WARTA ARDHIA
Jurnal Perhubungan Udara
p-ISSN: 0215-9066 (print), e-ISSN: 2528-4045 (online), www.wartaardhia.com

An Analysis on Serious Incidents and Accidents in Aviation Using Shell Model

Pangsa Rizkina Aswia[1)], Dwi Lestary[2*)], Firdaus Masykur[3)], Gilang Trio Putra[4)]
[123]Politeknik Penerbangan Indonesia Curug, Tangerang, 15820, Indonesia
Email : pangsa.rizkina@ppicurug.ac.id [1)], dwi.lestary@ppicurug.ac.id [2*)],
masykurfirdaus@gmail.com [3)], gilang.trio@ppicurug.ac.id [4)]

INFO ARTIKEL

Article History:
Accepted: 26 April 2022
Revised: 10 May 2022
Approved: 26 may 2022
Publish Online: June 2022

***Keywords*:**
Accidents, Aviation Safety, NTSB, Serious Incidents, SHELL Model

Permalink/DOI:
https://dx.doi.org/10.25104/wa.v48i1.456.35-42

***ABSTRACT* / ABSTRAK**

A thorough investigation must be conducted in every aviation incident or accident to find the root cause so that recommendations can be drawn to prevent the same incident or accident from occurring again. This research is a descriptive analysis with quantitative methods. Data were collected from the final reports released by the KNKT from 2015 until 2019. The main causes were grouped using the SHELL Model analysis. The results showed that the most prevalent cause of aviation incidents/accidents in Indonesia was the mismatch between liveware-liveware of which the percentage reached 64%. Furthermore, this mismatch was caused by lack of supervision from management as many as 17 events or 74%; 5 events or 22% were caused by unavailability of rules; and lack of coordination with as many as 1 event or 4%. Within 17 events caused by lack of supervision from management, there were 3 phases of which the events occurred namely the landing phase comprising 59% or 10 events, the cruising phase comprising 18% or 3 events, and the approaching phase consisting of 24% or 4 events. Accidents and serious incidents may occur if latent causes such as lack of supervision from management, unavailability of rules and lack of coordination are not mitigated.

INTRODUCTION

From 2015 to 2019, there were more than 170 aviation accidents (see Table 1) classified as accidents and serious incidents in Indonesia. The causes of the accidents/serious incidents were caused by 3 main factors, namely technical factors, weather factors, and human error factors (Komite Nasional Keselamatan Transportasi, 2020). From 2015 to 2019, the National Transportation Safety Committee (*Komite Nasional Kecelakaan Transportasi* or KNKT henceforth) has investigated more than 170 aviation accidents caused by these factors as shown in the following table:

Table 1. Aviation accidents/incidents investigated by KNKT (2015-2019)

No	Year	Number of Events
1	2015	18
2	2016	45
3	2017	37
4	2018	44
5	2019	30

Source: (Komite Nasional Keselamatan Transportasi , 2021)

Based on the data above, aviation accidents/incidents in Indonesia experienced an increase in 2016 and tended to fluctuate whereas the goal of aviation safety was to reduce the accident or incident rate to the lowest or an acceptable level. The investigation mechanism carried out by the KNKT is based on national and international regulations. Civil Aviation Safety Regulations section 830 concerning Notification and Reporting of Accidents and Serious Incidents of Civil Aircraft and Procedures for Investigation of Accidents and Serious Incidents of Civil Aircraft states that "the sole purpose of conducting accident investigations by the KNKT is to find the causes that affect each accident. Furthermore, the results of this investigation can be used to improve aviation safety conditions and measures to prevent accidents with the same cause in the future."

Accidents occur due to 5 factors, namely organizational influences, risk control, local conditions, individual actions, and technical events (Australia Transport Safety Bureau, 2008). Humans are often the main factor causing accidents in addition to technical, environmental, and facility factors. Therefore, we need to know why humans are often the cause of accidents, even though we know that all parties related to aviation safety are always improving to reduce the causes of accidents caused by humans by following Standard Operating Procedures (SOP) and strict supervision, sophisticated tools, and the like.

The main factors that affect humans with other components at the time of an accident may occur at the stage before the accident (latent condition) and at the time of the accident (active condition). In the pre-event stage, there are several factors involved namely organizational influences, risk controls, and local conditions. At the stage of the incident, there are 2 factors involved namely individual actions and occurrence events. However, in this study, the authors limit the analysis to the latent conditions or causes that were not present at the time of the incident but were directly related to the incident and will not examine the active conditions. Latent hazards are hidden hazards and tend to be invisible but have a very significant effect on flight safety. Using the SHELL Model approach, we can find out each cause of the accident and how the human relationship indirectly caused the accident.

Based on these descriptions, it is very important to research to analyze the latent conditions of accidents and serious incidents in Indonesia. In this study, the authors analyze the accidents and serious incidents that occurred from 2015 to 2019. It is expected that the results of this study can contribute to the improvement of flight safety rating in Indonesia for the present time and in the future.

The research objectives are as follow:

1. To analyze the causes of latent failures in accidents and serious incidents in Indonesia in 2015 – 2019 using the SHELL model approach; and
2. To identify the main factors that cause accidents and serious incidents in airplane

accidents in 2015-2019 using the SHELL model approach.

LITERATURE REVIEW

High level of aviation safety can only be achieved if all system components in the aviation industry (consisting of airport operators, airline operators, air traffic operators, aircraft maintenance operators, and regulations set by regulators) function well. Every incident of aviation accident must be investigated to find the main cause (Poerwanto & Mauidzoh, 2016).

SHELL model is a conceptual model of human factors that explains the scope with other aviation factors and helps to understand human relationships with other aviation *system* resources (Hawkins & Orlady , 2016). *SHELL models* can be used as a framework for collecting data on human performance and *mismatch* components in aviation incidents or accident analysis or investigations as recommended in annex 13. For example, an accident investigation error on Asiana Flight 214 in 2017 in which there was a discrepancy between the pilot and the navigation device *(Liveware-Hardware)* (Miller & Holley , 2018).

Safety investigation is a process related to the purpose of preventing an accident which includes collecting and analyzing information, describing a conclusion, including considering the cause and or contributing factors, and if needed, making safety recommendations (International Civil Aviation Organization, 2020). KNKT job is to investigate aviation accidents that are included in *accidents* and *serious incidents* (KNKT, 2014) (Komite Nasional Keselamatan Transportasi, 2014)

METHODOLOGY

In this study, the authors used descriptive analysis, therefore there is no need for hypothesis testing. The authors answered the problem formulation related to the data obtained by the authors through the KNKT final reports and related documents. Based on the collected data, the researcher will analyze the following steps:

1. The causes of latent failures using the SHELL Model approach.
2. The main causes of latent failures using the SHELL model approach.
3. Categorization of the main causes; and
4. The phases at the time of the incident are based on the main cause.

In analyzing the reports, the authors adapted the Australian Transport Safety Bureau (ATSB) investigation model. The authors focused on the analysis, conclusions, safety action, and safety recommendation sections on final report for the following reasons:

1. Analysis

   The analysis section provides a detailed discussion of the safety factors identified during the investigation. It provides evidence and arguments needed to support contributing factors and findings. The content of the analysis addresses the results of the investigation rather than the process.
2. In the conclusion section there are 2 parts, namely:
   a. Findings

      Findings are statements of all significant conditions, events, or circumstances in the accident sequence. This discovery is an important step in the sequence of accidents, but it is not always the cause, or indicative of a deficiency. Some findings indicate conditions that preceded the accident sequence, but it is usually important to understand the events, usually in chronological order (Komite Nasional Keselamatan Transportasi, 2017).

      In the findings section, the authors can find out the sequence of an accident but are unable to conclude the main causes of an accident yet.

   b. Contributing Factors

      Contributing factors are events that occur alone, or in combination with others, resulting in injury or damage. It can be an act, omission, condition, or circumstance if omitted or avoided would prevent its occurrence or would reduce the resulting injury or damage

(Komite Nasional Keselamatan Transportasi, 2017).

In the contributing factors section, the authors can find out the events that occur and other factors, that, if omitted, accidents can be prevented.

3. Safety Actions

Safety actions are actions taken by parties related to accidents such as airlines, airports, and air navigation service providers, with the intention that incidents/accidents may be prevented from occurring (Komite Nasional Keselamatan Transportasi, 2017). In the safety actions section, the authors can find out what actions were taken by parties related to the incident/accident and what they did so that the incident could be prevented.

4. Safety Recommendations

Safety recommendation is a recommendation that focuses on knowing what to fix from a safety issue or weakness, not on explaining how to fix the error from each incident. From the recommendation, the authors can find out what must be corrected by the parties associated with each incident and if it has been repaired, it is expected that the incident will not happen in the future.

When viewed from the data source, the data collection in this study used secondary sources, namely sources that do not directly provide data to data collectors, for example through other people or documents (Sugiyono, 2017). In terms of data collection methods, this study uses documentation study techniques.

Documentation study is a data collection technique that is not directly aimed at the object of research. The documents studied are varied, not necessarily official documents but could be in the form of diaries, personal letters, reports, meeting minutes, case notes, and others (Aminarno, 2015). The documents studied in this study are documents containing investigation reports from the KNKT in 2015 - 2019 in the form of accident and serious incident investigation reports, namely 36 final reports downloaded from the KNKT website.

The authors did not examine the final report drafts because it is confidential and not published by the KNKT and the authors did not examine the preliminary reports because they are still preliminary. They only explain the chronology of the accident; there has been no analysis from the KNKT, and the reports are still incomplete. Also, the authors did not examine the interim statements because they are still incomplete, unlike the final report.

The authors used a descriptive analysis where the authors answered the problem formulation based on available data (Sugiyono, 2017). In analyzing the data, the authors went through several steps including:

1. Analysis of the KNKT Final Reports

The authors analyzed the important parts in the final report, namely analysis, conclusions, safety action, and safety recommendation, then the authors put them into the 5 components of the ATSB investigation model, namely:

a. Occurrence events (including technical problems)
b. Individual actions
c. Local conditions
d. Risk controls (including preventive and remedial measures)
e. Organizational influences

In the last part, namely organizational influences, the authors concluded the latent failures and their relationship using the SHELL model.

2. Data processing of the causes of latent failures and their relationship using the SHELL model.

When the latent failures data and their relationships have been obtained, the authors processed the data using Microsoft excel to obtain the main causes of all events in 2015-2019 including (for example see Table 2):

a. Year of occurrence
b. Aircraft type and registration
c. The scene
d. Event type
e. Phase at the time of occurrence
f. Latent causes
g. Classification in SHELL Model

Table 2. Example of table processing latent failure

Tahun	2016
Aircraft	PKTGL C172
Tempat	Bandara Budiarto
Tipe Kejadian	*Serious incident*
Fase	*Landing*
Penyebab latent	Tidak adanya pengenalan ALAR (*Approach Landing Accident Reduction)*
Hasil dalam *SHELL model*	L-L

Source : Author

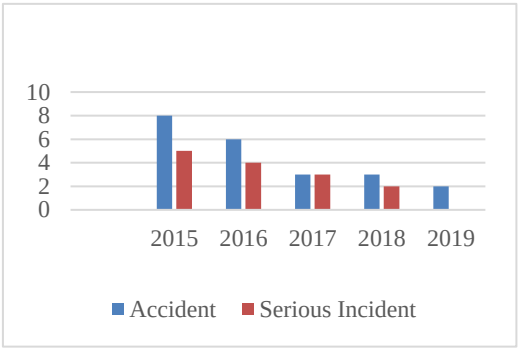
RESULT AND DISCUSSION

The authors retrieved 57 reports from the KNKT website, 36 of which are the final reports. The data recap of the 2015-2019 final reports can be seen in Table 3 and Figure 1.

Tabel 3. Final report data (2015-2019)

Year	Accident	Serious incident	Total
2015	8	5	13
2016	6	4	10
2017	3	3	6
2018	3	2	5
2019	2	0	2
	Total		36

Source: (Komite Nasional Keselamatan Transportasi , 2021)



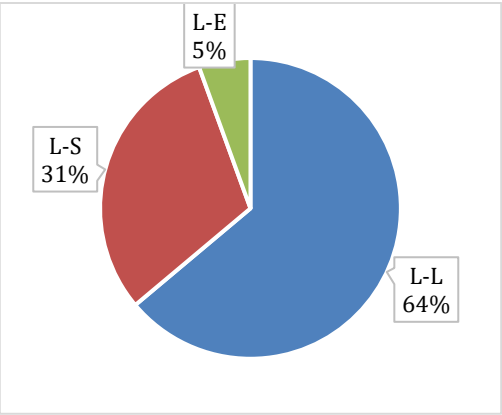
Source: (Komite Nasional Keselamatan Transportasi , 2021)

Figure 1. Comparison of the number between accidents & Serious incidents (2015-2019)

Based on the graph, it shows that flight accidents and serious incidents in Indonesia in the period of 2015 to 2019 tend to decrease. However, continuous preventive actions are still needed to ensure flight safety. All stakeholders including airlines, navigation providers, and air transportation authorities must work hand in hand in making policies, rules, regulations, and SOPs so that accidents and serious incidents can be prevented from occurring.

The authors then analyzed the data from 36 final reports and put accidents and serious incidents together because these two types of events were the objects investigated by the KNKT. Fort, the purpose of this study, accidents, and incidents will be used interchangeably. SHELL Model theory is applied in the analysis of the data. Of the 36 final reports, the factors that contributed the most will be analyzed, and the mismatch between the elements (Liveware-Software, Liveware-Hardware, Liveware-Environment, Liveware-Liveware) that caused the accidents to occur will also be analyzed. Each element found was then calculated in percentage, then the largest percentage of mismatch in that element was analyzed more deeply.

The data analysis result shows that the largest percentage of the causes of accidents and serious incidents is the mismatch between liveware and liveware, as many as 64% or 23 incidents as can be seen in figure 2.



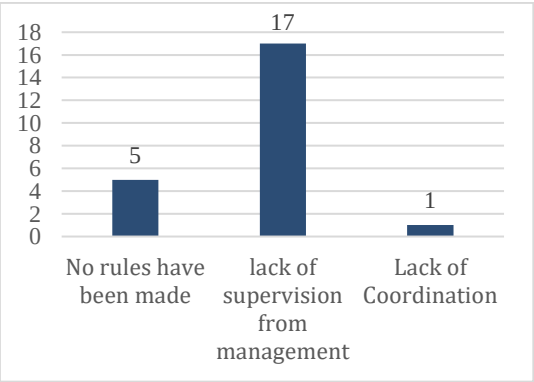
Source: Author

Figure 2. Latent influence chart based on SHELL Models approach

More specifically, the mismatch between Liveware-Liveware occurred due to lack of supervision, unavailability of rules, and lack of coordination.

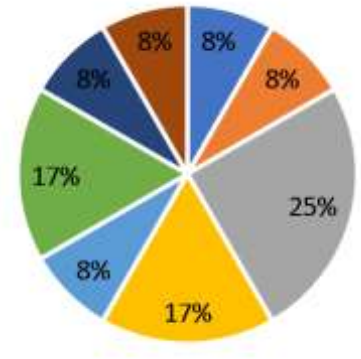
The categorization of Liveware-Liveware identification in figure 3 means the following:

1. Supervision from management: rules have been made by regulators, aircraft manufacturers, and companies but accidents or serious incidents still occur.
2. Unavailability of rules: events occur because rules have not been made or existing rules do not mitigate the events.
3. Lack of coordination: different assumptions between personnel in the field about the rules that have been made.



Source: Author

Figure 3. Liveware-Liveware Identification



Source: Author

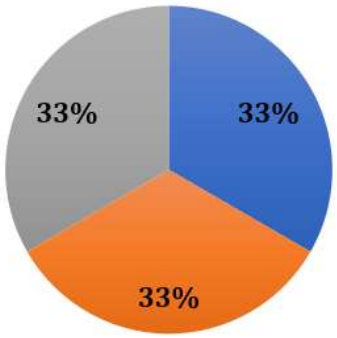
Figure 4. The accident occurred in the landing phase

According to the data analyzed by the author, it was found that the largest percentage of the liveware-liveware categorization was supervision from management as many as 74% or 17 events. The next analysis is to look at the phases when the accident occurred and the causes. There are 3 phases recorded in the existing data, namely landing, cruising, and approaching phases.

In the landing phase (see Figure 4), there are 8 causes of the 10 events due to the contribution of the lack of management supervision, which can be elaborated as follow:

1. lack of implementation of CRM (Crew Resource Management) as many as 25% or 3 incidents.
2. lack of implementation of FOQA (Flight Operations Quality Assurance) as many as 17% or 2 incidents, mainly in the part of pilot schools.
3. an error in landing the aircraft properly and its mitigation counts for 17% or 2 incidents.
4. lack of implementation of wind shear training as many as 8% or 1 incidents.
5. lack of understanding of cumulonimbus clouds as many as 8% or 1 incident.
6. absence of knowledge and implementation of ALAR (Approach and Landing Accident Reduction) in pilot training as many as 8% or 1 incident.

7. unrecorded maintenance as many as 8% or 1 incident; and
8. lack of understanding of safety culture as many as 8% or 1 incident.

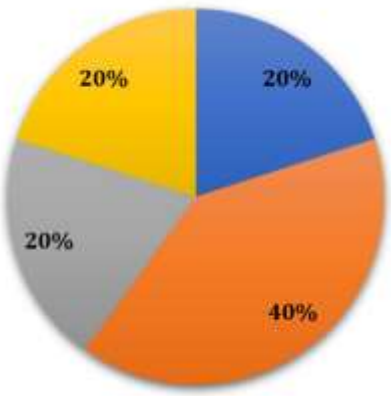


Source: Author

Figure 5. The accident occurred in the cruising phase

During the cruising phase (see Figure 5), the authors found 3 main causes of 3 accidents which can be described as follow:

1. Errors in providing knowledge about aircraft systems on the part of instructors as many as 33% or 1 incident.
2. Lack of supervision in terms of flying below minima as many as of 33% or 1 incident; and
3. Lack of socialization about the area to be visited in the part of airlines as many as 33% or 1 incident.



Source: Author

Figure 6. The accident occurred in the approaching phase

During the approaching phase (see Figure 6), the authors found 4 main causes of 4 accidents namely:

1. Unrecorded maintenance as many as 40% or 2 incidents.
2. Unfamiliarity with the area as many as 20% or 1 incident.
3. Lack of understanding of Terrain Awareness and Warning System (TAWS) as many as 20% or 1 incident; and
4. Lack of understanding of safety culture as many as 20% or 1 incident.

CONCLUSION

1. Main causes of latent failures

In this study, it was found that the main causes of latent failures in accidents and serious incidents in 2015 – 2019 using the SHELL model approach were a mismatch between humans and humans (Liveware-Liveware) as many as 64% or 23 events followed by Liveware-Software as many as 31% or 11 events and Liveware-Environment as many as 5% or 2 events.

2. The main factors that cause a mismatch between humans and humans (Liveware-Liveware)

Factors that caused a mismatch between humans and humans (liveware-liveware) and caused accidents and serious incidents in airplane accidents in 2015-2019 using the SHELL model approach are as follow:

a. Unavailability of rules.
b. Lack of coordination; and
c. Lack of supervision from management.

ACKNOWLEDGEMENTS

We would like to express our special thanks and gratitude to Director Politeknik Penerbangan Indonesia Curug and Badan Penelitian dan Pengembangan Transportasi who gave us the support to do this wonderful project. This project was founded, independent. Secondly, we would also like to thank our friends who helped us a lot in finalizing this project within the limited time frame.

REFERENCES

Aminarno. (2015). *Metode Penelitian Ilmiah.* PPI: Curug.

Australia Transport Safety Bureau. (2008). *Analysis, Causality and Proof in Safety Investigations.* Canberra: Australian Transport Safety Bureau.

Hawkins, F. H., & Orlady , H. W. (2016). *Human Factor in Flight.* New York: Routledge.

International Civil Aviation Organization. (2016). *Aircraft Accident & Incident Investigation.* Canada: ICAO.

Komite Nasional Keselamatan Transportasi . (2021). *Laporan Final Penerbangan.* Jakarta: KNKT.

Komite Nasional Keselamatan Transportasi. (2014). *Buku Saku Tentang Petunjuk Pelaksanaan Investigasi Kecelakaan Transportasi Penerbangan.* Jakarta: KNKT.

.

Komite Nasional Keselamatan Transportasi. (2017). *Investigation Guidelines 2nd Edition.* Jakarta: KNKT.

Komite Nasional Keselamatan Transportasi. (2017). *Report Writing Guidelines 3rd Edition.* Jakarta: KNKT.

Komite Nasional Keselamatan Transportasi. (2020). *Status Laporan Investigasi Kecelakaan Transportasi dan Monitoring Rekomendasi Keselamatan Transportasi.* Jakarta: KNKT.

Miller, M., & Holley , S. (2018). SHELL Revisited: Cognitive Loading and Effects of Digitized Flight Deck Automation. *Springer International Publishing*, 1-2.

Poerwanto, E., & Mauidzoh, U. (2016). Analisis Kecelakaan Penerbangan di Indonesia Untuk Peningkatan Keselamatan Penerbangan. *Jurnal Angkasa, II*(12), 9-26.

Sugiyono. (2017). *Metode penelitian kuantitatif, Kualitatif dan R&D.* Bandung: CV Aksara