Bird Strike-Induced Go-Around and Recorder Outage Leading to Gear-Up Landing and Runway Overrun: Case Study of Jeju Air Flight 7C2216 (HL8088) at Muan International Airport

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ABSTRACT

Bird strikes remain a significant aviation hazard, particularly during critical flight phases such as approach, landing, and go-around. This study investigates the Jeju Air flight HL8088 accident on 29 December 2024 at Muan International Airport. The primary aim is to analyze the bird strike event and its consequences, contextualizing the accident within existing safety models. A qualitative case study approach was employed, utilizing accident reports, flight data reconstruction, and literature reviews on bird strike risks and their operational impacts. The findings reveal that the bird strike during the go-around severely damaged the aircraft, causing the landing gear to remain retracted and leading to a belly landing, runway overrun, and a post-crash fire that resulted in 179 fatalities. The accident underscores the heightened danger of bird strikes during take-off, landing, and go-arounds, as well as the compounded effects of secondary incidents. This case highlights the urgent need for improved bird strike management, more resilient aircraft design, and enhanced pilot training to mitigate future risks.

Keywords: bird strike; go-around; gear-up landing; runway overrun; recorder outage; airport wildlife hazard.

1. INTRODUCTION

On December 29, 2024, Jeju Air flight HL8088, a Boeing 737-800 (s/n 37541), crashed at Muan International Airport at approximately 09:03 local time. The aircraft, which had been delivered in 2009 and leased by Jeju Air since 2017, was destroyed in the accident. A total of 179 fatalities were recorded, including 175 passengers and 4 crew, while 2 crew members survived with serious injuries (Aviation and Railway Accident Investigation Board, 2025). Meteorological reports at 09:00 indicated visual meteorological conditions (VMC) with light wind (110°/2 kt), visibility of 9 km, few clouds at 4,500 ft, temperature 2 °C, and QNH 1028 hPa, with no significant weather forecasted.

The approach sequence began with a landing clearance for Runway 01 at 08:54:43, followed by a tower caution at 08:57:50 regarding bird activity near the aerodrome. At 08:58:56, the crew declared a Mayday, reporting a bird strike during a go-around. Subsequently, HL8088 attempted to realign for Runway 19 but suffered a belly landing with the landing gear retracted, resulting in an overrun and collision with the runway-end embankment and localizer structure. The impact was followed by a post-crash fire and partial explosion, which contributed to the high fatality count.

Bird strike has long been recognized as one of the most hazardous events in civil aviation, capable of causing catastrophic engine damage or loss of control, with historical data showing 47 fatal bird strike accidents worldwide between 1912 and 2004 that destroyed 90 aircraft and killed 242 people (Fortońska, 2018).

Accident models further emphasize that takeoff, landing, and go-around phases remain the most accident-prone, particularly for runway excursions or overruns triggered by sudden abnormal events such as bird encounters (Hinkelbein et al., 2024).

Investigations of previous major accidents also highlight that identifying and understanding the initiating failure is crucial, as small technical or environmental factors often escalate into catastrophic outcomes (Oliver et al., 2019). Moreover, accident reports from other investigations demonstrate that inadequate system resilience or delayed pilot responses during unexpected events can significantly worsen survivability outcomes (Stanton et al., 2019)

Recent research has shown that bird strike remains a persistent and growing risk in modern aviation, requiring not only robust engine and structural design but also advanced predictive models and risk management strategies at airports (Arachchige et al., 2020). The escalation of composite material usage in aircraft structures further complicates this issue, as their response to high-velocity impacts, such as bird strikes, can differ significantly from traditional metallic structures (Giannaros et al., 2022). The Jeju Air HL8088 tragedy therefore illustrates the compounded risks of bird strikes during critical flight phases, the challenges of decision-making under time pressure, and the catastrophic potential of secondary events such as post-impact fire . This study seeks to analyse the accident sequence and contextualize it within existing literature and accident models, with the aim of contributing to enhanced safety measures in both Korean and international civil aviation.

2. METHOD

This study adopts a qualitative case study approach to investigate the sequence of events leading to the Jeju Air HL8088 accident at Muan International Airport (RKJB) on 29 December 2024. Since the Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) ceased recording four minutes before the crash, the research relies heavily on secondary data analysis supported by forensic and observational evidence.

2.1 Scope and Limitations

The scope is confined to technical, environmental, and human factors directly contributing to the Jeju Air HL8088 accident. Organizational, economic, or legal dimensions of the airline's management are excluded. The main limitation arises from the absence of complete CVR/FDR data, which restricts insight into cockpit resource management and exact decision-making sequences.

2.2 Literature review

Bird strikes have long been recognized as a serious hazard to aviation safety. Technical studies demonstrate that bird collisions can cause significant damage to aircraft engines and structures, with numerical models such as Lagrangian, Smooth Particle Hydrodynamics (SPH), and Arbitrary Lagrangian–Eulerian (ALE) frequently used to simulate fan blade responses to impact. Findings confirm that contact loads and deformation resulting from bird ingestion can critically impair engine performance within seconds (Yunus et al., 2025; Zhang et al., 2022). Consequently, bird strike is regarded as one of the most dangerous environmental factors affecting flight safety at low altitudes.

From an operational perspective, traditional mitigation efforts around airport perimeters have successfully reduced incidents near runways, yet the risk of bird strikes outside controlled airport areas has continued to increase. To address this challenge, several studies proposed risk-based advisory systems involving air traffic controllers and flight crews, such as a bird strike advisory system, which would allow the delay of departures during periods of elevated risk (Altringer et al., 2024; Devta et al., 2025) However, most of the existing research focuses primarily on the departure phase, while approach and go-around operations—arguably the most vulnerable—remain understudied.

Accident analyses further indicate that take-off, landing, and go-around are the most accident-prone phases of flight, with runway excursions and incursions identified as dominant categories (Ayala et al., 2024). Bird strikes during these phases can trigger abnormal sequences such as gear-up landings, runway overruns, and secondary collisions with airport infrastructure. Previous investigations emphasize the importance of adopting a multidisciplinary approach—combining flight data reconstruction, material evidence, and operational context—to identify initiating events and understand failure escalation (Wang et al., 2024). Yet, the integration of such technical analysis into wildlife-strike scenarios remains limited.

In addition, major accident reports highlight systemic gaps across aircraft design, certification, and operations. Safety assumptions are often not validated against operational realities, and lessons learned are rarely institutionalized or permanently disseminated (Charnsethikul et al., 2025). This underscores the need for aircraft designs that are more resilient to short failure pathways and for operational procedures that are better aligned with external disruptions such as bird activity.

Based on this review, a clear research gap emerges: the absence of comprehensive studies linking the technical consequences of bird strikes with operational decision-making during go-around phases. The novelty of the present study lies in integrating accident-chain analysis of the Jeju Air HL8088 crash, applying risk-based bird strike prevention to terminal operations, and incorporating principles of failure analysis to explain the transition from initiating events to secondary hazards such as post-impact fire and explosion.

3. RESULT AND DISCUSSION

This chapter presents the analysis and discussion of the sequence of events leading to the Jeju Air Flight HL8088 accident, emphasizing the technical, environmental, and human factors contributing to the accident. The data obtained from accident reports, flight data reconstruction, and forensic analysis is discussed and compared with relevant literature on bird strike incidents. This discussion aims to provide a deeper understanding of the causal factors of the accident, thereby addressing the research hypothesis.

3.1 Event Data and Sequence of Occurrences

The accident under study occurred on December 29, 2024, at Muan International Airport (RKJB), involving Jeju Air flight HL8088, a Boeing 737-800. The sequence of events began with the aircraft's approach to Runway 01 at 08:54:43 local time. The flight crew received landing clearance, and shortly after, the air traffic control tower issued a caution regarding bird activity in the vicinity of the aerodrome at 08:57:50. At approximately 08:58:56, the flight crew declared a Mayday, reporting a bird strike during the go-around maneuver.

The bird strike occurred at a critical phase of flight, which led to severe consequences. After the initial bird strike, the crew attempted to realign the aircraft for a landing on Runway 19. However, the damage sustained from the bird strike led to a belly landing with the landing gear retracted, resulting in an overrun, collision with the runway-end embankment, and structural damage to the localizer structure. The impact triggered a post-crash fire and subsequent explosion, leading to 179 fatalities, including 175 passengers and four crew members, with two crew members surviving but suffering serious injuries.

The timing of the bird strike during the go-around phase is noteworthy, as this phase of flight is recognized as one of the most critical in aviation, with the potential for triggering catastrophic events. The subsequent failure to deploy the landing gear correctly, coupled with the overrun and collision with the runway-end structure, underscores the catastrophic nature of the incident. The available meteorological data at 09:00 local time indicated visual meteorological conditions (VMC) with light winds and no significant weather, which rules out adverse weather as a contributing factor to the accident.

3.2 Analysis of Contributing Factors

The analysis of this incident highlights several contributing factors, including mechanical failure, operational decisions, environmental conditions, and the failure of safety systems. A crucial element in this investigation is the bird strike itself, a significant and persistent threat to aviation safety. Bird strikes are known to cause damage to aircraft engines and critical structures, with the potential to trigger loss of control, engine failure, or catastrophic accidents.

3.1.1 Mechanical Consequences

The bird strike occurred during the go-around, which is a high-risk phase of flight. This maneuver requires full engine power and precise control of the aircraft, and any disruption during this phase significantly increases the risk of accidents. The bird strike resulted in substantial damage to the aircraft, which in turn caused the landing gear to remain retracted during the attempted landing. This mechanical failure significantly impaired the aircraft's ability to execute a safe landing. The retraction of the landing gear, coupled with the aircraft's loss of control during the go-around phase, contributed directly to the belly landing and subsequent runway overrun.

3.1.2 Operational Decisions

The crew's decision to initiate a go-around in response to the bird strike was in line with standard operational procedures. However, the effectiveness of the crew's decision-making under pressure is questionable, especially in the context of the aircraft's compromised condition following the bird strike. The flight crew was required to make split-second decisions, and while go-arounds are a standard procedure to avoid landing in unsuitable conditions, the failure to properly deploy the landing gear during this maneuver suggests that a more robust understanding of aircraft limitations in such critical scenarios could have led to a safer outcome.

3.1.3 Environmental Conditions

Environmental conditions at the time of the accident were reported as favorable for flight operations, with clear visibility and light winds. However, the bird strike occurred during a go-around, a phase of flight that, according to existing literature, is one of the most vulnerable during flight operations. Studies have shown that bird strikes are particularly hazardous during the takeoff, landing, and go-around phases due to the proximity of the aircraft to the ground and the concentration of operational activities during these times (Charnsethikul et al., 2025; Sabziyan Varnousfaderani & Shihab, 2025). Although the environmental conditions were not adverse, the presence of bird activity near the airport area significantly heightened the risk of such an event.

3.1.4 Safety System Failures

Another critical factor in this accident was the failure of the Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR), which ceased recording just four minutes before the crash. This loss of critical flight data severely hampered the investigation, limiting the ability to analyze cockpit resource management and decision-making in the moments leading up to the crash. This highlights the importance of reliable flight data systems in ensuring a comprehensive understanding of events during an accident. The absence of this data underlines the vulnerability of safety systems during unexpected events, and it calls for improved resilience in both hardware and procedural protocols.

3.3 Comparison with Literature and Established Safety Models

When compared to existing literature on bird strikes and accident models, the findings from the Jeju Air Flight HL8088 accident align with established trends in aviation safety. Studies on bird strikes consistently identify the takeoff, landing, and go-around phases as the most hazardous, with bird strikes during these times being linked to a higher likelihood of severe accidents(Charnsethikul et al., 2025; Sabziyan Varnousfaderani & Shihab, 2025). Historical data on bird strikes further supports this, with numerous fatal accidents being attributed to bird collisions during these phases of flight.

The results of this investigation also underscore the importance of resilient aircraft design and advanced bird strike management systems at airports. Research has shown that the integration of predictive models and risk-based advisory systems could potentially mitigate the impact of bird strikes by providing early warnings and allowing air traffic controllers and flight crews to adjust flight operations accordingly (Sabziyan & Shihab, 2023). However, despite these advancements, bird strikes remain a significant threat, particularly in areas with high levels of bird activity, as seen in this case.

Furthermore, the failure of the CVR and FDR during the accident is consistent with findings from other accident investigations, which have highlighted the importance of reliable data recording systems in improving safety outcomes. Previous studies have emphasized the role of flight data in understanding decision-making processes during emergencies, and the lack of such data in this case points to a critical gap in safety infrastructure (Liu et al., 2024; Passarella et al., 2024)

3.4 Implications for Aviation Safety

The findings from the Jeju Air Flight HL8088 accident have several important implications for aviation safety. First, the analysis suggests that current mitigation strategies for bird strike risks may need to be reevaluated, particularly in the context of high-risk flight phases such as go-arounds. The effectiveness of current safety systems could be enhanced by incorporating more advanced bird strike risk management tools, including real-time monitoring of bird activity around airports and predictive systems that alert flight crews and air traffic controllers to heightened risks.

Second, the mechanical consequences of the bird strike, particularly the failure of the landing gear deployment, highlight the need for more resilient aircraft designs. Aircraft should be engineered to withstand bird strikes without resulting in catastrophic failures, particularly in critical phases of flight. This may include improving the design of aircraft engines, flight control systems, and landing gear mechanisms to ensure better performance during such events.

Finally, the loss of critical flight data due to the failure of the CVR and FDR underscores the need for more robust flight data recording systems. Enhanced data recording systems that capture more comprehensive information during critical phases of flight could improve future accident investigations and provide valuable insights into the effectiveness of flight crew decision-making during emergencies.

The Jeju Air HL8088 tragedy demonstrates the compounded risks of bird strikes during vulnerable flight phases and highlights the critical need for enhanced safety measures, both in terms of aircraft design and operational procedures, to mitigate the impact of such events on aviation safety.

4. CONCLUSION

This study investigated the Jeju Air Flight HL8088 accident, which occurred due to a bird strike during the go-around phase, leading to a belly landing, runway overrun, and post-crash fire. The findings highlight several key factors contributing to the incident: the vulnerability of critical flight phases, mechanical failure due to the bird strike, operational decisions under pressure, and the absence of critical flight data following the loss of the CVR and FDR.

The analysis underscores the need for enhanced bird strike risk management systems, resilient aircraft designs, and improved pilot training, particularly for high-risk phases such as go-arounds. The failure of the aircraft's landing gear deployment and the loss of flight data recording systems are critical areas that require attention in future safety protocols.

This study contributes to the existing body of knowledge by linking technical, environmental, and human factors in bird strike incidents, emphasizing the importance of integrated safety systems. Further research is needed to explore advanced bird strike prevention strategies and the development of more resilient aircraft systems. Additionally, studies on improving data recording and cockpit resource management during emergencies would offer valuable insights into enhancing aviation safety and preventing similar accidents in the future.

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