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The Impact Of Kite And Bird Activities On The Management Of The Aviation Operational Safety Area (KKOP) At I Gusti Ngurah Rai International Airport, Bali

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Abstract

This study examines the impact of kite activity and bird strikes on the management of the Aviation Operational Safety Area (KKOP) at I Gusti Ngurah Rai International Airport, Bali. The study aims to analyze aviation safety risks, evaluate the effectiveness of mitigation strategies, and identify obstacles to implementing aviation safety policies in the KKOP area. The study used a mixed methods approach with an explanatory design. The study population included the airport safety unit, AirNav Indonesia, the Airport Authority Region IV, and the community around the airport. The sample was determined using purposive sampling. Data collection was conducted through semi-structured interviews, documentation, and aviation incident reports for the period 2020–2025. Data analysis used descriptive statistics, Hazard Identification and Risk Assessment (HIRA), thematic analysis, and SWOT analysis. The results showed that bird strikes were more dominant than kite disturbances, with the highest risk occurring in the runway, taxiway, and apron areas during the takeoff and landing phases. The threat of kites was influenced by socio-cultural factors of the community, while bird strikes were influenced by environmental conditions around the airport. This study concludes that integrated preventive, regulatory, technological, and collaborative strategies are needed to improve aviation safety management and support the zero accident target.

Keywords: Aviation Safety, Bird Strike, Flight Operational Safety Zone, Kite Activity, Risk Management

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INTRODUCTION

Air transportation plays a crucial role in supporting global connectivity and economic growth. In recent years, increased flight mobility post-pandemic has encouraged airports to strengthen operational safety aspects, particularly in Flight Operational Safety Areas (KKOP). KKOPs are strategic areas because they directly impact the safety of aircraft takeoffs and landings (Faturachman et al., 2023; Martadinata et al., 2021). Furthermore, increased development and community activity around airports have increased the potential for aviation safety threats, such as obstacles, kites, and bird strikes (Rahim et al., 2022; Putra & Hidayat, 2024).

I Gusti Ngurah Rai International Airport in Bali is one of the busiest airports in Indonesia, managed by PT Angkasa Pura I. Throughout 2022, the airport served more than 12.5 million passengers and 87,558 aircraft movements (PT Angkasa Pura I, 2023). This high flight activity increases the need for optimal KKOP supervision. However, kite activity, the presence of birds, and building obstructions around the airport area still pose threats to flight safety, especially during takeoff and landing (Suputri, 2025; Yusuf et al., 2022).

Extensive research has been conducted on KKOP management and aviation safety. Several studies have shown that obstacles and community activity around airports can increase flight safety risks (Faturachman et al., 2023; Martadinata et al., 2021). Other research confirms that bird strikes pose a serious threat to flight operations, necessitating an effective mitigation system (Rahim et al., 2022). Furthermore, the effectiveness of KKOP management is greatly influenced by coordination between airport management, the government, and the surrounding community (Putra & Hidayat, 2024).

However, previous research still has limitations. Most studies only address the technical aspects of obstacles or bird strikes without integrating social factors and the comprehensive implementation of safety policies. Furthermore, studies on the management of KKOP at tourism-focused international airports such as I Gusti Ngurah Rai Airport in Bali are still limited (Yusuf et al., 2022; Wibowo & Prasetyo, 2023). The discrepancies in research findings regarding the effectiveness of controlling community activities also indicate that aviation safety mitigation strategies are suboptimal (Rahim et al., 2022).

Based on these conditions, there is a research gap regarding an integrated analysis of aviation safety risks, the effectiveness of KKOP management, and obstacles to policy implementation at I Gusti Ngurah Rai Airport, Bali. Therefore, this study focuses on analyzing safety risks caused by kites and birds, evaluating the management strategies implemented, and identifying obstacles to implementing aviation safety policies in the KKOP area.

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This study aims to assess the level of aviation safety risk in the KKOP area of I Gusti Ngurah Rai Airport, Bali, and to formulate a more effective management strategy. This research is crucial given the high flight activity and potential safety disruptions around the airport. The novelty of this research lies in the integration of aviation safety risk analysis with KKOP management based on cross-sector coordination and community activities. Theoretically, this research is expected to enrich aviation safety management studies, while practically, it can provide recommendations for airport managers and aviation authorities in strengthening KKOP supervision..

METHOD

This study uses a mixed methods approach with an explanatory design to analyze aviation safety risks due to kite and bird activity in the Aviation Operational Safety Area (KKOP) of I Gusti Ngurah Rai International Airport, Bali. This approach was chosen because it integrates quantitative and qualitative data, providing a more comprehensive understanding of the research phenomenon (Creswell & Creswell, 2023; Sugiyono, 2022). The quantitative approach was used to analyze the frequency and risk level of aviation incidents, while the qualitative approach was used to understand stakeholders' perceptions and mitigation strategies through in-depth interviews (Emzir, 2020; Neuman, 2014).

The research was conducted at I Gusti Ngurah Rai International Airport in Bali due to its high traffic volume and the risk of flight safety disruptions due to kite flying and bird strikes. The research focused on the management of the KKOP and the implementation of flight safety regulations, which refer to the provisions of the ICAO and the Ministry of Transportation of the Republic of Indonesia (International Civil Aviation Organization, 2021; Ministry of Transportation of the Republic of Indonesia, 2021).

The study population included parties involved in aviation safety management in the KKOP area of I Gusti Ngurah Rai Airport, Bali, such as the safety unit, AirNav Indonesia, Airport Authority Region IV, and the community surrounding the airport. This population was selected because it is directly related to aviation safety risk monitoring and mitigation (Sugiyono, 2022).

The sampling technique used purposive sampling, taking into account the informants' experience and involvement in KKOP management. The research sample consisted of safety unit officers, AirNav Denpasar, Airport Authority Region IV, and the community surrounding the airport area. Additionally, secondary data was obtained from aviation incident reports, regulations, and airport operational data for the 2020–2024 period (Creswell & Creswell, 2023).

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The research instruments consisted of semi-structured interview guides, incident report documents, aviation regulations, and statistical analysis tools. Interviews were used to obtain information on incident frequency, mitigation effectiveness, and the implementation of aviation safety regulations (Sugiyono, 2022; Emzir, 2020). Documentation was used to obtain secondary data in the form of aviation safety reports and KKOP policies.

Data analysis was conducted quantitatively and qualitatively. The quantitative analysis used descriptive statistics and the Hazard Identification and Risk Assessment (HIRA) method to measure the level of aviation safety risk (Halim & Santosa, 2023). The qualitative analysis was conducted through thematic analysis of interview results to identify patterns and challenges in KKOP management. Furthermore, a SWOT analysis was used to formulate strategies to improve aviation safety.

The research procedure was conducted in four stages: preparation, data collection, data analysis, and report preparation. The preparation stage included problem identification, literature review, and the development of research instruments based on ICAO regulations and previous research related to aviation safety (Faturachman et al., 2023; International Civil Aviation Organization, 2021).

The data collection phase involved interviews and documentation studies of flight safety reports and airport operational data. The data was then analyzed using a mixed methods approach to integrate the statistical and thematic analysis results. The final phase involved compiling a report and drawing conclusions to formulate strategic recommendations for improving the management of the KKOP at I Gusti Ngurah Rai International Airport, Bali.

RESULTS AND DISCUSSION

Aviation Safety Risk Level in the KKOP Area of I Gusti Ngurah Rai International Airport

Table 1. Recapitulation results of the number of kite and bird strike incidents

Year	Kite Incident Report	Bird Incident Report	Total
2020	17	25	42
2021	2	9	11
2022	0	18	18
2023	9	13	22
2024	12	26	38
2025	4	20	21

Research shows that kite and bird activity at the KKOP of I Gusti Ngurah Rai Airport remains a threat to flight safety. Disturbances increase during the dry season, causing go-

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arounds, flight delays, and increased operational costs. Bird strikes pose the most serious risk, potentially damaging aircraft engines and endangering flight safety.

Table 2 Results of Descriptive Statistical Tests of Flight Safety Disturbances

Variables	N	Min	Max	Std. Dev	Mean
Y (Number of Events)	6	11	42	11,907	25.83
X1 (Kite)	6	0	17	6,501	7.33
X2 (Bird Strike)	6	9	26	6,656	18.50

Based on descriptive statistics, kite incidents average 7.33 per year, while bird strikes reach 18.50 per year, making them a more dominant threat to aviation safety in the KKOP area. The total number of aviation safety disruptions reaches an average of 25.83 per year, indicating that the risk level remains quite high and fluctuating. Kite incidents are influenced by community activities, while bird strikes are influenced by environmental conditions around the airport. Therefore, continuous strengthening of KKOP mitigation and supervision is needed.



Figure 1 Map of Distribution of Kite and Bird Incidents

Based on the spatial map, the most dominant bird incidents occurred in the runway area, particularly runway 27, as well as on the taxiways and aprons. This condition indicates that the threat of bird strikes is concentrated in the core operational area of the airport and poses a high risk during the take-off and landing phases. Meanwhile, kite incidents were more frequently found in the airside area and areas surrounding the airport, such as Jimbaran, Negara, and Legian, which are related to community activities around the KKOP. Overall, the threat of birds

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is influenced by natural environmental conditions, while the threat of kites is influenced by community social factors. Therefore, bird control in the airport operational area and strengthened supervision of kite activity around the KKOP are needed to continuously improve flight safety.

Table 3 Risk Analysis Results (HIRA)

No	Hazard	Potential Risks	*Likelihood*	*Severity*	Risk Level (ICAO Matrix)	Mitigation / Follow-up
1	Kite flying activities around KKOP (especially dry season, May–September)	Aircraft must go-around, loss of visibility, potential impact with aircraft structure	*Probable*(3) – frequently reported, several times per year	*Major*(3) – significant disruption (go-around, delay, accident incident)	*High*	- Intensive community-based socialization - Coordination between Avsec, TNI AU, village officials - Enforcement of regulations & sanctions - Routine patrols and sweeping of vulnerable areas
2	Kite string hits helicopter (2021 case)	Immediate safety hazard, potential for fatal accident	*Rare*(1) – rare, but it has happened	*Severe*(4) – endangers the lives of crew and aircraft	*Medium*	- Incident investigation & regulatory reporting- KKOP education to the community outside the airport (Denpasar City, Gianyar, Jimbaran, etc.)- Additional air patrols
3	Bird strike (seagulls, storks, sparrows) around the runway	Aircraft engine failure, potential aborted take-off/landing, fatal accident	*Frequent*(4) – occurs regularly every year	*Severe*(4) – potential for major damage & loss of life	*High*	- Bird control & bird repellent - Monitoring bird habitats around the airport (beaches, waterways) - Collaboration with environmental agencies
4	FOD (Foreign Object Debris) kites on apron/taxiway/runway strip (2023–2025)	Potential damage to aircraft tires/engines, operational delays	*Frequent*(4) – found repeatedly (daily log)	*Moderate*(2) – minor–moderate disruption (minor damage/delay)	*High*	- Immediate FOD cleanup & area inspection - Avsec & AMC patrols tightened - Daily FOD log recording - Education of surrounding community

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5	Low public awareness and compliance with KKOP regulations	Repetitive activity (kites), social resistance	*Probable*(3) – repeats every year	*Major*(3) – not immediately fatal but greatly increases the risk	*Medium*	- Participatory socialization (banjar, school, community) - Cultural approach (alternative kite festival) - Firmer law enforcement

Effectiveness of Management Strategies to Address Safety Threats in the Aviation Operational Safety Area (KKOP) of I Gusti Ngurah Rai International Airport

Table 4 Evaluation and Recommendations for Improvement of Safety Threat Management Strategy in the Flight Operational Safety Area (KKOP) of I Gusti Ngurah Rai International Airport

Strategies Implemented	Strategy Effectiveness	Success Indicators	Remaining Weaknesses	Recommendations for Improvement
Visual Surveillance (CCTV and visual spotting)	Not yet fully effective for early detection and rapid response, depending on weather and visibility	Visual and rapid detection of foreign objects by ATC, Safety Unit, and PKP/PK	Still depends on the weather and limited visibility	Improving the visual surveillance system with more advanced technology (e.g. cameras with wider coverage and strengthening human resources)
Use of Secondary Surveillance Radar (SSR)	Effective for monitoring aircraft movements, but not for detecting small objects such as kites.	Monitoring aircraft movements with precision	Radar does not detect non-conventional objects such as kites or UAVs	Integration of avian 3D radar or mmwave radar for detection of small non-metallic objects
Increased Ground Patrols Around the Airport Perimeter	Quite effective, but limited in area and personnel	Violations can be detected and violators given warnings or education.	Limited personnel and large area, as well as community dynamics	Adding patrol personnel and using supporting technology to expand the scope of surveillance
Preventive and Repressive Approaches (Violations)	Effective for enforcing rules, but less than optimal for dealing with larger violations.	Number of violations detected and acted upon	Limited supervision and lack of community involvement in early detection	Increased collaboration with law enforcement and the use of more sophisticated detection tools

Obstacles in the Implementation of Aviation Safety Policy at KKOP

1. Challenges and Obstacles in Mitigation: Technical and social obstacles faced in KKOP supervision.

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Figure 2: Several Residents Playing Kites Near Kelan Beach (Source: Personal Documentation, 2025)



Figure 3. A sign prohibiting kite flying, drone flying, hot air balloon flying, and similar activities in the Kelan Beach area. (Source: Researcher Documentation, 2025)

Interviews with the Safety Unit, Otban IV, AirNav Denpasar, and the community around I Gusti Ngurah Rai Airport indicate that risk mitigation in the KKOP area still faces technical, social, and cultural challenges. Technically, monitoring of kite flying activities is still carried out visually and is reactive due to the lack of a dedicated detection system, so response relies on reports from pilots and ground personnel. Socially, low public awareness and the tradition of kite flying in Bali are major obstacles to controlling activities around flight paths. Furthermore, outreach campaigns through banners, billboards, schools, and social media are considered ineffective in reaching the entire community. Overall, aviation safety management in the KKOP area requires not only strengthening surveillance technology but also a social and cultural approach through education, community engagement, and more collaborative and sustainable policies.

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Perception of Regulation and Socialization: Level of Public Awareness and Response to the Ban on Kite Flying Activities



Figure 4. Interview with residents flying kites at Kelan Beach. (Source: Researcher Documentation, 2025)

Interviews indicate that public awareness of the ban on kite flying in the KKOP area of I Gusti Ngurah Rai Airport remains low. Some people are only aware of the ban, but do not fully understand the flight safety risks and legal consequences. Furthermore, kite flying is still considered a local tradition, which often hinders supervision through social and cultural barriers. Public awareness campaigns conducted by the Safety and AirNav Units are also still formal and do not involve active community participation. Weak law enforcement leads to the perceived lack of clarity in the regulations. Therefore, a more participatory and culturally-based educational approach is needed to raise awareness of flight safety in the KKOP area.

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Obstacles in Mitigating Bird Strike Risk at KKOP I Gusti Ngurah Rai International Airport



Figure 5: Many birds flying around the landing area of Runway 27 at I Gusti Ngurah Rai International Airport, Bali. (Source: Researcher Documentation, 2025)

Bird strike control at I Gusti Ngurah Rai Airport's KKOP is hampered by the surrounding environment, such as beaches, waterways, and mangrove forests, which serve as bird habitats. Bird strikes are most common on runways, taxiways, and aprons, increasing the risk during takeoff and landing.

Despite the use of bird deterrent systems, bird control remains limited because bird movements are influenced by seasons and environmental conditions. Furthermore, mitigating bird strikes requires cross-sector coordination between airports, the government, and the community to more effectively manage bird habitats around the KKOP area.

Table 5 Summary of Challenges in Implementing KKOP Policy and Its Impact on Aviation Safety

No	Why the KKOP Policy is Difficult to Implement Optimally	Factors Inhibiting Implementation	Gap between Regulations and Field Conditions	Impact on Aviation Safety
1	Monitoring of kite activity is still not supported by specialized detection technology. Monitoring still relies heavily on visual spotting by officers, CCTV, pilot reports, and ATC.	The limitations of small object detection tools such as kites, the absence of a routine inspection schedule, and a monitoring system that tends to be reactive.	Regulations prohibit activities that endanger airport airspace, but in the field, detection of violations cannot be carried out quickly and comprehensively.	Mitigation responses may be delayed, potentially allowing the intruder to enter operational airspace and increasing the risk of flight disruption.
2	The KKOP policy clashes with the tradition of kite flying, which	Cultural factors, seasonal customs, kite competitions, and	Regulatoryly, kites around KKOP are seen as a safety threat, but	The potential for repeat violations remains high,

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	has long been embedded in the lives of Balinese people.	the public's perception that this activity is ordinary entertainment.	socially, the community still interprets it as a tradition and communal activity.	especially during the easterly wind season or the dry season, making threats to flight safety difficult to fully control.
3	Public understanding of KKOP regulations remains low. Some people only know the prohibition from banners or billboards without understanding the safety reasons behind it.	Socialization has not reached all levels of society, especially children, teenagers, kite communities, and residents from outside the Badung area.	Regulations have set out prohibitions and sanctions, but public understanding of the legal basis and safety risks has not yet been fully established.	The public tends to consider violations as trivial because they do not always have a direct impact on the aircraft.
4	Socialization methods are still one-way and formal, such as lectures, banners, billboards, and media campaigns.	The communication approach is still technocratic, less participatory, and has not been fully adapted to the local culture of the community around the airport.	Regulations require active compliance from the public, but the approach on the ground has not been sufficient to build a sense of ownership and shared responsibility.	Collective awareness of airspace safety is not yet strong, so that the community has not yet fully become part of the community-based early detection system.
5	Law enforcement against minor violations is still weak, especially if the violation does not result in a direct accident.	The difficulty in identifying the perpetrator, limited visual evidence, the location of the incident being outside the direct supervision area, and limited personnel.	The regulations contain administrative and criminal sanctions, but their implementation in the field has not always been implemented firmly.	The public may consider the ban to be not seriously binding, so the deterrent effect is low and the potential for repeat violations remains.
6	The responsibility for maintaining airspace safety is still perceived as the sole responsibility of airport officials.	Low understanding of the concept of shared responsibility between airport managers, government, officials, communities and the surrounding community.	Regulations require the involvement of many parties, but in the field, the community still tends to position itself as a passive party.	The monitoring system is becoming less robust because early detection is not supported by active participation of the community around the KKOP.
7	The KKOP area is extensive and includes residential areas, coastal areas, and dynamic public areas.	Limited number of personnel, high public mobility, and many points prone to kite activity around the airport.	The KKOP provisions apply to a wide area, but the field monitoring capacity is not yet commensurate with the scope of the area that must be monitored.	Violations at vulnerable points can escape supervision and only become known after a report from the pilot, ATC, or field officer.
8	The existence of bird habitats that support bird activities around the airport.	Water areas, beaches, waterways and mangrove forests support the presence of birds.	Bird habitat management has not addressed the environmental factors that influence bird presence.	Increased risk of bird strikes in the takeoff and landing phases, increasing the threat to flight safety.
9	Limitations of bird repellent mitigation systems and detection technologies.	The use of bird deterrent systems is limited, as is the need for more adaptive and real-time technology.	Bird monitoring still relies on conventional methods which are less effective.	The inability to detect birds before they enter critical areas reduces the effectiveness of mitigation and increases safety risks.
10	Limited cross-sector coordination in bird habitat management.	Bird habitat management is not only in the airport area, but also outside the management area.	There is insufficient coordination between airports, local governments, and surrounding communities regarding bird habitat management.	Uncontrolled bird disturbance outside the airport area can increase the risk of bird strike incidents within the KKOP area.

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Based on Table 5, the implementation of the KKOP policy at I Gusti Ngurah Rai Airport still faces obstacles in monitoring kites and bird strikes. Kite monitoring is still limited to visual monitoring, while cultural factors and low public awareness often lead to the ban being ignored.

In addition, bird habitats around the airport, such as beaches and mangroves, increase the risk of bird strikes, while limited technology and coordination between parties means that flight safety mitigation in the KKOP area is less than optimal.

Formulating Strategies to Improve the Effectiveness of KKOP Management

SWOT Analysis

Table 6 Results of SWOT Factor Identification

Internal / External Factors	Positive	Negative
Internal	**Strengths:** 1. Clear aviation safety regulations and KKOP regulations. 2. Well-documented flight disruption incident data. 3. Support from airport authorities and AirNav in air traffic control. 4. Stakeholder commitment to zero accidents.	**Weaknesses:** 1. Public awareness around the airport is still low. 2. The number of patrol personnel is limited. 3. Birdstrike mitigation is still reactive, not based on habitat management. 4. Minimal cross-sector coordination (local government, airport, community).
External	**Opportunities:** 1. Support for modern monitoring technology (bird radar, surveillance). 2. Potential for safety education campaigns based on local wisdom. 3. Collaboration with conservation institutions to mitigate birdstrikes. 4. National and international regulations encourage higher safety standards.	**Threats:** 1. The high frequency of birdstrikes significantly impacts aviation incidents. 2. The culture of people flying kites around airports. 3. Bird population growth due to open garbage and natural ecosystems near airports. 4. The potential for a spike in incidents as air traffic increases post-pandemic.

Table 7 Results of SWOT-Based Strategy Analysis

Types of Strategy	Strategy Design
SO (Strengths–Opportunities)	Leveraging safety regulations and aviation authority support to develop risk monitoring technology (bird radar) and conduct public education campaigns for more effective mitigation.
WO (Weaknesses–Opportunities)	Reducing limited patrols and low public awareness by expanding community collaboration programs based on local wisdom, and collaborating with local governments to strengthen regulations prohibiting risky activities in KKOP.
ST (Strengths–Threats)	Using incident data and stakeholder support to anticipate birdstrike threats by implementing habitat management, as well as enforcing laws more strictly against kite flying activities around airports.
WT (Weaknesses–Threats)	Addressing the lack of cross-sector coordination by establishing a permanent aviation safety mitigation forum, while simultaneously developing SOPs for rapid response to address the potential spike in incidents due to kite flying and the increasing bird population.

The level of flight safety risk in the KKOP area of I Gusti Ngurah Rai International Airport is determined by the activity of kites and birds.

The research results show that kite and bird activity in the KKOP area of I Gusti Ngurah Rai Airport remains a serious threat to flight safety. These disturbances increase during the dry

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season and cause go-arounds, flight delays, and increased operational risks. Bird strikes are the most significant threat, potentially damaging aircraft engines and endangering flight safety.

Spatial analysis shows that bird incidents predominantly occur on runways, taxiways, and aprons, while kite incidents are more common in areas surrounding airports affected by public activity. The HIRA analysis places kite and bird strikes in the Medium to High risk category due to their high frequency and impact on flight safety.

Overall, the high aviation safety risks are influenced by bird strikes, kite activity, low public awareness, and limited technology and inter-agency coordination. Therefore, an integrated mitigation strategy is needed through strengthened surveillance, bird habitat management, and public education in the KKOP area.

The effectiveness of the management strategy implemented by the airport is an important factor in overcoming safety threats caused by foreign objects in the KKOP area.

The aviation safety disruption management strategy at I Gusti Ngurah Rai Airport includes preventive, curative, and collaborative measures with various stakeholders. Internally, the airport has implemented mitigation standard operating procedures (SOPs), increased KKOP patrols, deployed a bird deterrent system, and enforced a ban on risky activities around the airport. However, its effectiveness remains hampered by low public awareness.

Management also involves AirNav Indonesia, the Airport Authority, local governments, security forces, and the public through aviation safety education and outreach programs. Analysis shows that external stakeholder support significantly reduces the risk of aviation safety disruptions.

Based on the risk analysis, the implementation of mitigation strategies has successfully reduced the intensity of disruptions caused by kites and bird strikes over the past two years, although the threat has not completely disappeared. Overall, the management strategy is considered quite effective, but it still requires strengthened public participation and law enforcement to optimally minimize aviation safety risks.

Obstacles faced in implementing aviation safety policies at KKOP, particularly in controlling risky activities

The implementation of aviation safety policies at I Gusti Ngurah Rai Airport still faces various obstacles, both internal and external. The main obstacles stem from social and cultural aspects, particularly kite flying, which is still considered a local tradition and therefore difficult to control despite prohibitions and public awareness campaigns.

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From a regulatory perspective, law enforcement against violations in the KKOP area remains inconsistent and has not yet provided a deterrent effect. Furthermore, technical obstacles arise due to limited kite detection and bird strike control technology, as well as the vast KKOP surveillance area, which requires greater resources.

Other obstacles include budget constraints and suboptimal coordination between stakeholders such as airports, local governments, security forces, and the public. Overall, obstacles to implementing aviation safety policies at the KKOP encompass socio-cultural, regulatory, technical-operational, and cross-sectoral coordination, necessitating regulatory strengthening, technological advancements, and public participation to enhance the effectiveness of aviation risk mitigation.

A strategy to increase the effectiveness of KKOP management is needed to minimize the potential for aviation accidents and support the achievement of the zero accident target.

Based on the analysis, the management of the KKOP at I Gusti Ngurah Rai International Airport needs to be carried out through preventive, regulatory, technological, and collaborative approaches. Preventive strategies are implemented through community education based on local wisdom, bird habitat management, and increased early detection of kites. From a regulatory perspective, stricter law enforcement and the formation of an integrated cross-agency team are needed to strengthen KKOP supervision. Furthermore, the use of technologies such as bird radar and foreign object detection systems needs to be optimized to support real-time monitoring. Strengthening coordination between stakeholders and community involvement is also crucial to increase the effectiveness of risk mitigation. Overall, the integration of these strategies is expected to reduce the risk of bird strikes and kite activity and support the achievement of flight safety and the target of zero accidents at I Gusti Ngurah Rai International Airport.

CONCLUSION

Based on the research results, it can be concluded that kite flying and bird strike activities in the Flight Operational Safety Area (KKOP) of I Gusti Ngurah Rai International Airport, Bali, still pose a serious threat to aviation safety. The highest risks are found in the runway, taxiway, and apron areas, especially during the takeoff and landing phases of aircraft. Kite flying is influenced by social and cultural factors, while bird strikes are influenced by environmental conditions around the airport, such as beaches, waters, and mangrove forests, which are bird habitats. Mitigation strategies implemented through patrols, outreach, visual surveillance, and the use of

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bird deterrent systems are considered quite effective in reducing the intensity of disturbances in the past two years, but have not been able to optimally eliminate the threat. The main obstacles to policy implementation include low public awareness, weak law enforcement, limited detection technology, and suboptimal cross-sectoral coordination in KKOP management.

This study is limited by the limited coverage of incident data within a specific period and the lack of comprehensive real-time monitoring technology such as bird radar and small object detection systems. Furthermore, this study focused on I Gusti Ngurah Rai Airport, so the results cannot necessarily be generalized to all airports in Indonesia, each with its own unique characteristics. Therefore, further research is recommended to develop analyses based on spatial data and modern technology, expand the scope of research locations, and examine the effectiveness of cultural approaches and community participation in aviation risk mitigation. Practically, the results of this study can serve as recommendations for airport managers, local governments, AirNav, and aviation authorities to strengthen KKOP supervision through technology integration, bird habitat management, regulatory strengthening, and community-based public education to support aviation safety and the goal of zero accidents.

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