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DATA ANALYSIS OF COMMERCIAL AIRCRAFT LANDING ON THE RUNWAY AIRPORTS IN INDONESIA

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Summary. A runway excursion is a runway safety issue in which an aircraft exits the runway improperly. Therefore, we believe it is necessary to conduct a data investigation of commercial airplanes landing at the airport in order to provide criticism, learning, and social control to airlines and air service policymakers in Indonesia so that they can become involved in protecting public transportation users, particularly those using air transportation. This study focuses on the procedural safety of commercial airplanes landing on the runway at airports in Indonesia. The data utilized for landing analysis is historical ADS-B data collected and acquired from the Flightradar24 website in 2019. The approach utilized in this study is exploratory data analysis (EDA), in which we explored the dataset to find trusted data (128 tier-1 data points). The results of this study showed that the aircraft that was the object of research was unlikely to land at the Touch Down Zone (TDZ), while the rest showed that its landing was highly likely outside the TDZ.

Keywords: ADS-B, procedural landing safety, runway safety issue, touch down zone

1. INTRODUCTION

Whether an aircraft is flying in conformity with safety rules is not always known to passengers on commercial flights. The one thing passengers know is that the plane landed safely, with no turbulence and a smooth landing. Whereas, conceptually, airplanes have safety procedures in all phases of flight [1,2]. Therefore, this study was carried out to comprehend the issue of flight safety and inform passengers (users of air transportation) about the landing phase. It is necessary to convey and inform this idea so that pilots and co-pilots would take precautions and propriety when performing landings in accordance with the procedure to reduce incidents and accidents that could result in losses for all parties.

Indonesian air transportation experienced rapid growth starting in 2000 with the entry of a new trend, namely Low-cost carrier (LCC). This is due to population factors, economic growth, and the reach of the archipelago, causing the air transportation industry to be an option for the transportation of people and goods. However, with this growth, the number of accidents has also increased, caused by runway excursions, including runway overrun. A runway excursion is a runway safety issue in which an aircraft exits the runway improperly. Runway overruns happen when an aircraft is unable to stop before reaching the end of the runway. Runway excursions can occur as a result of pilot error, bad weather, or an aircraft malfunction [3].

Therefore, we believe it is necessary to conduct a data investigation of commercial airplanes landing at the airport in order to provide criticism, learning, and social control to airlines and air service policymakers in Indonesia so that they can become involved in protecting public transportation users, particularly those using air transportation. This study focuses on the safe landing of a commercial aircraft on the runway at Indonesian airports. With the advancement of aircraft monitoring utilizing ADS-B (Automatic Dependent Surveillance-Broadcast) technology, numerous global researchers have been able to further investigate information and research on commercial aviation in order to improve flight safety [4-6]. The ADS-B data exploration is an important lesson in improving the development of aircraft navigation systems with the advantages offered by this system, such as easily accessible data, and real-time flight operational data. Thus, this technology can help provide increased commercial aviation security.

This study focuses on ADS-B investigation data on the safety procedures of commercial aircraft landing on runways at airports in Indonesia. In order to determine whether the aircraft landed in the safety zone and, if it did not, whether the speed was within the acceptable range. In addition, the research subject in the form of a commercial airplane in this paper does not mention its registration code (PK-???) but is only mentioned as an airplane.

The paper is organized as follows: the background section contains information regarding an accident or incident that occurred on an Indonesian airline as a result of an overrun during the landing phase. In order to have better knowledge of a safe aircraft landing, subsequent studies are reviewed, including a literature review of the theory supporting the landing strategy. The data and methodology parts provide the information and the methods to reach the goal. This section also discusses the study's limitations. The results and discussion section cover the findings and outcomes of the data. Finally, in the conclusion section, we highlight the contributions of this work.

2. BACKGROUND

Several aircraft mishaps in Indonesia, including runway overruns, have also raised concerns about commercial aviation safety and comfort. According to the National Transportation Safety Committee (Komite Nasional Keselamatan Transportasi-KNKT) report and analysis [7], there were 69 occurrences on Indonesian territory between January 2015 and August 2022, according to data on overrun accidents as shown in Fig 1. It was noted to have a peak incidence of 14 occurrences in 2016. The trend then turned downward until 2019, but then turned upward again in 2020, reaching 11 events and representing an increase of 83.3%. Papua province is the biggest contributor to the record of overrun events, contributing 28 times, or 41%. This data also shows that the province of Papua requires special attention to the transportation industry and air flight safety [8]. Furthermore, based on data analysis of accident data given by the official KNKT agency from 1997 to 2020, pilots and co-pilots (human factors) contributed to a significant number of accidents and incidents in the history of commercial aviation in Indonesia, amounting to 52.6% [9].

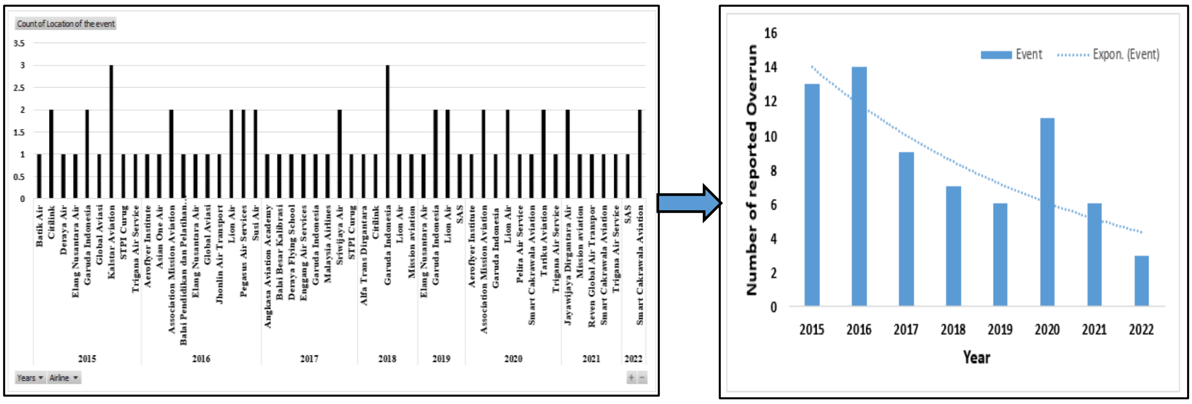


Fig. 1. Summary of KNKT reports based on aircraft accidents and incidents due to overrun from 2015-2022

Another study [10], revealed that the total aviation accidents in Indonesia from 2007 to 2014 recorded 228 aircraft accidents, with 80 of them being RE (Runway Excursion), or aircraft accidents attributable to RE accounted for 35% of the total accidents during the 8-year period.

In the meantime, according to a data analysis and statistical overview of commercial jet aviation accidents issued by Boeing in 2021, fatal accidents in the RE category occurred 7 times between 2012 and 2021 and were the second-greatest occurrence after the loss of control-in-flight (LOC-I)[11]. Meanwhile, the rate of fatal incidents reported from 2012 to 2021 was 50% when examined in the flight phase (Fig. 2). This proportion indicates the high likelihood of landing mishaps.

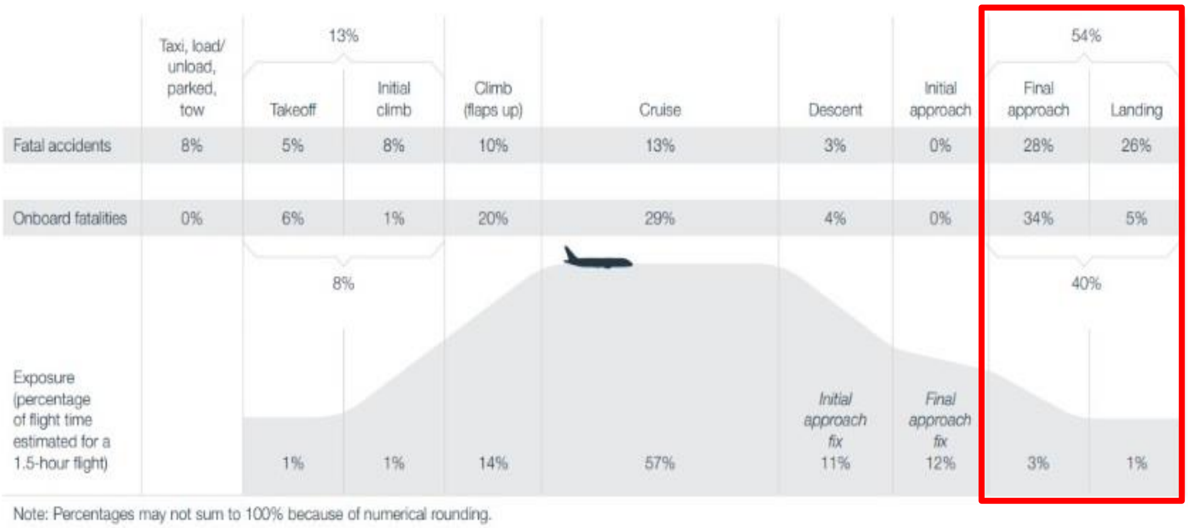


Fig. 2. Percentage of fatal accidents and onboard fatalities by phase of flight [11]

Another comparable research included only overrun instances that happened between 1980 and 1998 in Australia, Canada, the United Kingdom, and the United States [12]. 137 (76%) of the 180 commercial aircraft occurrences happened during landing, while 43 (24%) occurred during take-off. ACRP also investigated overrun and undershoot incidents to construct a global database [13].

According to the FAA, in 90% of overrun incidents, the aircraft exceeds the runway end at 70 knots or less and mostly stops within 306 meters of the extended runway centerline. Therefore, 306 m long RESA is recommended by FAA to provide enough braking space for aircraft with 70-knot speed [14,15].

Therefore, in order to reduce the number of overrun events, it is necessary to investigate the runway of an airport in Indonesia. During the observation process, data is needed about the location or position where the aircraft is declared touchdown. These statistics can be obtained from ADS-B data. In addition, the rules regarding runways and landing zones that have been established are also referred to in this research. So that the conclusions obtained are facts.

Based on [16], in his presentation, the touch-down zone or point (TDZ) is 1/3 of the runway length, which is marked with several markings on the runway (Fig. 3). In the event that a commercial aircraft is unable to land at TDZ, the aircraft should turn and attempt another landing. Additionally, according to studies cited on the website of the flight safety organization, 52% of airport aircraft landings involve steady approaches, while 48% involve unstable approaches. But in reality, this landing approach is affected by several variables, one of which is TDZ, with the main landing gear on both sides of the runway centerline. Go around if all the main landing gear is located on one side of the centerline. The next variable is that if there are still 2,000 feet (609.6 meters) of runway to cover, then the aircraft speed must be less than or equal to 80 knots.

As a result, we can use these 2 variable points as a guide for conducting research on commercial airplanes.

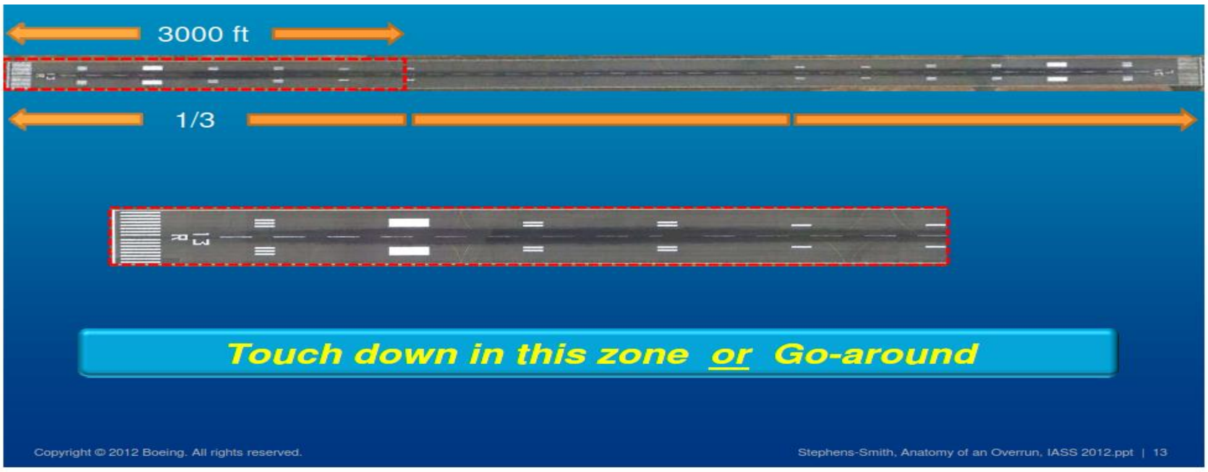


Fig. 3. The airplane touches down zone (TDZ) [16]

3. DATA AND METHOD

The approach taken to answer the research objectives is how to get data, how to process data, and how to generate data insight.

ADS-B is being used to provide an alternative to the use of conventional radar in commercial flight monitoring. ADS-B data is public and can be viewed and monitored through several sites, one of which is flightradar24. The B737 MAX 8 was one of the aircraft whose data we were interested in, and we tracked its journey since the tragic aviation accident by retrieving all of its flight history data until the day the Indonesian aviation authorities decided to ground it due to the ongoing investigation into the B737 MAX 8 crash.

The Boeing 737 MAX 8 airplane with registration in Indonesia territory (production year 2017) that executes phase landings at airports in Indonesia was the subject of this investigation. The data utilized for landing analysis is historical ADS-B data collected and acquired from the flightradar24 website in 2019.

The flight recorded data is taken from March 19, 2018, to October 2, 2019, which is equivalent to 1 year, 6 months, and 14 days (582 days). According to the raw data, during this duration, the aircraft made a total of 1400 landings, with 1227 of them being national landings (Indonesian jurisdiction) at 33 airports, while the rest were landings at overseas airports. The distribution map of airports landed is shown in Fig. 4, with the largest bubble data point being Ngurah Rai International Airport, Denpasar (IATA: DPS- with 105 landings), followed by Hassanudin International Airport, Makassar (UPG- with 60 landings) and Supadio International Airport, Pontianak (PNK- with 38 landings).

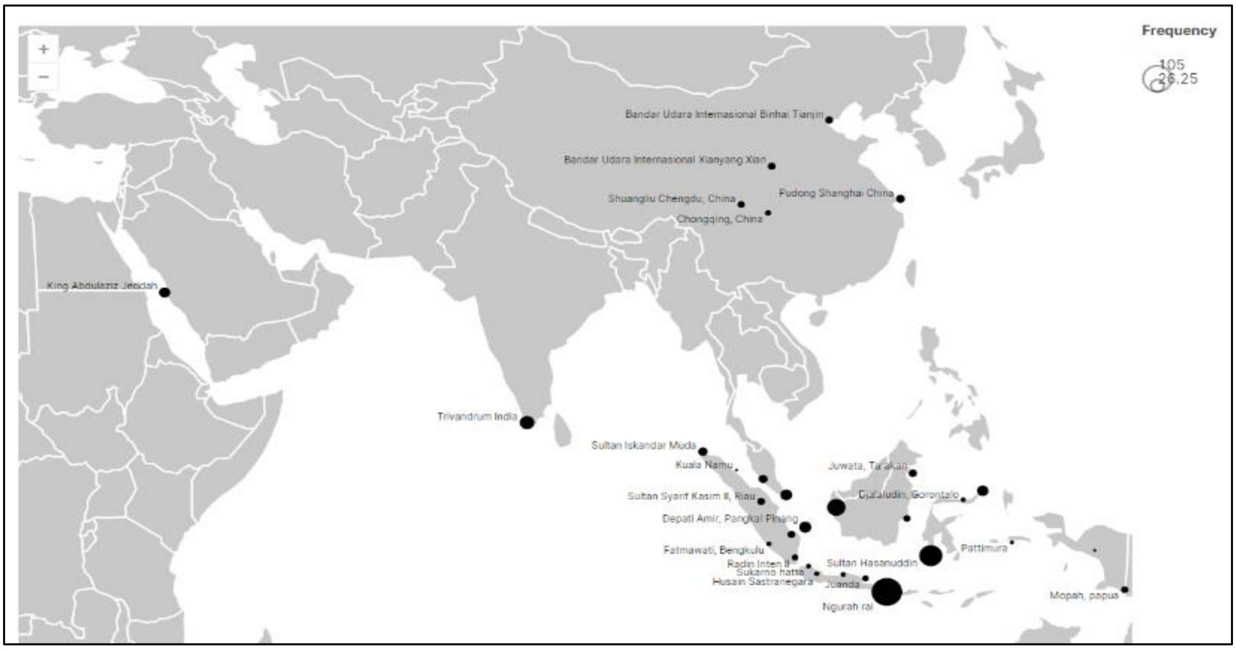


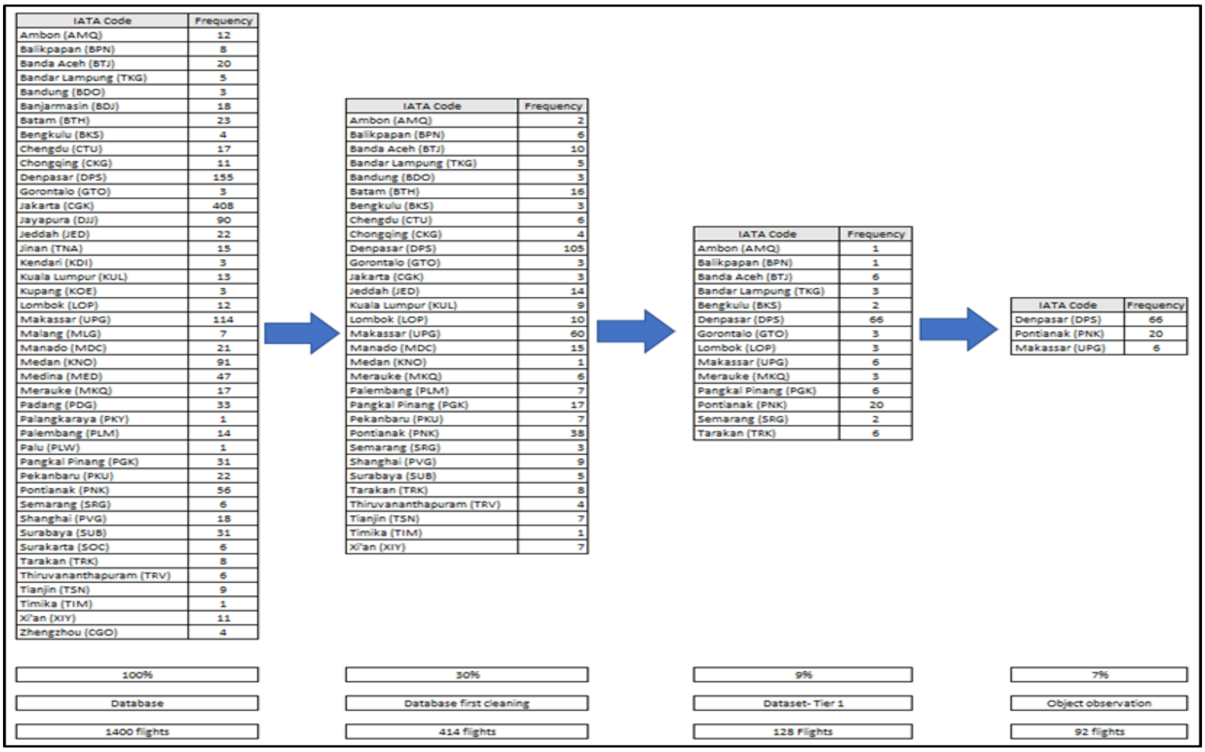
Fig. 4. Bubble distribution map of airport data points visited by the aircraft object during its 582 days of commercial flight service

The national landings made by the aircraft for 582 days are represented by a proportion of 61% of the total number of landings from the three airports (DPS, UPG, and PNK). Therefore, 3 airports that are frequently landed by aircraft were analyzed and looked at for data insights and data patterns to gain knowledge about compliance with landing procedures.

3.1. Data

In terms of procedure, the dataset was prepared in multiple steps, beginning with a visit to the Flightradar24 website and then obtaining the aircraft-specific data saved for each flight in *.csv (Comma Separated Values) format. 1400 flying observation data points were collected. These data were then processed in a variety of ways, including confirming each flight has its landing data, specifically the landing altitude indicator with a value of 0. This technique reduces the data to 414 flight data points; statistically, the data reduction at this stage is 70%, implying that only 30% of the data is viable for the next step. Following the collection of 414 flight data points, the next stage is to separate data with the ICAO (International Civil Aviation Organization)-recommended quality for ADS-B data, namely tier 1 (update message interval less than 10 seconds), tier 2 (update message interval less than 20 seconds), and tier 3 (update message interval greater than 20 seconds and less than 60 seconds). The results of separating data based on this tier revealed that tier 1 had up to 128 flight data points, tier 2 had up to 200 flights, and tier 3 had up to 86 flights.

This study used tier 1 data, as much as 128 flight data, implying that only 9% of the data from the 1400 database was utilized. Three airports were chosen from this 9% for analysis, which is referred to as a dataset (Fig. 5). This dataset will be used in the following procedure to achieve the study objectives. The method part will go over the specifics of this explanation.



IATA Code	Frequency
Ambon (AMQ)	12
Balikpapan (BPN)	8
Banda Aceh (BTJ)	20
Bandar Lampung (TKG)	5
Bandung (BDO)	3
Banjarmasin (BDJ)	18
Batam (BTH)	23
Bengkulu (BKS)	4
Chengdu (CTU)	17
Chongqing (CKG)	11
Denpasar (DPS)	155
Gorontalo (GTO)	3
Jakarta (CGK)	408
Jayapura (DJJ)	90
Jeddah (JED)	22
Jinan (TNA)	15
Kendari (KDI)	3
Kuala Lumpur (KUL)	13
Kupang (KOE)	3
Lombok (LOP)	12
Makassar (UPG)	114
Malang (MLG)	7
Manado (MDC)	21
Medan (KNO)	91
Medina (MED)	47
Merauke (MKQ)	17
Padang (PDG)	33
Palangkaraya (PKY)	1
Palembang (PLM)	14
Palu (PLW)	1
Pangkal Pinang (PGK)	31
Pekanbaru (PKU)	22
Pontianak (PNK)	56
Semarang (SRG)	6
Shanghai (PVG)	18
Surabaya (SUB)	31
Surakarta (SOC)	6
Tarakan (TRK)	8
Thiruvananthapuram (TRV)	6
Tianjin (TSN)	9
Timika (TIM)	1
Xi'an (XIY)	11
Zhengzhou (CGO)	4

100%
Database
1400 flights

IATA Code	Frequency
Ambon (AMQ)	2
Balikpapan (BPN)	6
Banda Aceh (BTJ)	10
Bandar Lampung (TKG)	5
Bandung (BDO)	3
Batam (BTH)	16
Bengkulu (BKS)	3
Chengdu (CTU)	6
Chongqing (CKG)	4
Denpasar (DPS)	105
Gorontalo (GTO)	3
Jakarta (CGK)	3
Jeddah (JED)	14
Kuala Lumpur (KUL)	9
Lombok (LOP)	10
Makassar (UPG)	60
Manado (MDC)	15
Medan (KNO)	1
Merauke (MKQ)	6
Palembang (PLM)	7
Pangkal Pinang (PGK)	17
Pekanbaru (PKU)	7
Pontianak (PNK)	38
Semarang (SRG)	3
Shanghai (PVG)	9
Surabaya (SUB)	5
Tarakan (TRK)	8
Thiruvananthapuram (TRV)	4
Tianjin (TSN)	7
Timika (TIM)	1
Xi'an (XIY)	7

30%
Database first cleaning
414 flights

IATA Code	Frequency
Ambon (AMQ)	1
Balikpapan (BPN)	1
Banda Aceh (BTJ)	6
Bandar Lampung (TKG)	3
Bengkulu (BKS)	2
Denpasar (DPS)	66
Gorontalo (GTO)	3
Lombok (LOP)	3
Makassar (UPG)	6
Merauke (MKQ)	3
Pangkal Pinang (PGK)	6
Pontianak (PNK)	20
Semarang (SRG)	2
Tarakan (TRK)	6

9%
Dataset- Tier 1
128 Flights

IATA Code	Frequency
Denpasar (DPS)	66
Pontianak (PNK)	20
Makassar (UPG)	6

7%
Object observation
92 flights

Fig. 5. The reduction data is based on the quality of the ADS-B update message interval

3.2. Method

The approach utilized in this study is EDA (Exploratory Data Analysis) in which we explored the dataset to find trusted data (128 tier-1 data points) with 14 landing airports in 128 flight data points. These 14 airports are then ranked to determine the three airports with the highest frequency. Denpasar (DPS), Pontianak (PNK), and Makassar (UPG) are the three target airports for inquiry, having 66, 22, and 6 landings data, respectively.

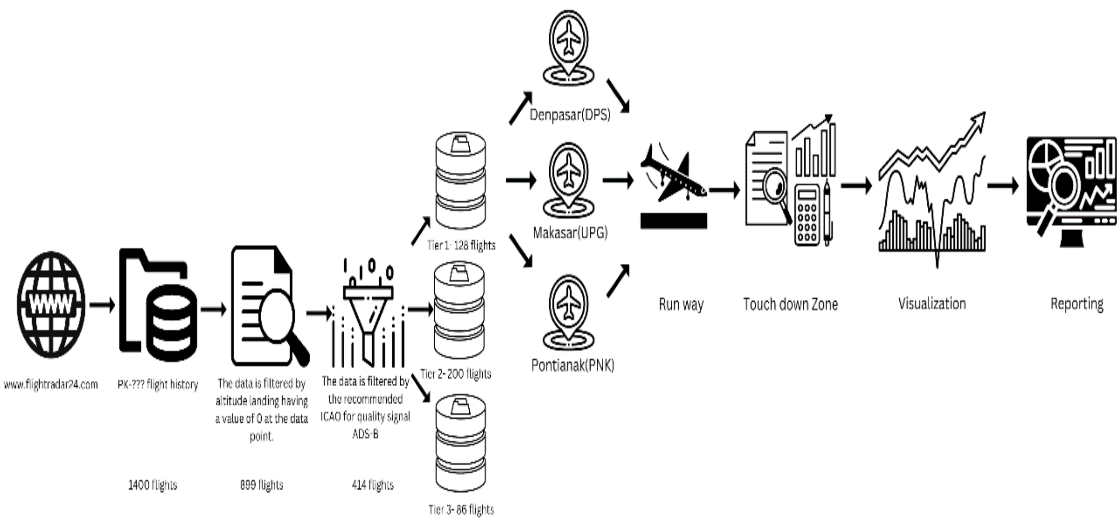


Fig. 6. The approach taken to analyze aircraft landings in this study

After determining the three airports, the next step is to map the GPS position of the observed aircraft landing, which is based on latitude and longitude data. Following the plotting with Google Maps, the next step is to detect the TDZ. From the plotting and TDZ results, it is known how much flight data lands in the TDZ and how much is outside the TDZ. Scatter plots and violin plots are then used to visualize the data. An illustration of our approach is depicted in Fig. 6. While the tool used to visualize data is Scimago Graphica [17], for data processing, namely orange data mining [18].

3.3. Limitations

In addition to the investigative data material used and the approach taken to obtain data insight, it is also necessary to explain the limitations of the research we conducted. First, the data used is secondary flight data taken from the ADS-B system stored on the filightradar24 website. This data has undergone several calibrations that are explained on its website to ensure that the data presented and stored is reliable. Flightradar24 has 100% coverage in Europe and America, but in the following countries: Canada, Mexico, the Caribbean, Venezuela, Colombia, Ecuador, Peru, Brazil, South Africa, Russia, the Middle East, Pakistan, India, China, Taiwan, Japan, Thailand, Malaysia, Indonesia, Australia, and New Zealand are well covered, especially around airports [19].

The second step is to standardize data. In this study, we track the performance of ADS-B data using the standard message update interval, namely the maximum update interval (x<10) [20].Third, the data that is the focus and is trusted to be studied is data that is included in tier-1(x<10) such that data transfer before and during landing occurs in less than 10 seconds. Fourth, we only utilize one airplane as an example of a landing for study purposes. Fifth, the study is limited to the top three airports where the airplane lands.

4. RESULTS AND DISCUSSION

Based on the research method approach, the results and findings, as well as the data insights that can be known and learned from the flight data stored on the flightradar24 (ADS-B) site, are described in this section. Each target airport is presented with the results and followed by a discussion.

In processing the dataset of 128 flight data, we found that the aircraft we observed underwent a rough landing in the form of bouncing during landing, which is indicated by altitude 0. Then the next data shows that the altitude changes and returns to altitude 0. We assume this phenomenon is known as a hard landing. The number of flights that experienced this was 5, with the most frequently occurring airport being Denpasar, and the rest being Pontianak. The identification of this hard landing data is shown in Tab 1.

Tab. 1
Indications that the aircraft experienced a hard landing based on historical data

Callsign	Date	Airports
LNI 3829	14/09/2018	Denpasar
LNI 988	26/10/2018	Pontianak
LNI 2610	04/11/2018	Denpasar

LNI 2622	09/03/2019	Denpasar
LNI 2622	12/03/2019	Denpasar

4.1. Finding - Denpasar (DPS)

I Gusti Ngurah Rai International Airport (IATA: DPS, ICAO: WADD), also known as Denpasar (DPS), is an international airport in Tuban Village, Kuta District, Badung Regency, about 13 kilometers from Bali's capital, Denpasar. The airport has two runway directions, 09 and 27, and a 3,000-meter-long asphalt runway surface. It is Indonesia's second-busiest airport.

According to the data set, the number of aircraft landings with ADS-B data quality according to ICAO standards (Tier-1), namely update message intervals of less than 10 seconds, is 66, which is further divided into two headings or landing directions, namely runways 09 and 27, with 44 and 22 landing data points, respectively.

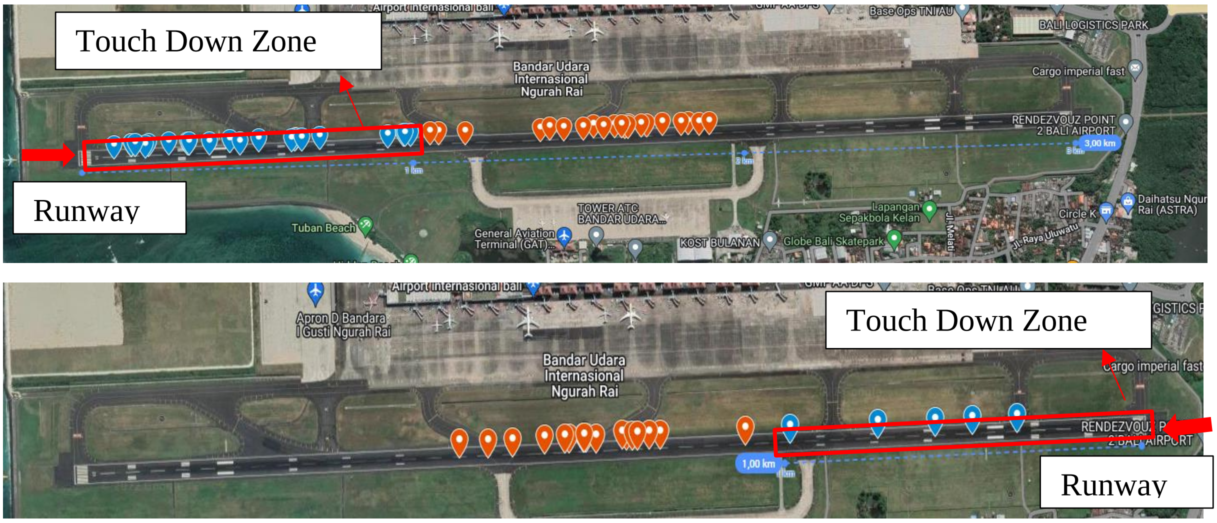


Fig. 7. Data points for the aircraft object landings at Denpasar Airport (DPS) runways 09 and 27

The landing data points were then transformed into data visualizations as shown in Fig 7. The visualization used is a scatter plot. Scatter plots are commonly used to show the relationship between two variables displayed on a graph. The x-axis shows the range of runway 27 starting from a zero point at the beginning of the runway, while the y-axis shows the meter distance from the landing point of the aircraft based on ADS-B data (latitude and longitude) measured from the base point of runway 27 using equation (1).

To determine how far the aircraft's ADS-B transponder began to detect from the base point of runway 27, it is necessary to calculate the distance of two GPS (Global Position System) location points (latitude and longitude). This study's calculations used the Haversine equation. This formula (equation 1) is used because the earth's surface is affected by a curvature [21].

Harvesine formula:

$$d = 2r\, arcsin\sqrt{sin^2\left(\frac{\emptyset_2-\emptyset_1}{2}\right) + cos(\emptyset_1)\,.cos(\emptyset_2).sin^2\left(\frac{\gamma_2-\gamma_1}{2}\right)} \quad (1)$$

The symbol r is the earth's radius (6371 km), and the latitude and longitude are $\emptyset$ and γ, respectively. The degree will be converted into radians, as 1 degree equals 0.0174532925 radians. The formula was then translated into a Python programming language to calculate the ADS-B signal's distance traveled from the aircraft touch-down at the runway to the base point of the runway.

Fig. 8(a) depicts the runway 27 landing data point, where only 5 data points show the aircraft landing at the TDZ point, while the remaining 17 points are outside the TDZ. In other words, only 23% of landings that have ADS-B data that meets the standards show the aircraft pilot landing in accordance with the safety zone.

Looking deeper into the landing data, the next variable is the aircraft's speed when landing in two zones, inside and outside. As a result, we employ the violin plot to properly visualize it (Fig 8(b)). A violin plot uses density curves to represent numerical data distributions for two groups (0 stands for Inside TDZ and 1 for outside TDZ). Each curve's breadth correlates to the estimated frequency of data points in each location. To offer extra information, densities are frequently accompanied by an overlaid chart type, such as a box plot.

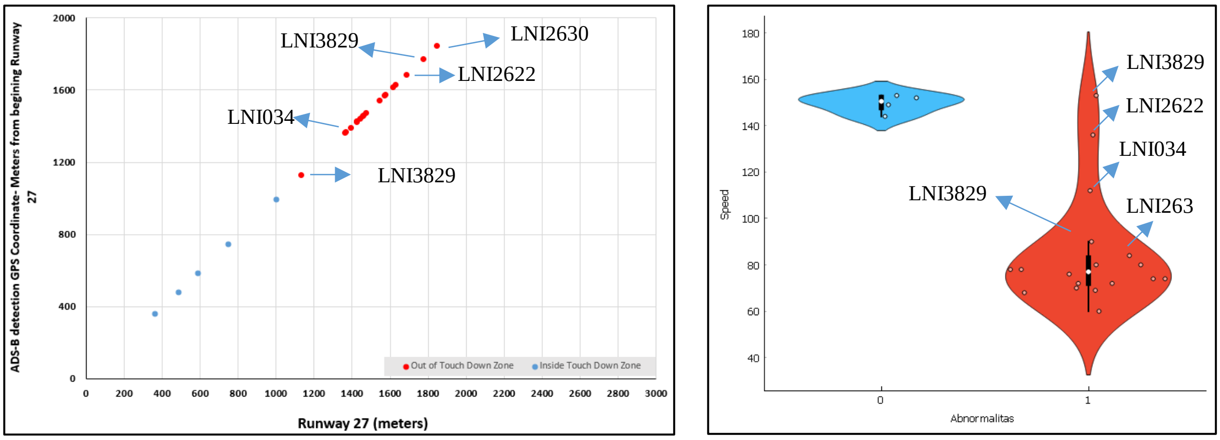


Fig. 8. Results of the aircraft landing data visualization at Denpasar airport (DPS) on runway 27
(a) Data points are plotted in a scatterplot, based on their distance from the threshold bar of runway 27.
(b) Violin Plot based on aircraft speed versus abnormalities
(0 stands for Inside TDZ; 1 for Outside TDZ)

We can see two groups of landing zones in Fig. 8(b). The violin plot in Group 0 shows that the distribution of aircraft speed data during landing varies between 140-160 knots, but the distribution of speed data in Group 1 shows that the aircraft landed outside the TDZ. This demonstrates that even though the aircraft is landing inside two-thirds of the runway length, the speed is already below 100 knots. However, the data reveals that three data points indicate that the aircraft landed on two-thirds of the runway with speeds over 100 knots. This is a point of concern for us.

Based on the violin plot, it can be seen that aircraft landing outside the TDZ (between 1000 meters and 3000 meters) have an average speed below 80 knots, except for five landings exceeding the recommended speed. By rule, these 5 landings should go around and re-land because if they are still forced to land, there is a risk of overrun. The data points of the five flights can be seen in Fig 8 (a) and (b).

The following analysis is of runway 09, which is still at Denpasar airport. A scatter plot in Fig. 9(a) shows that 22 aircraft landings are within the TDZ and 22 are outside the TDZ, indicating that 50% of the observed aircraft landing data on runway 09 is within the TDZ and vice versa. Meanwhile, if we look at Fig. 9 (B), namely the violin plot, it can be seen that landing in the TDZ has an average aircraft speed of 144 knots, and outside the TDZ in the zone between 1000 meters and 3000 meters on runway 09, the average speed of the landing aircraft is 87 knots, of which 13 landings out of 22 outside the TDZ exceed the 80-knot procedure speed, or in other words, 59% of the total landings outside the TDZ should perform the go-around procedure.

Thus, it can be concluded that of the 66 landings made at Denpasar airport, 27 were in the TDZ while 39 were outside the TDZ, with 18 of those outside the TDZ at a risk of overrun.

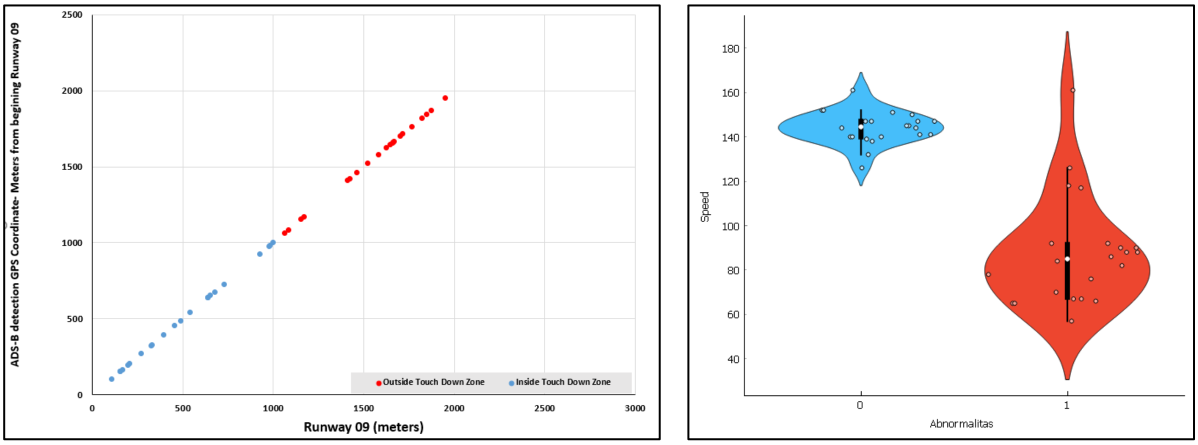


Fig. 9. Results of the aircraft landing data visualization at Denpasar airport (DPS) on runway 09
(a) Data points are plotted in a scatterplot, based on their distance from the threshold bar of runway 09
(b) Violin Plot based on aircraft speed versus abnormalities
(0 stands for Inside TDZ; 1 for Outside TDZ)

4.2. Finding - Makasar (UPG)

Makasar Airport (UPG), also known as Hasanudin Airport, has four runways, which are numbered 03, 13, 21, and 31. The combination of runway 03 and 21 has a length of 10171 ft x 148 ft (3100 meters’ x 45 meters), while the next combination is runway 13 and 31, with a length and width of 8202 ft x 148 ft (2500 meters x 45 meters). A surface of asphalt spans these four runways. Based on the dataset, the airplane flight was detected to have good data quality (tier-1) for only six landings out of the 60 landings it had made during the database collection (582 days). This means that only 10% of landings at the airport have good ADS-B data quality.

The six landings were made on runway 31, which has a runway length of 2500 meters. In the landing history data, it was found that only 2 flights landed at the TDZ point (33.3%), while the remaining 4 landed outside the TDZ point. The landing position at this airport based on GPS points from ADS-B data can be seen in Fig. 10(a), while when viewed from the violin plot (Fig.10(b)), it can be seen that the 2 landings in the TDZ have an average speed of 158 knots, while the 4 landings outside the TDZ zone have an average speed of 59.75 knots.

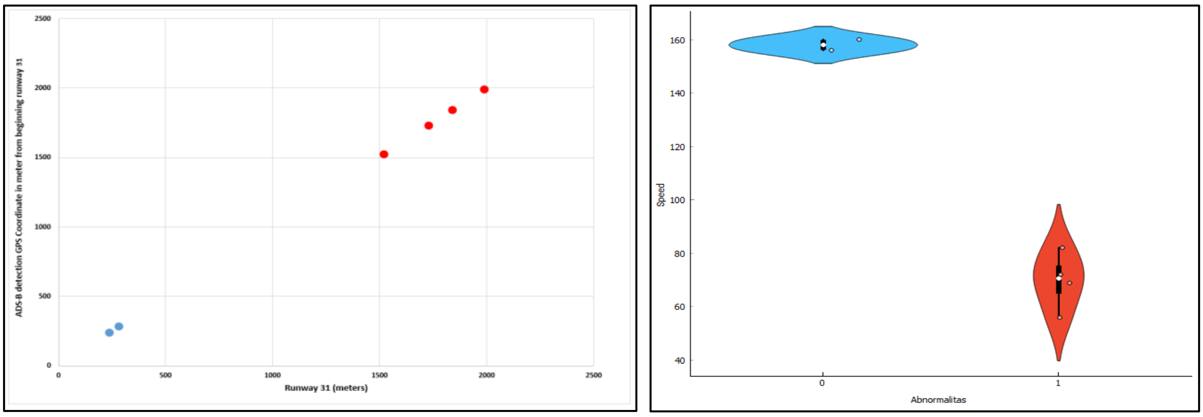


Fig. 10. Results of the aircraft landing data visualization at
Makasar Airport (UPG) on runway 31
(a) Data points are plotted in a scatterplot, based on their distance from
the threshold bar of runway 31.
(b) Violin Plot based on aircraft speed versus abnormalities
(0 stands for Inside TDZ; 1 for Outside TDZ)

Furthermore, based on Fig 10(a) and (b), the airplane was detected landing at a point of 1990 meters from the starting point of runway 31, which means that there are only 510 meters left where the end of runway 31 will end, despite the fact that the aircraft's landing speed is only 69 knots. However, what the pilot did on flight LNI795 (Departure from Jayapura) on July 23, 2018, has a risk that endangers passengers and aircraft in the form of overrunning.

4.3. Finding - Pontianak (PNK)

According to Pontianak airport information, it has a runway with two landing directions, namely runway 15 and runway 33. In the filtered data, there were 8 B737 MAX aircraft that landed at this airport and had tier 1 quality; 20 landings were found, all of which landed via runway 15. For reference, runway 15 measures 7382 feet by 148 feet (2250 meters by 45 meters) and has an asphalt surface. The TDZ zone has a length of 2460 feet (750 meters) measured from the beginning of runway 15.

According to Fig 5, only 20 of the 38 landings made by the aircraft during its 582-day flight history have Tier-1 data quality. Or, if converted into a percentage, the value is 52.63%. In the 20 flights of Tier-1 data, only 4 flights made landings at TDZ (20%); the remaining 16 other flights made landing points outside TDZ.

Fig. 11(a) and (b) displays two landings, LNI686 and LNI988, on runway 15 of Pontianak airport (PNK), exceeding 2/3 of the runway, leaving only 1/3 of the runway with speeds of 84 and 92 knots, respectively. With a speed value of this magnitude and the remaining runway being less than 750 meters (1/3 the length of the runway), the aircraft must perform a maximum speed reduction, which can affect the lifetime of the braking device. This maximum braking action was forced by the pilot to avoid overrunning.

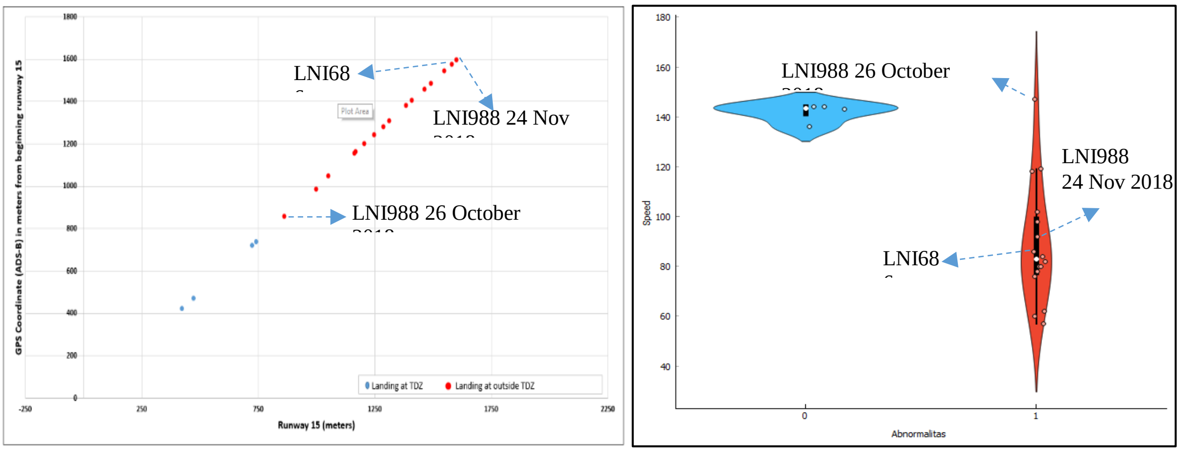


Fig. 11. Results of the aircraft landing data visualization at
Pontianak airport (PNK) on runway 15
(a) Data points are plotted in a scatterplot, based on their distance from
the threshold bar of runway 15.
(b) Violin Plot based on aircraft speed versus abnormalities
(0 stands for Inside TDZ; 1 for Outside TDZ)

4.4. Summary of findings

Based on the findings of the landing data at the three airports, the aircraft that became the object of research showed that it was unlikely to land at the TDZ, while the rest showed that it was highly likely to land outside the TDZ, which should be a safety procedure to take go-around action. For more details, see Tab. 2.

Tab. 2

Summary of findings

Airport	Tier 1 ADS-B Data	TDZ	Non TDZ
Denpasar (DPS)	66	41%	59% with 46% Risk of Overrun
Pontianak (PNK)	20	20%	80% with 12.5% Risk of Overrun
Makasar (UPG)	6	33%	67% with 25% Risk of Overrun

5. CONCLUSION

The investigation into two B737 MAX 8 incidents that occurred in late 2018 and early 2019 led to the decision to halt this aircraft as of October 3, 2019, according to a study of landing history data for this aircraft obtained from March 19, 2018, to October 2, 2019. We discovered that, according to the ICAO-established message interval quality standard, only 9% of the ADS-B data from the flight history of the analyzed aircraft can be used for analysis. We solely concentrate on the top three airports, Denpasar (DPS), Pontianak (PNK), and Makassar (UPG). Additionally, we discovered that there were five rough landings, with Denpasar Airport (DPS) accounting for most of them (Tab. 1). Furthermore, data analysts showed that this aircraft fleet is unlikely to land in TDZ zones and does not comply with go-around procedures if the landing point is outside the TDZ (Tab. 2).

The results of this study can be utilized to help airlines and air service policymakers in Indonesia evaluate current practices and acquire additional data, so they can actively defend passengers using public transportation, especially those traveling by air.

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Credit author statement

Rossi Passarella: conceptualization, methodology, investigation, writing-original draft preparation. Siti Nurmaini: supervision, reviewing data curation, validation. Muhammad Naufal Rachmatullah: visualization, investigation, software. Osvari Arsalan: formal analysis. Rizki Kurniati: formal analysis. Aditya Aditya: investigation. Indra Gifari Afriansyah: investigation. M Rifqi Fathan: investigation, software. Rani Silvani Yousnaidi: investigation. Harumi Veny: data curation, reviewing and editing, formal analysis.

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