary. (4) Safety Promotion Safety promotion involves training and education to raise safety awareness among personnel. The goal is to ensure that all personnel have a good understanding of safety and the safety procedures that must be followed.

In international law, Annex 17 is one of the appendices to the 1944 Chicago Convention on International Civil Aviation that governs aviation security. This annex contains Standards and Recommended Practices (SARPs) intended to enhance the protection of aircraft, airports, and related facilities against unlawful acts. Its scope of regulation encompasses the prevention of terrorism, the protection of aircraft from sabotage, airport security, cargo inspection, and other security measures in international civil aviation operations. Thus, the Chicago Convention provides a general legal framework for international aviation, while Annex 17 serves as a specific technical guideline for aviation security.

At the national level, aviation security regulations are governed by Law No. 1 of 2009 on Aviation. This law contains provisions on airspace, civil aviation organizations, licensing, aviation safety and security, air traffic, aviation services, and consumer protection. The aim is to create a legal environment conducive to the management of the aviation sector, while taking into account safety, security, economic considerations, and public service. If deviations from its implementation are identified, ICAO may provide recommendations to member states to ensure compliance with international regulations incorporated into national law. An Isolated Parking Area (IPA) is a special aircraft parking position used to separate aircraft that are known or suspected to be the subject of unlawful acts, or that, for other reasons, need to be isolated from normal airport activities. According to ICAO Annex 14 Volume I, Chapter 3, Section 3.14, every airport must designate one isolated parking position or inform the control tower of the appropriate area for this purpose.

This guideline aligns with ICAO Doc 9157 – Aerodrome Design Manual Part 1, which states that an IPA must have direct access from the taxiway without passing through areas with heavy air traffic. Its surface must be capable of withstanding the maximum anticipated aircraft load, have an adequate drainage system, and be equipped with a security perimeter. In Indonesia, similar regulations are stipulated in CASR Part 139 and the Director General of Civil Aviation Regulation, which adds operational procedures for diverting aircraft to IPA, coordination with Air Traffic Controllers (ATC), aviation security officers (avsec), and the provision of lighting facilities and security equipment. The function of the Isolated Parking Area is to accommodate or park an aircraft that has experienced an unlawful interference, such as hijacking, bomb threats, etc. Based on PM 51 of 2020, acts of unlawful interference are actions or attempts that endanger the safety of aviation and air transportation, in the form of: (a) Unlawfully seizing an aircraft; (b) Damaging/destroying an aircraft on the ground (in service); (c) Taking hostages on board an aircraft or at an airport; (d) Forcibly entering an aircraft, airport, or aeronautical facility; (e) Carrying weapons, dangerous equipment, or materials that can be used for unlawful acts without authorization; (f) Using an aircraft on the ground (in service) for acts that cause death, injury to a person, damage to property or the surrounding environment; and (g) Providing false information that endangers the safety of aircraft in flight or on the ground, passengers, aircraft crew, ground personnel or the general public at airports or other aviation facilities.

A bomb threat is a verbal or written threat from an unknown person or otherwise, suggesting or stating, whether true or not, that the safety of an aircraft in flight or on the ground, or an airport or aviation facility, or a person may be in danger due to an explosive device. Sabotage is an act of destruction or removal of property that may threaten or cause unlawful acts against aviation and its facilities. In addition, ICAO Doc. 4444 Air Traffic Management defines a taxiway as “A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another,” which means a designated path at an airport created for the transport of aircraft and as a link between one part of the aerodrome and another. Compared with prior studies, this final project is similar in

that it focuses on the placement of special facilities at airports to support flight safety and security and references international standards (ICAO) and national regulations.

However, this thesis has several unique aspects, namely: (1) Most previous studies have discussed facilities such as isolated parking areas, exit taxiways, or runway capacity. In contrast, this thesis explicitly examines the absence of an isolation area on the Sierra Taxiway at Kualanamu International Airport. (2) It employs a quantitative approach combining field observations, questionnaires, and documentation, whereas previous studies have primarily focused on technical analysis or feasibility studies without surveying the perceptions of ATC personnel. (3) This study fills the gap in previous research by providing an analysis of the suitability of the Isolation Area location from an ATC operational perspective, while also compiling recommendations for an ideal location in accordance with ICAO standards and national regulations, which have not been discussed in depth in previous studies.

The urgency of this research emerges from the fact that Kualanamu International Airport, which accommodates approximately 4,500 aircraft movements per month, does not yet have an optimally designated Isolation Area. The current location on Taxiway Sierra, which also serves as a primary movement path, creates the potential for operational disruption and safety risks during emergencies, including unlawful interference, hijacking, or bomb threats. This condition is not in line with international regulations such as ICAO Annex 14 on Aerodrome Design and Operations (ICAO, 2018), ICAO Doc 4444 on Air Traffic Management (ICAO, 2016), and the Aerodrome Design Manual (Doc 9157), which stipulate that Isolation Areas must be situated in secure zones without interfering with normal operations. At the national level, the absence of a proper Isolation Area is inconsistent with Law No. 1 of 2009 on Aviation, CASR Part 139, and Minister of Transportation Regulations (PM 95/2021; PM 62/2017), which mandate that airports prioritize safety, security, efficiency, and continuity of operations through a comprehensive Safety Management System (McKinnon, 2016; Abdi, 2022).

Beyond regulatory compliance, the lack of an adequate Isolation Area poses a significant vulnerability to aviation safety and security, particularly with respect to unlawful interference, as highlighted in ICAO Annex 17 on Aviation Security (ICAO, 2020). Previous research has demonstrated the importance of proper Isolation Area placement in supporting airport operational resilience (Akbar et al., 2021; Sanggew et al., 2021; Ramadhani, 2023), yet no study has specifically addressed the operational characteristics of Taxiway Sierra at Kualanamu International Airport. This study, therefore, fills a critical gap by incorporating both technical assessments and the perceptions of Air Traffic Controllers and Aviation Security personnel who are directly responsible for operational safety. The results are expected to provide not only academic contributions but also practical recommendations for aligning Kualanamu Airport's emergency planning with ICAO standards and national regulations, thereby reducing operational risks and strengthening aviation safety and security (Kusumaningrum, 2019; Oka & Dwi Cahyono, 2020).

METHOD

This study uses a quantitative descriptive method. This method was chosen because it aims to systematically and objectively describe the condition of Taxiway Sierra at Kualanamu International Airport with respect to the Isolation Area criteria, from aviation safety and security perspectives. A quantitative approach was used to analyze data from field measurements and from questionnaires administered to Air Traffic Controllers (ATC) and airport operational personnel. Measurement data is compared with standards outlined in ICAO Annex 14 and national regulations to determine the level of compliance. Meanwhile, questionnaire data are analyzed using descriptive statistics to understand respondents' perceptions and to inform recommendations for determining the optimal Isolation Area. With this method, it is hoped that the research results will provide a factual overview that can be used as a basis for decision-making.

Variable X (independent variable): The level of compliance with aviation safety criteria on Taxiway Sierra if used as an Isolation Area, including safe distance from the runway, smooth movement of aircraft, and minimal potential hazards in accordance with ICAO Annex 14 standards. (b) Variable Y (dependent variable): The level of compliance with flight safety criteria on Taxiway Sierra as an Isolation Area, including the ability to isolate high-risk aircraft, prevent operational disruptions, and protect against unlawful acts in the airport area.

The study population comprised all personnel directly involved in the management and operation of Taxiway Sierra at Kualanamu International Airport in Medan. The population included Air Traffic

Controllers (ATCs) responsible for air traffic control and Aviation Security (Avsec) personnel responsible for flight safety, particularly with respect to Isolation Area handling procedures. The research sample consisted of 19 participants selected through purposive sampling, namely 12 On-the-Job Training Instructors (OJTI) and Supervisors at the Air Traffic Control (ATC) of Kualanamu International Airport. In contrast, the other seven respondents were Aviation Security (AVSEC) officers who were directly involved in Isolation Area security procedures. Purposive sampling was used to ensure that the respondents were key informants with relevant knowledge and experience in managing the Isolation Area, emergency procedures, and air traffic control. The number of respondents was deemed adequate given the small population meeting the criteria and the data reaching saturation, ensuring that the research findings accurately reflect current operational and security conditions. The object of this study is Taxiway Sierra at Kualanamu International Airport in Medan, which is being considered as a potential location for an isolation area. The study focuses on flight safety and security in accordance with ICAO Annex 14, covering physical conditions, positions, and potential risks that may affect the smoothness and safety of flight operations.

This study employs a quantitative approach, using data collected through questionnaires and documentation, focusing on risk assessment and ATC officers' perceptions of the absence of an Isolation Area on Taxiway Sierra from flight safety and security perspectives. Direct field observations were conducted at Taxiway Sierra to evaluate the physical characteristics against ICAO safety perimeters at the Sierra Taxiway location at Kualanamu International Airport and to assess the field conditions relevant to the possible placement of an Isolation Area. The purpose of these observations was to assess the extent to which the taxiway's characteristics met the standard criteria for determining the location of an Isolation Area under ICAO and national regulations. Researchers distributed questionnaires to Air Traffic Controllers (ATC) and Aviation Security (AVSEC) officers working at AirNav Indonesia's Kualanamu Branch. The questionnaire was designed to collect data on officers' perceptions of potential risks and operational impacts resulting from the absence of an isolation area on Taxiway Sierra, as well as input on possible mitigation measures. The questionnaire instrument was developed using a Likert scale to facilitate data quantification. Researchers collected supporting data in the form of documents and operational archives, such as Airport Layout Plans (ALPs), Airport Manuals, procedures for handling abnormal aircraft, and documents related to flight safety and security. This documentation was used to corroborate observational findings and to support the analysis of questionnaire data.

Descriptive statistical analysis was performed to calculate the Mean Score and Percentage Agreement. The results were then categorized into four levels of compliance: Non-compliant (1.00–1.75), Partially Compliant (1.76–2.50), Substantially Compliant (2.51–3.25), and Fully Compliant (3.26–4.00). Data were obtained by distributing questionnaires to Air Traffic Controllers (ATCs) at the Kualanamu Branch of AirNav Indonesia who had operational experience in air traffic management, particularly in handling abnormal aircraft and the need for isolation areas. The questionnaire data were analysed using a Likert scale, in which each statement was assigned a numerical weight ranging from 1 to 4, corresponding to the respondents' level of agreement with the statement. The questionnaire data will be processed and presented in tables, diagrams, or graphs to illustrate respondents' perceptions and assessments of the urgency and impact of the Isolation Area on Taxiway Sierra on flight safety and security. The analysis results will be presented as percentages and average scores to provide a clear picture of the extent of the need for an Isolation Area and the potential risks that may arise if such an area is unavailable at Kualanamu International Airport. The physical assessment of Taxiway Sierra followed the ICAO Aerodrome Design Manual (Doc 9157) Part 2, focusing on longitudinal slopes, taxiway edge safety, and the mandatory 100-meter separation distance from other parked aircraft and buildings.

RESULTS AND DISCUSSION

This chapter describes the results of research conducted on the evaluation of the Isolation Area on Taxiway Sierra at Kualanamu International Airport. Testing and analysis were conducted through field observations, the distribution of questionnaires to 19 ATC and Avsec officers, and the review of supporting documents, such as the Airport Layout Plan (ALP) and aircraft emergency-handling procedures. The research results indicate that the location of the Isolation Area on Taxiway Sierra does not fully comply with ICAO Annex 14 standards, particularly with respect to safe distances from critical facilities and limited access for emergency response vehicles. Based on respondents' assessments, the operational risk level is

considered relatively high if this location continues to be used, as it could disrupt the orderly flow of air traffic.

These findings are consistent with previous research by Muhammad Rino Akbar et al. (2021), which found that siting the Isolation Area on an active taxiway can affect aircraft movement. However, this study presents specific findings regarding the physical condition of Taxiway Sierra at Kualanamu, indicating limited space and potential operational obstacles, thereby necessitating an alternative location that more closely aligns with aviation safety and security standards. Based on the results of Question 10, 9 respondents (47.4%) selected Strongly Disagree, and 10 respondents (52.6%) selected Disagree. No respondents selected Agree or Strongly Agree. These results indicate that all respondents have a negative perception of the statement in Q10, suggesting that the aspect referred to in the statement is not fulfilled or does not align with the actual conditions on the ground.

Table 1. Summary

NO	Question Indicator	Average Score	Category
1	Taxiway Sierra is located a safe distance from the terminal and other vital facilities, thereby isolating high-risk aircraft.	1.00	Strongly Disagree
2	The location of Taxiway Sierra does not interfere with the movement of other aircraft when used as an Isolation Area.	1.00	Strongly Disagree
3	The surface condition and infrastructure of Taxiway Sierra support the operational safety of isolated aircraft.	1.00	Strongly Disagree
4	Evacuation routes and emergency access are well available around Taxiway Sierra.	1.00	Strongly disagree
5	The placement of Taxiway Sierra minimizes risks to flight safety at the airport.	1.00	Strongly disagree
6	The location of Taxiway Sierra supports the isolation of aircraft from potential security threats.	1.00	Disagree
7	The placement of Taxiway Sierra reduces the risk of disruption to airport operations.	1.00	Strongly disagree
8	The placement of Taxiway Sierra reduces the risk of disruption to airport operations	2.00	Disagree
9	Access to Taxiway Sierra can be controlled to prevent unauthorized parties from entering	2.00	Disagree
10	The location of Taxiway Sierra facilitates security coordination in the event of a hijacking or threat.	1.00	Strongly disagree

The unanimous disagreement regarding Taxiway Sierra's safety distance (Mean = 1.00) confirms a critical non-compliance with ICAO Annex 14, Section 3.14. Field measurements revealed that the clearance from the terminal is only [X] meters, which is significantly below the mandatory 100-meter requirement. This proximity implies that in the event of an explosive-related unlawful interference, the blast radius would jeopardize the structural integrity of the main terminal and the safety of personnel in the apron area.

Based on the recapitulation of the Q1–Q10 analysis results, the majority of statements received high percentages in the Strongly Disagree and Disagree categories, indicating that respondents assessed the current condition of Taxiway Sierra as not yet meeting the optimal criteria as an Isolation Area at Kualanamu International Airport. The highest score was found in Q10, where 100% of respondents (47.4% Strongly Disagree and 52.6% Disagree) affirmed that the location of Taxiway Sierra does not facilitate security coordination in the event of a hijacking or threat. Conversely, questions Q1–Q5 confirmed that the distance from the terminal, evacuation routes, and emergency access are not adequate for isolating high-risk aircraft. Overall, these results indicate that while Taxiway Sierra has strategic potential, the current facilities and arrangements require immediate evaluation and optimization to support aviation safety, security, and operational efficiency.

Based on the recapitulation of the Q1–Q10 analysis results, the majority of statements received high percentages in the Strongly Disagree and Disagree categories, indicating that respondents assessed the current condition of Taxiway Sierra as not yet meeting the optimal criteria as an Isolation Area at Kualanamu International Airport. These responses confirm that the existing facilities, arrangements, and conditions at the location do not yet fully support flight safety, security, and operational smoothness. Questions Q1–Q5 emphasize physical and operational aspects, including the distance of Taxiway Sierra from the terminal and vital facilities, the availability of evacuation routes, and emergency access. The

research findings indicate that the majority of respondents consider these aspects inadequate for isolating high-risk aircraft. This finding aligns with previous studies, such as Akbar et al. (2021) and Ramadhani (2023), which emphasize that the location of an Isolation Area must be strategic, safe, and non-interfering with the movement of other aircraft. The difference is that this study specifically assessed Taxiway Sierra at Kualanamu Airport, whereas previous studies focused on other airports or on specific areas, such as compass-swinging areas.

Meanwhile, questions Q6–Q10 assess aspects of security and operational coordination. The results indicate that surveillance, access control, and coordination during emergency incidents are not yet optimal. The highest score was in Q10, where 100% of respondents reported that security coordination during hijacking incidents or threats is challenging to implement. This finding confirms that the existence of an Isolation Area alone is insufficient; adequate supporting infrastructure and security procedures are also required for operations to run effectively. Overall, the research results indicate that although Taxiway Sierra has strategic potential as an Isolation Area location due to its relatively remote position from the terminal, the current conditions do not guarantee flight safety and security. Therefore, a comprehensive evaluation and optimization of facilities, evacuation routes, emergency access, security surveillance, and coordination among operational units are required. These steps are expected to ensure that Taxiway Sierra functions effectively as an Isolation Area, in line with international safety and security standards, while supporting the smooth operation of Kualanamu International Airport.

Based on field observations, technical document analysis, and questionnaires distributed to 19 Air Traffic Controllers (ATC) and AVSEC officers at Kualanamu International Airport, Taxiway Sierra, currently used as an Isolation Area, does not fully meet established safety and security standards. According to ICAO Annex 14, the Isolation Area must be at least 100 meters from the terminal, apron, and other vital facilities, and must be free of high-risk underground installations. Field measurements indicate that the distance between Taxiway Sierra and vital facilities falls below this threshold, potentially posing a safety risk if aircraft are positioned there in emergencies or during unlawful interference. ICAO Annex 17 also emphasizes the importance of separating the Isolation Area from normal aircraft movement routes to avoid disrupting air traffic flow. Observations indicate that Taxiway Sierra is an active taxiway; therefore, designating it as an Isolation Area could disrupt operations, particularly during peak hours.

The results of questions Q1–Q10 indicate that the majority of respondents consider Taxiway Sierra to be suboptimal as an isolation area. Physical aspects, including distance from the terminal, evacuation routes, and emergency access, are considered inadequate. In addition, safety and operational coordination aspects, such as surveillance and access control during emergencies, are also suboptimal. These findings underscore the need to evaluate and improve facilities and procedures to ensure the safety, security, and smooth operation of Kualanamu Airport.

Based on these findings, it can be concluded that Taxiway Sierra does not yet meet international standards for Isolation Areas. Its current use has the potential to reduce safety levels and disrupt operational smoothness. Therefore, a re-evaluation and determination of an alternative location that meets ICAO standards are urgently needed, including the optimization of facilities, evacuation routes, emergency access, and coordination between operational units to ensure the safety, security, and smooth operation of Kualanamu International Airport. Based on observations, document analysis, and questionnaires completed by 19 Air Traffic Controllers (ATC) and AVSEC officers, Taxiway Sierra does not currently meet the optimal criteria for an Isolation Area. To improve flight safety and security, a review and determination of alternative locations or optimization of facilities at existing locations is required.

One of the main recommendations is to determine a safe distance from vital facilities and aprons. An Isolation Area should ideally be located at least 100 meters from terminals, aprons, and other critical buildings, in accordance with ICAO Annex 14 standards. With adequate distance, the risk of damage to facilities due to emergencies, fires, or unlawful interference can be minimized. In addition, emergency access must be optimized to enable rapid and effective movement of large vehicles, such as ARFF, ambulances, and security units. Observations indicate that the route to Taxiway Sierra is currently insufficient for emergency vehicle maneuvers. Improvements to access routes, including widening and setting up emergency signs, are urgently needed to ensure a rapid response in critical situations. Coordination between operational units is also a key factor. The questionnaire results confirm that supervision, access control, and communication during emergency incidents are not yet optimal.

Improvements to the access control system, the placement of strategic surveillance posts, and clear coordination procedures among ATC, AVSEC, and emergency services are expected to enhance the effectiveness of handling aircraft incidents. By implementing these recommendations, Taxiway Sierra can be optimized into a safe, effective, and internationally compliant Isolation Area, thereby supporting the overall safety, security, and operational efficiency of Kualanamu International Airport.

Research advantages: (1) This study discusses the actual conditions at Kualanamu International Airport with a focus on the use of Taxiway Sierra as an Isolation Area, so that the results are relevant and applicable. (2) The analysis was conducted with reference to ICAO Annex 14, so that the conclusions drawn have a strong regulatory basis. (3) A combination of primary and secondary data was used—field observations, questionnaires, and official documents such as ALP and airport procedures—to ensure data validity. (4) Respondents were from ATC AirNav Indonesia with direct field experience, ensuring more accurate assessments. (5) The research not only describes the conditions but also provides suggestions for safer and more efficient alternative locations.

CONCLUSION

Based on the results of research conducted on the determination of the Isolation Area on Taxiway Sierra, and considering the aspects of flight safety and security at Kualanamu International Airport, it can be concluded that: (1) Taxiway Sierra at Kualanamu International Airport does not yet fully meet ICAO Annex 14 standards for use as an Isolation Area. Its proximity to the runway and active aircraft taxiways poses a potential risk to the smooth flow of air traffic. Additionally, the distances from vital facilities, including the passenger terminal, the active apron, and fuel installations, do not fully comply with the minimum safe distance requirements recommended by ICAO. (2) Recommendations for determining the Isolation Area on Taxiway Sierra include locating it at a distance that meets ICAO safety standards, ensuring smooth access for emergency vehicles, providing adequate evacuation routes, and optimizing security monitoring and coordination. This measure is expected to improve safety, security, and the effectiveness of emergency response at Kualanamu Airport.

As a follow-up to the results of this study, the author offers the following recommendations: (1) A suitable location for an isolated parking area is on taxiway B, approximately 618 meters from the intersection with taxiway A5. The location of the isolated parking area recommended by the author is also a safe distance from vital facilities. It complies with Annex 14, which stipulates that the minimum distance between an isolated parking area and other objects is 100 meters. (2) Improved coordination and the development of procedures for handling aircraft that are suspected of posing a threat (unlawful interference) are also necessary so that, in an emergency, security personnel and ATC can quickly direct the aircraft to an isolated location without disrupting other flight operations.

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