Research Paper

Analysis of Runway Incursion Incident Using Report for the Years 2012-2022

Fajar Islam[1*], Wildan Ahmad Rizkinsya Aulia[2]
[1,2] Akademi Penerbang Indonesia Banyuwangi, Indonesia

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Abstract

Runway incursion is a serious problem in industry flights that could threaten flight safety. This research aims to analyze the main causes of several events runway incursions that occurred in Indonesia based on KNKT reports from 2012 to 2022. The National Transportation Safety Committee is an institution of the Indonesian non-structural government that is responsible for investigating and analyzing transport accidents and incidents, including aviation, maritime, rail, and road accidents. This study covers a 10-year period to understand trends, causal factors, and safety of airport operations in Indonesia. This study employs a qualitative approach using literature study methods. The study's findings indicate that several factors contribute to runway incursion incidents. In addition, it can be used as a basis for increasing awareness, communication, and coordination between Air Traffic Control and pilots in reducing the risk of runway incursion. Analysis showed that there was a communication error between the ATC and the pilot as the main cause. Misunderstanding of instructions, lack of coordination between Air Traffic Control with different frequencies, and lack of clear understanding are the main factors in the occurrence of runway incursions in Indonesia.

Keywords: *Aviation; Runway Incursion; Pilot; Air Traffic Control; KNKT*

INTRODUCTION

The most widely used mode of transportation today is air transportation (Sambo et al., 2017) or air freight. In the era of globalization, everything is faster and more practical. Air transportation services play an important role in the development of the world society. It can be seen from the transport process goods and passengers by traveling long distances in a short time. To fulfill the objectives of air transportation services, its implementation often experiences obstacles in the form of accidents and serious problems experienced by an aircraft, resulting in good losses of soul and material.

Plane accidents can occur both in the air and on the ground. Ground incidents generally occur in the airport area. Accident location planes that often occur in the airport area are on the runway. One of them is runway incursion, an event on the runway (Filyashkin & Sidorenko, 2020) pertaining to the unauthorized presence of an aircraft, vehicles, items, or persons within the airport's restricted area intended for landing or taking off an aircraft. Example of a runway incursion (Ahmed et al., 2018) where Plane 1 has arrived at the runway (Samuel, 2022) and wants to go to the parking lot, at the same time plane 2 will land on the same runway as aircraft runway 1. The potential collision that occurs in this example is a high probability of a collision and is in accordance with perception understanding runway incursion (Jiang et al., 2020). From aircraft accident data collected and investigated by the National Transportation Safety Committee (KNKT), Ministry of Transportation, Republic of Indonesia, for 10 years from 2012 to 2022, runway incursions (Peter & Umap, 2021) have occurred 4 times from figure 1. Where the KNKT conducts accident investigations flights that are categorized as accidents or serious incidents, an incident that results in loss of life or serious injury, serious damage 2 on the aircraft (Hieu et al., 2019), as well as the serious incident category where the incident occurred approaching an accident.

The aviation sector places a high premium on aviation safety, which makes this research

Corresponding author's email: islamfajar83@gmail.com

extremely urgent. Runway mishaps may result in aircraft collisions, accidents, or fatalities, among other dire outcomes. This study can assist in identifying patterns and causes that underlie the incidents by examining the reports of occurrences from 2012 to 2022. This will allow for creating more effective preventive strategies to lower the risk of future runway mishaps. As a result, our research helps airlines and airports run more efficiently while simultaneously promoting aviation safety.

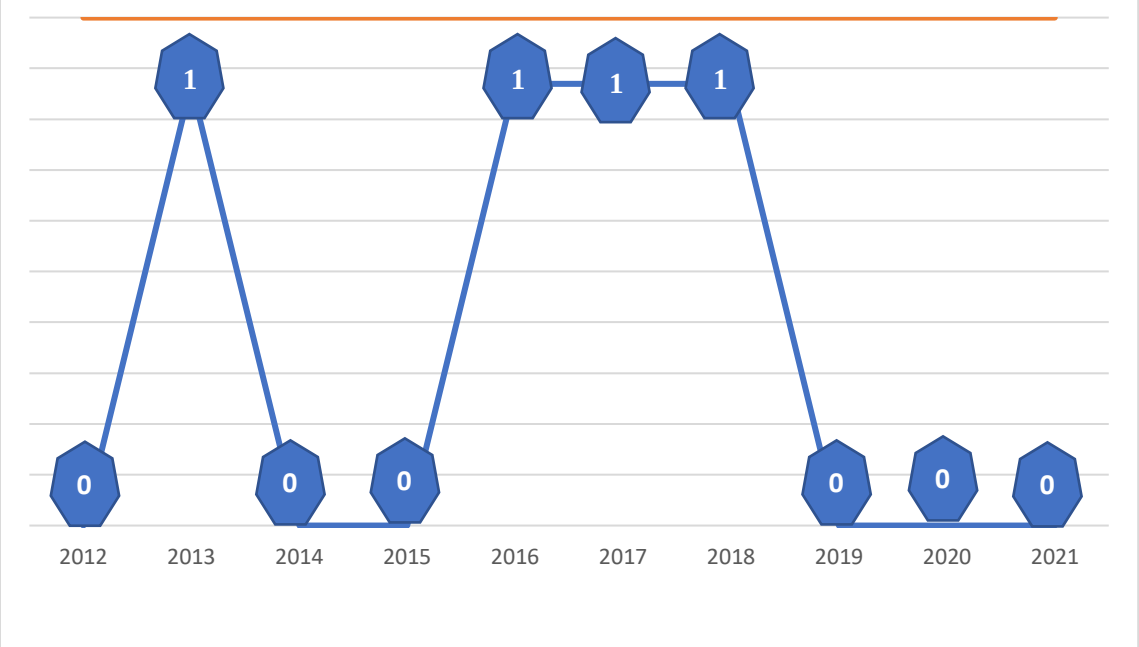

Figure 1. Runway incursion graph from 2012 to 2022

This is considered very important for research on the problem of runway incursion (Ison, 2020) in Indonesia. Thus, this research will provide an important contribution to improve aviation security and safety (Supardam & Fitrianti, 2020) in Indonesia, protecting lives and property, and increasing the reliability and operational efficiency of airports and air transportation systems.

This study's objectives comprise, among other things: Identification of causative factors: Studies can pinpoint the elements—such as human error, malfunctioning systems, bad weather, or infrastructure issues—that lead to runway mishaps. Analysis of trends: Throughout the course of the study, the number of runway incursions may be examined to determine if there is a consistent pattern. For instance, did the annual number of incidents rises, fall, or remain the same? Impact assessment: Studies can evaluate the effects of such occurrences on aviation safety and the operational consequences for airports and carriers. Suggestions for enhancements: Drawing on the analysis's results, the study may offer suggestions for enhancing security and averting such instances in the future. These can include enhancements to staff training programs, modifications to airport layouts, or adjustments to operational protocols. Contribution to aviation safety: To strengthen aviation security and lower the number of runway mishaps in the future, regulators and the aviation sector are anticipated to derive significant insights from this research.

LITERATURE REVIEW

Runway

The runway (Shi et al., 2021) is a very important airport facility for landing (Suroso & Revadi, 2019) and takeoff of aircraft. The runway (Roksolyana, 2019) is a square area on the surface of an airport prepared for take-off and landing of aircraft. Without a well-planned and managed runway,

the plane will not be able to use the airport. In designing a runway (Zagrajek & Hoszman, 2019), it is strictly regulated regarding length, width, orientation (direction), configuration, slope/grade, and runway thickness. The runway (Agarwal & Sharma, 2023) is facilitated by the system markings, lighting systems, and signs to identify runways and provide directional guidance to current pilotsaircraft running, taking off, landing, and taking off.

Runway Incursion

If quoted from aviation documents, namely Runway incursion is explained in International Civil Aviation Organization Doc.9870 (Liu et al., 2022), it is any incident on the runway involving the improper presence of aircraft, vehicles, objects, or people in a restricted area of an airport designated for landing or takeoff aircraft. Therefore, any object that is not supposed to enter the area limited where planes can land and take off increases the risk of accidents in aviation, which is what is called runway incursion.

Runway Incursion (Eid & Jensen, 2021) is an incident where a violation occurs in the space or trajectory of an aircraft on an airport runway (Noever, 2022). The main causes include human error, poor communication, air traffic congestion, environmental factors, infrastructure factors, and lack of training and awareness. To prevent runway incursion (Ge et al., 2022), steps are needed such as improved communication, increased training, increased awareness situational, and the use of technology that helps in reducing these risks.

National Transportation Safety Committee

According to president's rules No. 2 of 2012, the National Transportation Safety Committee is an abbreviation for the National Transportation Safety Committee. The National Transportation Safety Committee is an institution of the Indonesian non-structural government that is responsible for investigating and analyzing transport accidents and incidents, including aviation, maritime, rail, and road accidents. Accident The flight investigated by the National Transportation Safety Committee was an incoming incident. The accident category is an incident that results in loss of life and/or serious injury and/or serious damage to the aircraft, or category of incident serious (serious incident) where the incident approaches an accident. A National Transportation Safety Committee flight accident investigation was conducted into the accident civil aviation that occurs in the territory of the Republic of Indonesia, both to aircraft registered in Indonesia and foreign civil aircraft. The National Transportation Safety Committee investigation may include official representatives from foreign countries, namely the representative of the country where the aircraft is registered, the country the location of the air transportation business entity, the country where the aircraft was designed air, the country where the aircraft (Jiang et al., 2020) is manufactured, and the country that owns it interest because there are citizens who are victims. The National Transportation Safety Committee has the following duties:

1. Conducting transportation accident investigations;
2. Provide recommendations on the results of transportation accident investigations to related parties; And
3. Provide suggestions and considerations to the President based on the results of the investigation of transportation accidents to achieve safe transportation.

RESEARCH METHOD

Research methods are a scientific way of gathering data for specific purposes. Scientific approach, data, goals, and utilization are the four key terms. Method study is a scientific approach to gathering information for a certain goal. According to the scientific method, research projects are grounded in the rational, empirical, and systematic qualities of science. It is clear from the

explanation that research methods are a scientific approach to gathering data for a certain goal.

Research Design

This study employs qualitative methodologies based on literature analysis. The author employs a qualitative research strategy, which is a methodical approach to studying or examining an object in its natural environment without modifying it or conducting hypothesis testing. This qualitative research method is also known as an ethnographic method because it was originally used in field research in cultural anthropology. It is also known as a "naturalistic research method" because the research is conducted in a natural setting. Finally, it is known as a qualitative method because the data collected and the analysis are more qualitative in nature.

Data Collection Technique

Data collecting instruments are tools that researchers choose and use to collect data so that their activities become easier and methodical. Data collection procedures are techniques or methods that researchers might use to collect data. In this study, the author used data collection techniques that are secondary data that is collected by someone else, not the researcher himself. This information is typically derived from additional studies carried out by establishments or groups like BPS and others. In this case, the author takes data from reports that have been published publically by KNKT, a non-structural government institution in Indonesia that performs the duties and functions of accident investigation transportation.

Data Analysis Techniques

In qualitative research, data analysis is conducted both during the ongoing data collection process and after the data collection is completed within a specific time frame. "Activities in qualitative data analysis are conducted interactively and continuously until completion, so that the data is saturated. "Data reduction, data visualization, and conclusion drawing or verification are examples of data analysis tasks. The following is the flow of activities in the qualitative data analysis process:

Reduction in Data

The process of choosing, concentrating, and paying attention to abstraction, simplification, and "rough" data transformation that resulted from field notes that were written down is known as data reduction. Minimization of data and processes. Following the field study, this transformation continues until the report's final draft is written. One aspect of the analysis is data minimization. Data reduction is an analytical technique that involves refining, categorizing, prioritizing, eliminating superfluous information, and arranging data to enable the derivation and validation of final conclusions.

Data Display

Data presentation is the second crucial flow of the analysis process. The presentation functions as an organized compilation of data that allows for inference and subsequent action. Presentations can be shown as charts, graphs, networks, and matrices. Everything is made to blend organized data into a format that is easy to understand and coherent.

Draw conclusions/verify

The third important analytical verification and conclusion-drawing are activities. Depending on the extent of field notes collected, their coding, storage, and distribution techniques, and the

researcher's expertise, final conclusions might not become clear until after final data gathering. Making inferences is one task in a comprehensive arrangement.

FINDINGS AND DISCUSSION

This research analyzes runway incursion incidents according to National Transportation Safety Committee reports (KNKT) within a period 2012-2022. This analysis will provide more in-depth understanding of the factors that cause runway incursion and identify trends and patterns, and mitigation steps that occur during the period studied. The results of this analysis can provide guidance for improving flight safety and reducing runway incidents. Runway incursion is an undesirable encroachment on the runway area, including the entry of aircraft, land vehicles, or pedestrians unauthorized persons while the aircraft is landing, taking off, or moving on the runway. This incident is very dangerous because it can cause Fatal collisions that threaten flight safety.

Air Asia and the Batik Air Runway Incursion Incident

Event Information

Table 1 details the incident that resulted in the temporary shutdown of operations from Adisutjipto Yogyakarta Airport on November 20, 2023. It involved an Airbus A320 aircraft with flight number AWQ 8411 and a Boeing 737-800 Batik Air aircraft with registration PK-AXG and flight ID 6360.

Table 1. Information on RI Air Asia and Batik Air

No	Information	Air Asia	Batik Air
1.	Time	November 20, 2023	
2.	Location	Adisutjipto Airport, Yogyakarta	
3.	Damage	No Damage	
4.	Aircraft Type	Airbus A320	Boeing 737-800
5.	*Flight Number*	AWQ 8411	ID 6360
6.	Aircraft Registration	PK-AXG	PK-LBH

Cause of the Event

There was a misunderstanding between the pilot and the controller regarding the location of runway 27's holding point and the taxi's approval, which was never requested and nor explanined. The Yogya Approach controller provided landing authorization for flight ID 6360, and there was no transfer of control from that controller to the Adi Tower controller, which resulted in the AWQ 8441 pilot not knowing that aircraft ID 6360 had been given permission to land and the initiative instructions from the controller. Adi Tower told the ID 6360 pilot to perform a go-around without the ID 6360 pilot knowing.

Mitigation Steps

To ensure that the controller is aware of and uses standard radiotelephony phraseology correctly. To increase the controller's understanding of aircraft operation and performance. This is a reference to the controller's conclusion that, despite aircraft procedures indicating that a go-around can be executed as long as the aircraft has not landed, an aircraft doing a go-around from a short final approach could jeopardize flight safety. Add the NP and N3 taxiways to the airport layout in the Adisutjipto Airport's AIP (Aeronautical Information Publication). The pilot must confirm if there are unclear ATC instructions or use of non-standard words. Pilots must maintain traffic awareness.

Batik Air and TransNusa Runway Incursion Incident

Event Information

Table 2 details the incident that occurred on April 4, 2016, in the airside area between an Airbus A320 aircraft type operated by Batik Air (flight number ID 7703) and a TransNusa ATR 42-600 aircraft (registration PK-TNJ; no flight numbers) that resulted in a temporary operational stop from Halim Perdana Kusuma Jakarta Airport.

Table 2. RI Batik Air and TransNusa

No	Information	Batik Air	TransNusa
1.	Time	April 4, 2016	
2.	Location	Halim Perdana Kusuma Airport, Jakarta	
3.	Damage	a. There was damage to the left wing, approximately 575 cm from the wing tip. Part of the winglet and aileron come off at the tip of the wing b. The apex of the wing is fractured into three broad segments	a. A little over 260 mm from the tip of the left wing, damage was sustained b. The horizontal and vertical stabilizers of the aircraft are separated from the fuselage
4.	Aircraft Type	Airbus A320	ATR 42-600
5.	*Flight Number*	ID 7703	-
6.	Aircraft Registration	PK-LBS	PK-TNJ

Cause of the Event

The pilot, controller, and driver of the towing car are all rendered unaware when two actions in the same region are handled by separate controllers on different frequencies without sufficient coordination. The fact that the towed aircraft ran onto the runway is probably due to a misinterpretation of the communication instructing it to follow ID 7703. The lighting conditions in the tower cabin and the runway 24 pad area may have made it harder for the controller and pilots to identify towed aircraft that were not properly lit.

Mitigation Steps

Check ground traffic before and during taxiing. Ensure the runway is clear before takeoff. In the maneuver area, move with the same active frequency. Engineers require the use of portable VHF radios as a communications backup during towing. All towing aircraft must turn on navigation lights. All towing aircraft must communicate with the published tower frequencies. When providing air traffic services at night, air traffic controllers must lower the light intensity in the tower cabin. Towing movements must be documented on the flight progress strip.

Lion Air and Wings Air Runway Incursion Incident

Event Information

Table 3 details the August 3, 2017, air-side incident involving a TransNusa ATR 42-600 type aircraft, flight number IW 1252, and a Lion Air Boeing 737-900, flight number JT 197, which resulted in a temporary shutdown of operations at Kualanamu Field Airport.

Table 3. RI Lion Air and Wings Air

No	Information	Lion Air	TransNusa
1.	Time	August 3, 2017	
2.	Location	Kualanamu Airport, Medan	
3.	Damage	a.Approximately 575 cm from the wing tip, the left wing sustained damage. A portion of the winglet and aileron came off along with the wing tip. b. Wing tips split into three large parts.	a. A little over 260 mm from the tip of the left wing, damage was sustained. b. Both horizontal and vertical stabilizers are detached from the fuselage.
4.	Aircraft Type	Boeing 737-900	ATR 42-600
5.	*Flight Number*	JT 197	IW 1252

Cause of the Event

Communication misunderstanding regarding conditional permission to enter the runway while the IW1252 pilots were unaware that after JT197 was given clearance to land, the IW1252 aircraft entered the runway because of its unnoticed movement. Approval to take off from a runway intersection at the pilot's request is permitted in accordance with Air Traffic Services Operational Procedures (ATS SOP). Line up uses RET (Rapid Exit Taxiway) which makes it difficult to determine the plane at approach. The IW1252 pilot was not aware of the presence of JT197, which wanted to land because when the JT197 pilot received permission to land, the pilot of IW1252 continued to use the Medan Ground control frequency. Along with an ATC route permit, the Medan Tower controller grants IW1252 a conditional permit to enter the runway behind the landing aircraft. The authorization is issued quicker than the ICAO document 9432s suggested speaking pace. The pilot of IW1252 was given conditional permission; however, it was unclear if this was because JT197, which was about to land, had been spotted by the pilot. This is not in line with AC part 170-02 criteria. Pilot IW1252, who is a Monitoring Pilot (PM), has relatively low experience and cannot receive all the information from the permit, which is conveyed at speed faster than necessary. PM IW1252 only repeated the final sentence of the license without the Medan Tower controller's correction. When granting conditional clearance, the Medan Tower controller failed to recall any misunderstandings made by the prior pilot. Despite the incomplete redback, Medan Tower controllers believed that the pilot had correctly recognized the clearance; thus, they decided that there was no need to take urgent corrective action to fix the issue in the pilot's readback.

Mitigation Steps

Prohibit aircraft from taking off from the junction of the Rapid Exit Taxiway (RET). Make sure that the controllers at Medan Tower keep an eye on every aircraft that circles the airfield. Avoid providing prolonged instructions and clarifications. Avoid using "behind landing traffic" conditional permissions. Must repeat and listen again to every instruction and clarification. At all times during the flight, maintain a high standard of airmanship and situational awareness.. Before being repeated, all ATC clarifications must be understood by both pilots. Any uncertainty must be verified with the ATC once again. Always take off at the end of the departure runway, if at all practicable. Steer clear of intersections whenever feasible. Before entering or passing over a runway, always be extremely cautious. Always listen well, understand well, and monitor ATC instructions well. To raise awareness of safety measures before taking the runway. Never hesitate to halt the aircraft and ask the ATC to repeat the explanation if you are unsure.

Wings Air Runway Incursion Event

Event Information

Table 4 details the event that occurred on June 19, 2018, in the airside area between Wings Air aircraft type ATR 72-212, flight number IW 1370, and the retreat of the PK-WHF aircraft. This led to the airport's temporary closure.

Table 4. RI Wings Air

No	Information	Wings Air
1.	Time	June 19, 2018
2.	Location	Susilo Airport
3.	Aircraft Type	ATR 72-212
4.	*Flight Number*	IW 1370
5.	Aircraft Registration	PK-WHF

Cause of the Event

This is PIC and SIC's inaugural flight to Tebelian Airport. 3 months before this catastrophic incident flight, PIC's last flight to Sintang occurred when Susilo Airport was still in operation. The pilot examines the variations in the data from the Sintang Aerodrome with the data from the aircraft operator's Airport Visual Guidance (AVG), which includes information about Susilo Airport, Sintang. The incident occurred on the Susilo Airport runway before the messy white cross lines were finished.

Mitigation Measures

Make sure that the pilot has the most recent information before beginning the flight. Ensure that all documents provided for flight operations are current and well documented. It is advised to ensure that the publication only contains the most recent information and to eliminate any content that is out of date.

Discussion

Air Asia and the Batik Air Runway Incursion Incident

1. Taxi Clearance

Runway holding point placements are required on all taxiways parallel to the runway, according to the ICAO Appendix. Two taxiways, N2 and N3, are located parallel to the runway at Adisutjipto Airport. It is possible to think of taxiway N3, which runs parallel to the beginning of runway 27, as the holding area for that runway. The tower instructed the AWQ 8411 pilot to taxi to the runway 27 holding point via November Two (N2) at 00:36 UTC. Through N2, AWQ 8411 pilot verified the clarification once more. The Adi Tower controller authorized ATC and reaffirmed that N2 was the taxiway utilized.

Pilot AWQ 8411 read back the clarification after acknowledging it. The AWQ 8411 pilot reaffirmed that taxiway N2 was the means of clarification. During the interview, it was revealed that the pilot believed that taxiway N3 was the best route to take to get to the runway 27 holding point without going onto the runway. The holding point for runway 27 was believed to be located near the runway 27 threshold. However, the Adi Tower controller was not given a clear explanation of the pilot's concerns. The Adi Tower controller reaffirmed that N2 was the taxiway used, with the intention of allowing landing aircraft to completely land on the runway before exiting via N3 and heading onto the apron.

The pilot of AWQ 8411 was not given any instructions by the Adi Tower controller to stop at the runway 27 holding point. Additionally, it can be inferred that the AWQ 8411 pilot was allowed

to get to that position via N2 and the runway based on the parallel interpretation between taxiway N3 and the runway as the runway 27 holding point. This investigation concluded that the pilot's interpretations of the position of the runway 27 holding point and the controller's taxi clarification were incorrect because they were never given a clear explanation.

2. Controller Coordination

Because the Adi Tower controller believed that the aircraft would halt before entering the runway, they neglected to alert the Yogya Approach controller that AWQ 8411 would be entering the runway. The Adi Tower controller alerted the Yogya Approach controller to instruct the ID 6360 pilot to execute a go-around while the aircraft was at a height of roughly 600 feet. The airplane, AWQ 8411, had cleared the runway holding mark, which was the cause. The Yogya Approach controller thought that the aircraft was in short final and that a go-around could jeopardize flight safety; therefore, he declined to grant the ID 6360 pilot instructions to execute a go-around.

Additionally, the pilot of AWQ 8411 stopped the aircraft after receiving a directive from the Adi Tower controller to maintain its current location. The aircraft had, however, cleared the runway holding mark. The Adi Tower controller gave the ID 6360 pilot the order to go around after noticing that the aircraft was getting closer. The pilot of ID 6360 proceeded with landing without responding to commands. Since the last instructions from the Yogya Approach controller were to notify the tower after landing, it seems likely that the ID 6360 pilot was still listening in on their frequency.

3. Go-around From 600 Feet

The Decision Altitude (DA) for runway 09 at Adisutjipto Airport is 640 feet, according to the Instrument Landing System (ILS) method. This indicates that a go-around is required when the pilot of an aircraft executing an ILS approach is unable to see the runway at 640 feet. This demonstrates that a go-around at 600 feet can be performed securely.

According to ICAO Document 8168, it takes the piapproximatelyound 3 seconds to react and change attitude and altitude correctly. This assertion can serve as a benchmark for human decision-making reaction times.

In actuality, however, the Adi Tower controller instructed the Yogya Approach controller to instruct the ID 6360 pilot to do a go-around when the aircraft reached a height of about 600 feet. The pilots of ID 6360 did not heed this instruction because they believed that flying in a short final could jeopardize flight safety.

Batik Air and TransNusa Runway Incursion Incident

1. Movement Control in the Maneuvering Area

It was discovered that a distinct channel of communication between the movement of the vehicle and aviation control before the accident. The controller is in charge of controlling aircraft movements, and 118.6 MHz is the frequency used for communications. An assistant controller controls the movement of the vehicle, and communication occurs at 152.73 KHz. There is no recording of communications at this frequency. The controller identified the location of the towed aircraft as parking lot B-1 after observing communications between the assistant controller and the driver of the towing vehicle. There was no proof that the assistant controller and controller had talked about their respective responsibilities for operating the towed aircraft.

When two motions occur in the same region but are handled by different controllers and on different frequencies without sufficient coordination, the controller, pilot, and tow car driver lose awareness of what is going on. The fact that the towed aircraft was on the runway was unknown to the controller and pilot. Evidence that the pilots discovered after getting off the plane that the

afflicted object was the aircraft being towed lends credence to this. After inquiring with the driver of the tow car, the air traffic control crew discovered that the pulled aircraft was on the runway and crashed with ID 7703.

2. Lighting Conditions

The lighting within the tower cabin and the controller's ability to see outside the tower were also examined. The majority of the lights within the tower cabin were turned on during the event and were reflected off the surrounding glass windows. Reflections on glass windows reduce the controller's ability to see contrast differences in items outside. Before approving ID 7703's takeoff, controllers find it more difficult to determine cars or other objects due to glare on the glass windows of the tower cabin.

The pilots noticed that the lights around the turn pad were extremely bright, which momentarily obscured their view ahead, when they were on the runway 24 turn pad, which is situated 200 m past the runway threshold. The rods and cones in the human eye are responsible for its ability to adapt in the dark. When exposed to light, these structures alter chemically, causing the retina to fire visual impulses. After being exposed to intense light, rods require 20–30 min or more of total darkness before reaching their full sensitivity.

The pilot reported lining up and being prepared for takeoff at 12:56:05 UTC. The pilot thought the ambient lighting was extremely bright. The pilot started taking off at 12:56:47 UTC, 42 s after coming into contact with a strong light. Given that the pilot was only in a dark environment for 42 s after being exposed to intense light, the inquiry could not determine the pilot's adaptation to darkness. Runway 24's illumination is not completely dark; rather, it is just dark enough for the eyes to adjust to after being exposed to extremely strong light. The pilots' ability to recognize objects on the runway rapidly may have been aided by having more time available, as there was less time needed for the eyes to attain their full sensitivity following exposure to strong light.

Lion Air and Wings Air Runway Incursion Incident

1. IW1252 Movement

The IW1252 pilots were using the Medan Ground frequency; thus, they were not monitoring this transmission when the Medan Tower controller authorized JT197 to land. IW1252 was not informed that JT197 was approaching its final position and had been given permission to land as a result. Due to delays in the flight, Pilot IW1252 requested permission from the Medan Tower controller to depart from taxiway D to expedite the departure process. The request was granted.

According to the ATS SOP, flights from runway intersections are allowed at the pilot's request. Once more, the IW1252 pilot was questioned by the Medan Tower controller to confirm that they were prepared to take off immediately. The fact that IW1252's ground speed data was zero at this point in the FDR indicates that the aircraft came to a stop close to runway 23. After completing the checklist in 3 seconds, PM IW1252 notified the Medan Tower controllers that they were prepared to depart immediately. Once JT197 has landed far enough away from other aircraft landing behind JT197, it is meant to confirm that IW1252 is prepared for an instant departure.

The pilots of IW1252 verified that they were prepared for an instant departure, and between 04:00:01 and 04:00:11 UTC, Medan Tower controllers issued a conditional clearance along with an ATC route clearance. With only 109 flight hours of experience, PM IW1252 failed to obtain all of the clearance information offered in a timely manner. PM IW1252 did not repeat the authorization with conditions; instead, she merely repeated the last sentence. The controller at Medan Tower has no prior experience with pilots misinterpreting authorization with constraints. The pilot had accepted the clearance correctly, the Medan Tower controller decided, despite the partial repetition.

Therefore, the essential step to rectify the disparity in the pilot's repeat was judged unnecessary. Another aircraft was making a landing approach on runway 23, and at 04:00:22 UTC, the Medan Tower controller instructed the pilot to continue the landing approach and advised him that there was an aircraft that Aircraft IW1252 reached the runway's waiting position limit mark at 04:00:32 UTC. The controllers at Medan Tower were focused on another aircraft that was approaching for a landing, thus they were not aware of this movement. Both aircraft CVRs captured contact sounds at 04:00:56 UTC when the left wing of JT197 and the right wing of IW1252 met.

2. JT 197 Movement

IW1252 was in close proximity to the runway when PM JT197 alerted the PF at 04:00:46 UTC, while at a height of 37 feet. The two planes are separated by approximately 643 meters. IW1252 had not yet passed over the runway side markers at that point. PF JT197 knew that IW1252 was supposed to be cleared to enter the runway following JT197's landing. It was thought by the JT197 pilot that IW1252 would not enter the runway. As a result, PF JT197 made the decision to concentrate on aircraft control and carry out the landing approach.

PM JT197 re-announced the PF of IW1252's location near the runway at 04:00:49 UTC, when JT197 passed roughly 7 feet and the distance between the two aircraft was approximately 431 meters. JT197's pilot believed that IW1252 would not enter the runway and decided to continue to land. After JT197 landed, it took another 2 seconds for PM JT197 to notify PF that aircraft IW1252 was approaching the runway. PF confirmed this information, and at that point, IW1252 had crossed the runway side line, also known as the white line. IW1252 and JT197 collided at 04:00:56 UTC. PM JT197 informed PF of IW1252's proximity to the runway at 04:00:46 UTC. It is possible that the pilot of IW1252, which was believed to be approaching the runway, made this introduction for the first time. FDR reported that the distance to IW1252 was roughly 643 meters, the altitude was 37 feet, the N1 was 52.58%, and the ground speed was 160 knots.

Resuming descent is a frequent practice on most airplanes soon after the go around starts. The time needed to tilt the aircraft into a climb attitude and the delay in the engines achieving climb power cause this height loss. When the pilot uses the correct technique, altitude loss on the Boeing 737-900 ER in this scenario is often restricted to a range of 30–50 feet. Given the anticipated loss of altitude that occurs immediately after the go-around, it is unlikely that a go-around carried out while the aircraft is falling through 37 feet will prevent a collision. Furthermore, there can be more delays in starting the go-around because of the time the PM must take to inform the PF of IW1252's location. Consequently, launching a go-around from 37 feet could lead to a more dangerous circumstance.

3. ATC Caution

The Medan Tower controller was in charge of three airplanes before the collision: IW1252, which was an aircraft departing, and JT197 and another aircraft arriving. IW1252 is scheduled to depart from Medan Tower controllers after JT197 lands and before other inbound aircraft land. The IW1252 pilot and the Medan Tower controller spoke about the conditional clearance to line up following JT197's landing between 04:00:01 and 04:00:15 UTC. The Medan Tower controller could not remember any misunderstanding by the pilot when issuing conditional clearance, based on prior experience.

Consequently, despite the incompleteness of the conditional clearance permit readback, the Medan Tower controller believed that the IW1252 pilot had received the permit and would line up after JT197 landed. The moment IW1252 crossed the runway holding point, the Medan Tower controllers were blind. Because the Medan Tower controller was busy directing other approaching

aircraft and assumed that the IW1252 pilot knew that he had permission to line up after JT197 landed, the controller did not keep an eye on IW1252's actions.

4. Conditional Clearance

To guarantee clear and well-received speech transmission, ICAO document 9432 suggests that the standard speech rate should not surpass 100 words per minute. Within 10 s, the Medan Tower controller issues the following conditional clearing permit with an ATC route permit: "Wings Abadi 1 2 5 2 behind traffic Lion short final landing passing line up behind runway 2 3 from intersection DELTA additional clearance after departure direct Meulaboh". With 10 seconds to deliver 28 words during this pass, the speaker is speaking at a rate of 168 words per minute. Giving 28 words in 10 s is seen as faster than the suggested practice in transmission techniques, when compared with 100 words per minute.

AC section 170-02 states that actions impacting an operating runway are not permitted to use conditional clearances such "behind landing aircraft" or "after departing aircraft," unless the aircraft or related vehicle is visible to the relevant controller and pilot.

5. Use of Rapid Exit Taxiway for Departure

Due to delays in the flight, the IW1252 pilot requested to use the Rapid Exit Taxiway (RET) for departure to expedite the process. The pilot's request to take off from the runway intersection is allowed according to the ATS SOP. The IW1252 pilot might not have been able to see JT197, which was on the short final, due to the RET's acute angle. The RET's acute angle is intended to reduce runway occupancy time by enabling airplanes to land at speeds greater than those possible on other exit taxiways.

Because it might be challenging for the outgoing pilot to see the arriving aircraft, there may be risks for aircraft leaving RET, particularly when they need conditional approval to line up behind a landing aircraft. The study failed to uncover any protocols that would have allowed air traffic control to advise pilots to exercise caution when using RET for departure. Furthermore, before this event, the safety measure of employing RET for departures was never brought up as a risk during regular operations in Medan.

Because of the steep angle of the RET, providing conditional clearance to the departing aircraft at RET makes it harder for the departing pilot to see the arriving aircraft.

Wings Air Runway Incursion Event

The flight officer (FOO) provides the captain with flight paperwork and a briefing on the weather, passenger count, and fuel on board. No briefing about the new airport operations was provided. The pilot looked over the Sintang Aerodrome Notam. At a frequency of 405 KHz, the pilot captured changes to Tebelian Airport data, including aerodrome height, runway threshold elevation, and NDB "SG" identity. Pilots check updates to the Sintang Aerodrome data with the data from the aircraft operator's Airport Visual Guidance (AVG), which includes information about Susilo Airport, Sintang.

Airport Visual Guidance (AVG) is a paper in the aircraft's document library. While the AVG revision status is number 5, dated August 25, 2017, the aircraft document library was upgraded in January 2018. The purpose of the amendment was to develop a new method. Information regarding AVGs linked to Sintang Airport that was available on the aircraft was released on March 2, 2018, and it became effective on March 9, 2018. Pilots utilize these documents when flying during serious incidents. Formerly, the main core of Sintang Regency in West Kalimantan was home to Susilo Airport. Since April 26, 2018, Susilo Airport has been closed to aircraft operations. The airport

relocated its operations to Tebelian Airport, a new airfield situated south of the city. At Susilo Airport, the white crosshairs signifying the runway's unsuitability were not finished when the event occurred. Formerly, the main core of Sintang Regency in West Kalimantan was home to Susilo Airport.

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CONCLUSIONS

The reason behind this runway incursion incident was an error or misunderstanding in communication between pilot and controller, lack of coordination between different air traffic controllers on different frequencies apart, the pilot's incomprehension or unawareness of its existence other aircraft or permits given by the controller, speed or inaccuracy in giving instructions or permits by traffic controller air, environmental factors, such as inadequate lighting, which hinders the ability of controllers and pilots to see clearly. Another influencing factor is the pilot's lack of experience in certain situations and misinterpretation of airport information. To avert such instances in the future, it is important to improve the understanding of communication standard phraseology, improve coordination between controllers and pilots, and pay attention to aspects of operational safety related to runway incursion.

Mitigation steps are a good effort to prevent future runway incursions. By paying attention to clear communication between pilot and controller, adequate knowledge of operations aircraft, as well as better monitoring of air traffic, runway risks incursion can be reduced. In addition, measures such as guarding the last land traffic, ensuring runway cleanliness, and frequency use. The right action is also an important measure in ensuring aviation safety. All of these mitigation measures must be implemented consistently and followed by all relevant parties, including pilots, traffic controllers, air traffic controllers, and airport operators. Thus, it is hoped that runway incursion incidents can be minimized and flight safety can be maintained.

LIMITATION & FURTHER RESEARCH

This study focuses on runway intrusion occurrences and is restricted to the years 2012–2022. The KNKT reports on runway incursions over that period provided the data needed in this investigation. This study limits its focus to the classifications and analysis of incidents categorized as runway incursions by KNKT. The research then considers the factors that may affect a runway incident, such as weather, communications, and navigation.

Advanced studies can focus on specific cases with a high degree of severity or a striking frequency of events. Further research may explore solutions and interventions to reduce the risk off runway incursions, including improved pilot training and improvements in airport navigation technology. In-depth study of psychological aspects and human performance in the context of an incursion runway can provide a better insight into prevention.

REFERENCES

Agarwal, S., & Sharma, A. (2023). "PiezoPort" energy harvesting on airport runway using piezoelectric devices. *Digest of Technical Papers - InnoTek 2014: 2014 IEEE Innovations in Technology Conference*, 1–7. https://doi.org/10.1109/InnoTek.2014.6877365

Ahmed, M. S., Alam, S., & Barlow, M. (2018). A Cooperative Co-Evolutionary optimisation model for best-fit aircraft sequence and feasible runway configuration in a multi-runway airport. *Aerospace*, *5*(3), 1–26. https://doi.org/10.3390/aerospace5030085

Eid, J., & Jensen, P. B. (2021). Runway Incursions in Norway 2009-2019: a Case Study of Extended Investigation Reports. *The Polish Journal of Aviation Medicine, Bioengineering and Psychology*, *25*(3), 5–14. https://doi.org/10.13174/pjambp.19.05.2021.01

Filyashkin, M. K., & Sidorenko, M. V. (2020). Short Runway Landing Automation. *Electronics and Control Systems*, *4*(66), 51–56. https://doi.org/10.18372/1990-5548.66.15231

Ge, X., Shao, S., & Meng, Y. (2022). Influence of Head up Display on Visual Fatigue and Eye-Hand Discoordination in Runway Incursion Scenarios. *Human Error, Reliability, Resilience, and Performance*, *33*, 43–51. https://doi.org/10.54941/ahfe1001566

Hieu, N. Van, Thuy, D. Van, & Tung, V. M. (2019). *A STUDY ON ROUGHNESS EVALUATION OF K AERODROME ' S RUNWAY 2 . Basis of some methods for evaluating airport pavement roughness*. (Table 1), 53–61.

Ison, D. C. (2020). Analysis of runway incursion trends: Implications for cost-benefit analysis of mitigation investments. *International Journal of Aviation, Aeronautics, and Aerospace*, *7*(1). https://doi.org/10.15394/IJAAA.2020.1438

Jiang, L., Yang, P., Ma, X., Yang, H., Li, T., & Yang, J. H. (2020). Comparison of Detection Technology for Runway Incursion Prevention in Airport Hot Spot. *Journal of Physics: Conference Series*, *1570*(1). https://doi.org/10.1088/1742-6596/1570/1/012052

Liu, S., Ling, J., Tian, Y., Hou, T., & Zhao, X. (2022). Random Vibration Analysis of a Coupled Aircraft/Runway Modeled System for Runway Evaluation. *Sustainability (Switzerland)*, *14*(5), 1–12. https://doi.org/10.3390/su14052815

Noever, D. A. (2022). *Runway Extraction and Improved Mapping from Space Imagery*. 97–108. https://doi.org/10.5121/csit.2022.120610

Peter, P., & Umap, P. V. S. (2021). A Review- Risk Assessment of Runway Overrun Incursion. *International Journal of Scientific Research in Science, Engineering and Technology*, *4099*, 455–458. https://doi.org/10.32628/ijsrset2183196

Roksolyana, K. (2019). Modern Technologies As a Component of the Runway Scenography. *World Science*, *2*(2(42)), 52–55. https://doi.org/10.31435/rsglobal_ws/28022019/6362

Sambo, A. M., Othman, M. F., & Omar, R. (2017). Liberia's Post-1990 Ecomog Incursion: An Assessment of Anglophone – Francophone Dichotomy. *Journal International Studies*, *13*, 47–65. https://doi.org/10.32890/jis2017.13.4

Samuel, A. O. (2022). US Incursion in Afghanistan: Right or Necessity. *International Journal of Emerging Multidisciplinaries …*, *1*(January 1980), 1–16. Retrieved from https://www.researchgate.net/profile/Ayoko-Samuel/publication/363680731_International_Journal_of_Emerging_Multidisciplinaries_Social_Science_US_Incursion_in_Afghanistan_Right_or_Necessity/links/6329c2d9873eca0c00a078a4/International-Journal-of-Emerging-Mu

Shi, X., Cai, L., & Wang, G. (2021). Traffic Volumes Test of Airport Runway. *Stavební Obzor - Civil Engineering Journal*, *30*(1), 63–77. https://doi.org/10.14311/cej.2021.01.0005

Supardam, D., & Fitrianti, S. N. Y. R. (2020). The Impact of Lack of Information regarding Runway Conditions after The Rain to Flight Safety. *Jurnal Teknik Dan Keselamatan Transportasi*, *3*, 30–34.

Suroso, H. C., & Revadi, C. E. (2019). *The Main Factors that Affect Pilot Attention and Decision Making During Landing Operation Leading to Runway Incursion*. *17*(Icoemis), 95–102. https://doi.org/10.2991/icoemis-19.2019.14

Zagrajek, P., & Hoszman, A. (2019). Runway Charges - Airport Management Perspective. *Transport Economics and Logistics*, *83*, 127–137. https://doi.org/10.26881/etil.2019.83.10