

A Study on Human, Technical, and Environmental Factors Contributing to the Bell 505 Helicopter Accident in Bali Caused by a Kite String

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ABSTRACT

This study aims to examine the Bell 505 helicopter accident in Bali caused by a kite string by analyzing human, technical, and environmental contributing factors. The research employed a qualitative descriptive method through document analysis, including news reports, scientific literature, and aviation safety regulations. The findings indicate that the accident occurred due to limited airspace supervision, low public awareness regarding restrictions on kite activities within the Airport Safety Zone (KKOP), and the absence of effective risk mitigation and communication systems among aviation authorities and operators. This research contributes to aviation safety science by emphasizing the importance of public education, strengthened regulatory enforcement, and improved risk management in helicopter operations, particularly in tourism areas with high environmental interference potential.

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1. INTRODUCTION

Air transportation is one of the fastest growing modes of transportation in the modern era, including helicopter services that are increasingly being used for various purposes such as tourism, business, medical evacuation, and rapid mobility between locations (Pan & Alouini, 2021). This trend indicates that helicopters are not only used for special missions, but have also become part of the tourism industry and public services, especially in areas with limited land accessibility (McMillan & Xu, 2024). In Indonesia, particularly in tourist areas like Bali, the use of helicopters is increasing as a premium service for tourists or as a fast transportation alternative between destinations (Wicaksono et al., 2024). However, increased helicopter operations also bring consequences in terms of increased potential for air accidents (Saleh et al., 2019). Unlike commercial aircraft, which have fixed flight paths at high altitudes, helicopters often operate at low altitudes (low altitude operations), especially when conducting tourist activities, hovering,

landing, or taking off in open areas (Jin et al., 2022). These conditions make helicopters more vulnerable to potential hazards on the ground and external objects located in low airspace, including power lines, building structures, communication towers, and even unusual objects such as kites (Chandrasekaran et al., 2020). On July 19, 2024, a Bell 505 helicopter crashed in the Pecatu area of Bali, strongly suspected to have been caused by the helicopter's rotor blades becoming entangled in a kite string (Weber et al., 2019). This incident attracted public and aviation authority attention because the cause of the accident was related to an unusual environmental factor that could endanger flight safety (Nævestad et al., 2021). This incident raises serious questions about the causes of accidents, especially in the context of helicopter flights (Saleh et al., 2019) in tourist areas and open airspace that are potentially disturbed by community activities. In aviation safety studies, the causes of accidents are generally a combination of several factors, namely human factors (human error), technical or maintenance factors, and environmental factors (Rajee Olaganathan, 2024). However, most previous studies have focused more on commercial aircraft accidents or accidents related to engine failure and procedural errors (Insley & Turkoglu, 2020). Very few studies have addressed helicopter accidents caused by interactions with objects in uncontrolled airspace, particularly kites (Rao & Marais, 2018).

This incident also draws special attention to the implementation of and compliance with Aviation Safety Operation Zone (KKOP) regulations, which prohibit unauthorized kite flying in flight paths or around areas with active flight activity (Smith & Bromfield, 2022). These regulations were actually created to prevent interference with aviation operations, both large and small. However, in practice, many people do not understand the boundaries of the KKOP and the risks posed by activities such as flying kites in airspace used for aviation (Psyllou & Majumdar, 2020). Considering this background, this study aims to examine the Bell 505 helicopter accident in Bali from the perspectives of human factors, technical factors, and environmental factors within the framework of a qualitative descriptive analysis based on documents. This study also identifies the relevance of the accident to the implementation of KKOP regulations as the legal basis for aviation safety in Indonesia. Through this study, it is hoped that the research can provide a comprehensive picture of the causes of the accident and contribute to the understanding, evaluation, and recommendations for improving helicopter flight safety in areas with high environmental disturbance risks.

In addition, this study is expected to benefit various parties, including aviation regulators, helicopter operators, local governments, and communities around the flight operation area. For regulators and operators, the results of this research can be used as evaluation material to strengthen safety procedures, risk mitigation, and safer flight route planning. Meanwhile, for local governments and communities, this research is expected to raise awareness of the importance of keeping airspace safe and free from interference in order to support flight safety (Wipf, 2020).

2. METHODS

This study uses a qualitative descriptive method to provide a systematic overview of the human, technical, and environmental factors involved in the Bell 505 helicopter accident in Bali caused by a kite string. This approach focuses on event-based analysis rather than statistical testing. The data used is secondary data obtained from various references and documents related to the incident (Liu & Yang, 2022), including reliable news articles, official documents and flight technical manuals, scientific literature on human error and flight safety, as well as public analysis from authorities such as the KNKT or AAIB.

Data collection was carried out through document analysis and comparison of various source perspectives to obtain a comprehensive interpretation. Data analysis used content analysis with grouping based on human, technical, and environmental factors, as well as event-based analysis to examine the chronology of events. Data validity was maintained through source triangulation, which is comparing various documents so that the information is more accurate and accountable.

3. FINDINGS AND DISCUSSION

Based on an examination of multiple news sources and preliminary technical reports, the helicopter accident is believed to have occurred after the aircraft made contact with a kite string that was present within its intended flight path. The presence of the kite string created an unexpected physical obstruction during a critical phase of flight. Given the relatively low altitude and reduced maneuvering margins typically associated with approach, landing, or takeoff operations, even a thin, nearly invisible object such as a kite string can pose a serious hazard to rotary-wing aircraft.

The accident site is located within an area routinely utilized for flight operations, particularly for approach and departure procedures. Such areas are generally subject to regulatory oversight due to their proximity to aerodromes and the heightened safety sensitivity of these flight phases. The location is also suspected to fall within the Kawasan Keselamatan Operasi Penerbangan (KKOP) zone, an aviation safety protection area intended to control obstacles and activities that may endanger aircraft operations. Activities that introduce potential airborne hazards, including kite flying, should be strictly managed within this zone to prevent interference with aircraft movement.

As illustrated in Figure 1 below, the helicopter wreckage was found at the base of a steep limestone ravine in Bali. The terrain characteristics suggest that once control was compromised—potentially due to entanglement with the kite string—the pilot had limited options for recovery, increasing the severity of the outcome.



Figure 1. Aerial view of the helicopter wreckage after it crashed in a steep limestone ravine in Bali, reportedly caused by entanglement with a kite string.

Based on a review of news reports and technical reports, the helicopter accident was caused by contact with a kite string that was in the flight path. The location is included in an area that is regularly used for flight operations (approach/landing/takeoff), and is suspected to be within the KKOP zone. As shown in the image above

Furthermore, there is no indication from the available documentation that the pilot or the operating company received prior information or official notification regarding kite-flying activities along the flight path. This absence of hazard communication suggests a breakdown in risk identification and dissemination processes. In aviation safety management, timely information sharing regarding potential obstacles or unusual activities in protected airspace is essential to enable effective risk mitigation.

The flight plan documentation, as referenced below, does not reflect any warnings, NOTAMs, or operational advisories concerning kite activity in the area. This implies that the risk associated with airborne obstructions was not formally recognized, assessed, or communicated before the flight. Consequently, the event highlights potential gaps in coordination between local authorities, aviation stakeholders, and the community in managing non-aviation activities that may impact flight safety.

Regulations governing the Kawasan Keselamatan Operasi Penerbangan (KKOP) strictly prohibit any “other activities” that may endanger aviation safety within protected airspace. These activities include, but are not limited to, kite flying, the operation of hot air balloons, laser emissions, and the release of airborne objects that could interfere with aircraft operations. Such restrictions are particularly critical in areas designated for approach, landing, and takeoff, where aircraft operate at low altitudes and have limited maneuvering capability. Any activity that introduces a physical obstacle—even one that appears minimal, such as a kite string—can pose a significant risk to both aircraft performance and flight crew response time. Activities of this nature may only be conducted if prior official authorization has been obtained from the competent aviation authority, ensuring that a proper risk assessment and safety mitigation measures are in place.

In the context of the Bali helicopter accident, the suspected presence of a kite string within the operational flight path indicates a potential violation of KKOP provisions. The absence of documented authorization or formal coordination suggests non-compliance with aviation safety regulations intended to prevent precisely this type of hazard.



Figure 2. Close-up view of the helicopter's main rotor assembly showing a kite string entangled around the rotor hub structure, identified as a contributing factor in the helicopter crash in Bali.

Violations of KKOP regulations are subject to criminal sanctions and/or administrative penalties in accordance with applicable aviation law. Legal consequences may include imprisonment for up to three (3) years and/or fines of up to IDR 1,000,000,000. These sanctions reflect the seriousness with which aviation safety is treated under national law, particularly when unauthorized activities directly endanger aircraft operations and human life.

In the accident under analysis, available evidence indicates that kite-flying activity was conducted in the vicinity of the flight path without prior authorization from the relevant aviation authority. Such activity constitutes a violation of regulations governing the Kawasan Keselamatan Operasi

Penerbangan (KKOP), which strictly restrict any airborne objects or activities that may pose hazards to aircraft operating within protected airspace.

As shown in Figure 2, the physical evidence recovered from the wreckage demonstrates direct mechanical interference between the kite string and the helicopter's rotor system. The documentation reveals strands of kite string tightly wrapped around the rotor hub and adjacent components, indicating that the aircraft made contact with the string while the rotor was rotating at operational speed. This type of entanglement can immediately disrupt rotor balance, increase aerodynamic drag, and induce severe vibration, potentially leading to loss of control.

The presence of this material firmly attached to critical flight components substantiates the conclusion that the kite string was not merely present in the vicinity but actively interfered with the helicopter's mechanical system. The evidence therefore reinforces the assessment that unauthorized kite flying within or near protected flight paths presents a significant and tangible threat to aviation safety.

Violations of these regulations are subject to criminal penalties and/or maximum fines in accordance with the provisions of the law: for example, imprisonment for up to 3 years and/or fines of up to IDR 1,000,000,000.

In the accident analyzed, kite flying appeared to be conducted without permission, thereby violating regulations, and the incident demonstrated that kites pose a real danger to flight safety. The following is evidence of the damage caused.

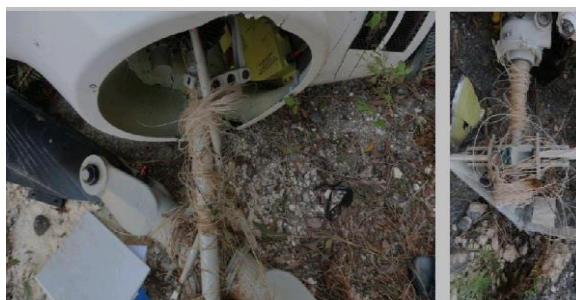


Figure 3. Close-up photographic evidence showing kite string entangled around the helicopter's rotor assembly following the Bali crash, illustrating the direct physical damage caused by the obstruction

4. CONCLUSION

a. Systemic Errors: Regulation vs. Public Awareness

Although KKOP regulations clearly prohibit kite flying in aviation safety zones without official permission violations continue to occur, leading to accidents. This shows that written regulations alone are not enough; socialization, law enforcement, and increased public awareness of the risks of activities in aviation zones are also necessary.

b. Lack of Communication and Monitoring of KKOP Zones

This incident indicates weak communication and monitoring mechanisms around KKOP zones. The lack of field monitoring and coordination between aviation authorities and local governments has resulted in risky activities going undetected or not being effectively regulated.

c. Operational and Safety Impacts

Kites in flight paths have the potential to cause technical damage, obstruct pilots' visibility, and even lead to fatal accidents. KKOP regulations are designed to prevent these risks, so this incident underscores the relevance and urgency of consistent enforcement of regulations.

d. Need to Strengthen Regulation Enforcement at Airports

To be effective, each airport needs to implement intensive public education, routine monitoring of sensitive zones, and strict coordination between aviation authorities, local governments, and law enforcement agencies.

e. Relevance to Aviation Safety Policy

The findings of this study confirm that KKOP regulations serve as a safety prevention instrument, not merely an administrative document. KKOP is a land, water, and airspace zone around an airport that restricts unauthorized objects and activities. Kite flying is a prohibited activity and is subject to criminal sanctions or fines. This case shows that violations in the zone contributed to the accident.

Conflicts of Interest: The authors declare no conflict of interest.

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