Paper Pak Sigit

by Tanika Sofianti

Submission date: 03-Apr-2023 04:38PM (UTC+0700)
Submission ID: 2054475981
File name: FINDINGS_AND_RECOMMENDATIONSWAMENA_AIR_ACCIDENTS_CASE_STUDY.pdf (398.64K)
Word count: 5598
Character count: 32643

INTERNATIONAL JOURNAL OF INDUSTRIAL MANAGEMENT (IJIM)
ISSN: 2289-9286 e-ISSN: 0127-564X
VOL. 13, ISSUE 1, 471 – 478
DOI: https://doi.org/10.15282/ijim.13.1.2022.6092

ORIGINAL ARTICLE

APPLICATION OF HFACS-HFIX FRAMEWORK IN NTSC'S FINDINGS AND RECOMMENDATIONS: WAMENA AIR ACCIDENTS' CASE STUDY

Aloysius Sigit Haryono[1], Tanika Dewi Sofianti[2], and Dena Hendriana[1]

[1]Master Program of Mechanical Engineering, Faculty of Engineering and IT, Swiss German University, 15143 Tangerang, Banten, Indonesia.
[2]Faculty of Industrial Engineering, Swiss German University, 15143 Tangerang, Banten, Indonesia.

ABSTRACT – Wamena airport experienced accidents in 2002, 2008, 2009, 2013, 2015, and 2016. All accidents were cargo flights and in approach and landing flight phases. As the Swiss Cheese concept, accident happened when errors penetrated safety defenses' layers in straight line. Structuring NTSC's investigations, under HFACS framework to understand the human factor failures type and HFIX strategy to close the failures by applying the recommendations, need to be done in air accident investigation. Eleven aviation experts and practitioners were interviewed in this study, to validate the framework. There were layers without any failures in accident 2008, 2013, and 2016. Accident in 2016 has no recommendation due operators' safety actions were considered relevant to block failures. Accidents in 2002, 2009, 2013, and 2015 have failure in a layer which intervened by two or more recommendations. There were failures remain open in accident 2002, 2009, 2013, and 2016. Repetitive failure, error or violation of repetitive accidents in 2002, 2009, 2013, 2015, and 2016 is un-stabilized approach and has not been blocked with effective interventions. HFACS and HFIX are useful to framework the accident investigation, preventing similar accident happened in the future.

ARTICLE HISTORY
Received: 17-2-2021
Revised: 7-4-2021
Accepted: 4-1-2022

KEYWORDS
Swiss Cheese
NTSC
HFACS
HFIX
Un-Stabilized Approach

INTRODUCTION

As Swiss Cheese Concept, accident is not caused by single factor but when four all layers: Organizational Influences, Unsafe Supervisions, Precondition for Unsafe Acts, and Unsafe Acts of defenses penetrated in straight line and result in accident (Reason, 1990). An aircraft accident is where an aircraft experienced mishap event and result in aircraft substantial damage and person suffers serious injury or death, incident means occurrence other than accident stated in Civil Aviation Safety Regulation 830 (CASR 830, 2014). The accidents can happen in a route of flight or on an airport, and the study is focusing in air accidents which happened on Wamena airport. Accident in 2002 has been investigated and recommendations have been made by Indonesia National Transportation Safety Committee (NTSC) or Komite Nasional Keselamatan Transportasi (KNKT) but following accidents in 2008, 2009, 2013, 2015, and 2016 happened with similar causes. Wamena's accidents between 2002 until 2017 contributed six accidents of 24 accidents which occurred on the airports all over Papua during that years. Human Factors Analysis Classification System (HFACS) framework (Shappell et al., 2003) as investigation tool to guide identifying failures in each safety defense's layers, and Human Factors Intervention (HFIX) framework is required to intervened the failures from investigation's recommendations or safety actions (Shappell et al., 2007). The significance of the study is done by a 29-year aviation experience practitioner author, two doctorate level co-authors. Eleven validation experts and practitioners interviewed consist of two engineers, three Air Traffic Controller (ATC), four pilots, and two authority inspector's pilots who have aviation experience in Papua more than ten years. The study's objective is to structure the accidents findings and recommendations into these frameworks, analyzing comprehensively for all layers. The expected outcome by identifying the investigation's weaknesses, layers of defense will not be penetrated, and if interventions' action done effectively will result next accidents with similar causes will be avoided.

RELATED WORK

HFACS framework widely used by researchers in aviation, (Efthymiou et al., 2019) studied about fifty Controlled Flight into Terrain (CFIT) between 2007 until 2017. Daramola (2014) analyzed accidents happened in Nigeria between 1985 until 2008 comparing accidents and fatality rates with global average levels using HFACS framework. Harris et al., (2008) studied of 41 accidents in Republic of China (ROC) between 1999 until 2006 frame-working with HFACS. Harris et al. (2008) also did a research about 523 military accidents of Republic of China (ROC) Air Force to identify poor pilots training deficiencies with two major causals are errors of judgment and poor decision-making in 2013 . Widyanti et al., (2018) analyzing 53 Indonesian air accidents between 2001 until 2012 the incorporating with Hofstede's national cultures with HFACS's framework. In this study the Indonesian characteristics of high collectivistic, low uncertainty avoidance,

*CORRESPONDING AUTHOR | AS. Haryono | ✉ aloysius.haryono@student.sgu.ac.id

high power distance, and masculinity dimension which influenced most to the air accidents. Filho et al., (2019) studied about 211 helicopters accidents in Brazil between 2006 until 2015 used the HFACS framework.

Weigmann and Shappell (2007) suggested, HFACS which is the framework of identifying human errors can be paired with HFIX as the intervention strategy framework when the causes of occurrence are determined. Chen et al. (2013) studied 31 investigated incidents report between 2009 until 2011, using HFACS framework of Unsafe Act Layer and HFIX intervention strategy implementations with Inter Rater Reliability. The major result recommendation on Organizational/Administrative and Human/Crew to implement on Decision Error and Violation respectively. Lin et al., 2015 analyzed 15 military accidents of Republic of China Air Force (ROCAF) approached under HFACS Unsafe Act layer framework and HFIX intervention with AHP to prioritize the hierarchy from eight commanders and 14 subordinates consists of ten pilots and four maintenance staffs. The top three result from commander order sequence weights are Task/Mission (0.215), Organization/Administrative (0.214, and Human/Crews (0.206). The subordinate order sequence weights are Task/Mission (0.203), Human/Crew (0.201), and Operational/Physical Environment (0.200). Chen et al. (2016) modeled HFACS framework on Unsafe Act layer, HFIX intervention strategy, Analytical Hierarchy Process (AHP), and Zero One Goal Programming (ZOGP) to mitigate skill-based errors in military flight operation, with result skill-based errors in flight operation can be mitigated by Human/Crew intervention. (Chen et al., 2017) approached the study with HFACS, HFIX, AHP and Zero One Goal Programming (ZOGP) methods for one of near miss incident case study in one commercial flight. Comprehensive approach was not only participated by three experienced pilots who log on 8,000 flight hours each but maintenance manager, finance, and marketing as decision makers. ZOGP used for applying the intervention strategy within limited resources, budget and manpower in the airline internally. The results, five interventions approach priorities to mitigate each of unsafe act using AHP are 1. Technology or engineering vs. skill based-errors with 35.3%, 2. Human/crew vs. decision errors with 34.5%, 3. Operational or physical environment approach vs. perceptual errors with 32.6%, 4. Organizational or administrative approach vs. violations with 31.9%. ZOGP result to optimize of budget and man power priorities as 1. Organizational or administrative with recommendation senior managers to motivate sub-ordinate in complying policy, Standard Operating Procedure (SOP) and regulations, 2. Human or crew with recommendation suspend the crews on duty for two weeks and send for Crew Resources Management (CRM) training, 3. Operational or physical environment with recommendation reducing interference from ambient environment. (Chen et al., 2018) studied 78 accidents applying HFACS framework on Unsafe Act layer and Human Factor Intervention Matrix (HFIX) to implement interventions strategy with hierarchical regression analysis. The main result Technology/Engineering intervention suitable to remedy Perceptual Error on Unsafe Act layer, and Human/Crew intervention on Decision Error in the same layer.

Human Factors Analysis Classification System (HFACS)

HFACS is developed from Swiss Cheese Concept of Human Factors Framework, into some categories and sub categories of failures in the layers of defense as shown in Figure 1 (Shappell et al., 2003).

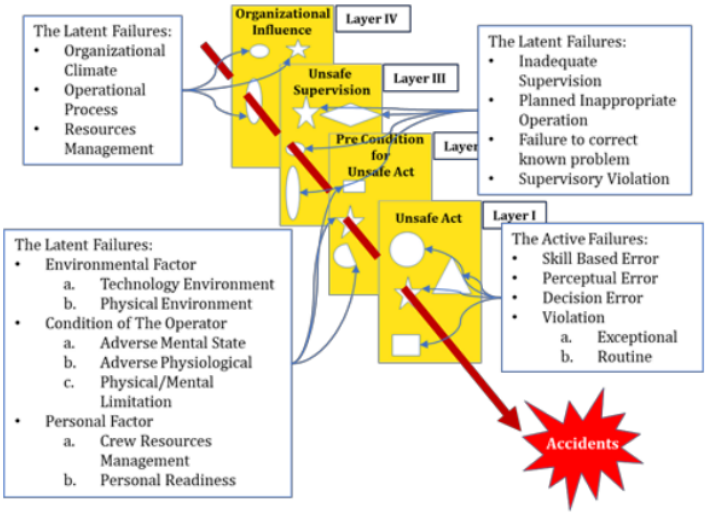

Figure 1. HFACS Model (Shappell et al., 2003).

Layer IV Organizational Influences, in this layer the latent failures are categorized as 1. Organizational Climate, in this category failures are viewed in the overall organization from policy, culture and strategic directions, 2. Operational Process, failures are viewed from operation's procedures, oversights which are done by organization's management to achieve the organization's goal, and 3. Resources Management, perspective of failures from financial, humans, facilities, and equipment resource.

Layer III Unsafe Supervisions, under HFACS framework in this layer latent failures are categorized as 1. Inadequate Supervision, personals and resources' inappropriate supervision and oversight failures, 2. Planned Inappropriate Operation, viewed failures of operation's assignments from inappropriate operational issues, 3. Failure to correct known problems, failures due to known problems by management and fail to act accordingly, and 4. Supervisory Violation, category of failures due to deliberate violation of procedure, policy, and regulation by management.

Layer II Precondition of Unsafe Act, inside this layer latent failures are categorized as 1. Environmental Factors which sub-categorized into Technology (from technology issues) and Physical (sets of physical operation and ambient environment failures), 2. Condition of The Operator which sub-categorized into Adverse Mental State (from mental condition which give negative affects to the performance), Adverse Physiologica (from acute medical condition which give limitations in safe operation, and Physical/Mental Limitation (due to permanent physical or mental disabilities which give negative impacts of operational performance, and 3. Personal Factor, sub-categorized into Crew Resources Management (failures in communication, teamwork, and coordination which affect in performance, and Personal Readiness (from the activities outside of duty which are effectively required to operate).

Layer I Unsafe Act, in this layer active failures categorized into 1. Skill Based Error (errors which came from no consciousness or little consciousness, 2. Decision Error (errors came from consciousness, misuse, behaviors mistake, misinterpretation from relevant info, 3. Perceptual Error (errors due degraded input sensors which gave inaccurate actions), and 4. Violation which sub-categorized into Routine (bending a rule, can be a nature habit which sometime violation accepted often facilitated) and Exceptional (breaking the rule).

Human Factors Intervention Matrix (HFIX)

HFIX is three dimensional framework of HFACS' failures in each layer which are approached by five alternative interventions and five evaluations criteria as shown in Figure 2 (Shappell et al., 2007).

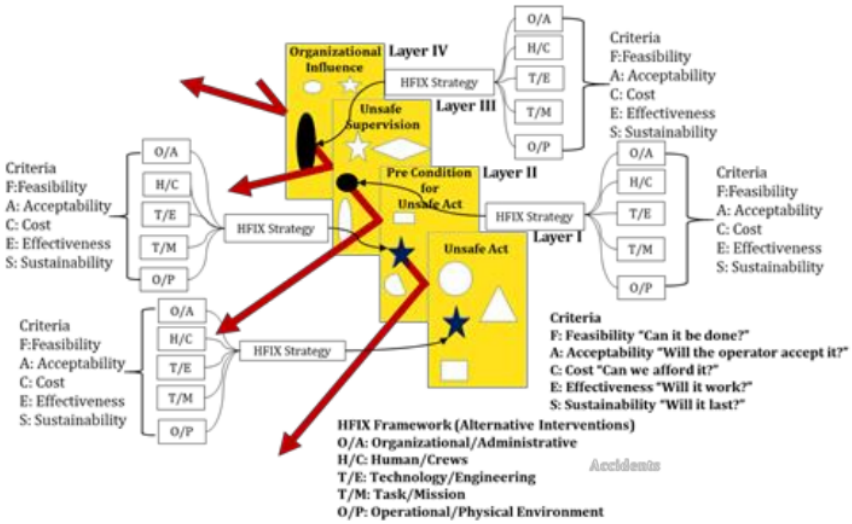

Figure 2. HFIX Model (Shappell et al., 2007).

The alternative interventions categorized into 1. Organizational/Administrative, concentrating in revising the process of management such as controlling, planning, staffing, leadership, and organization to increase safety level, 2. Human/Crews, focusing in enhance the human resources such as training, promotion, and selection, 3. Technology/Engineering, interventions using advance operational facilities, technology, job aids, and easy interface, 4. Task/Mission, managing tasks to reduce mental and physical workload, 5. Operational/Physical Environment, improving direct environment of front operations.

Crieteria of evaluations categorized into 1. Feasibility, whether the strategy can be done successfully, 2. Acceptability, whether the operator accept the strategy, 3. Cost, whether financial and opportunity cost can be afforded, 4. Effectiveness, whether objectives can be achieved, 5. Sustainability, whether the strategy will last.

RESEARCH METHODOLOGY

The secondary data were taken from official report of NTSC's investigation website. Structuring the data investigation report of NTSC's findings using HFACS framework and determining NTSC's recommendations to respective accident investigation result using HFIX approach done by the first author who has 29 years flying experience as pilot, co-authors

with doctorate level of education. Validating the previous step by conducting interview and discussion with experts from pilots, engineers, Air Traffic Controllers (ATC), authority inspector's pilots, and NTSC's investigators. Prior interview or discussion given to experts, the mind mapping of HFACS framework and HFIX strategy implementation were briefed and introduced.

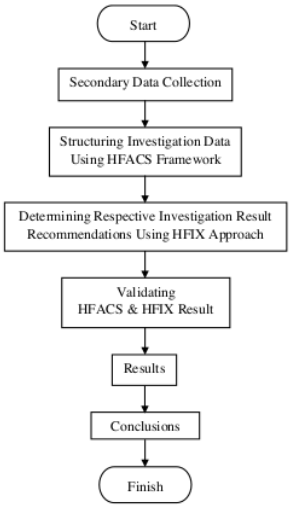

Figure 3. Flowchart of Research Methodology.

RESULTS

Accident in 2002

Layer IV - The recommendation "to stop non type certificate aircraft with special permit in 2004" will block "Aircraft on special permit Non-Type Certificate under Estonian registration and crews" and "Government Check Pilot didn't do the close supervision (giving exam or onboard inflight)" failures.

Layer III - "ATC didn't clearly give traffic sequence for landing" failure has no recommendation and still open condition, and the recommendation "to stop non type certificate aircraft with special permit in 2004" will block "crews on duty, new pairing was not regular set crews (Ex-Soviet common practice hardly change a set of crews)" failure.

Layer II - "Five traffics ingoing and outgoing almost same time" failure has no recommendation still open, 1. The recommendation "to regularly train the fire brigade personals" will block "fire brigade personals were not ready" failure, 2. The recommendation "to regularly check fire brigade equipment" will block "fire brigade equipment was unserviceable" failure, and 3. The recommendations "pilots temporary to do transmit blind when flying over gap" and "to install relay antenna for blank radio transmission between ATC to aircrafts" will block "blank radio transmission in gap area ATC to aircrafts" failure.

Layer I - 1. The recommendation "to stop non type certificate aircraft with special permit in 2004" will block "pilots failed to estimate distance to start the final turn properly" error, 2. The recommendation "to stop non type certificate aircraft with special permit in 2004" will block "aircraft landed and bounced three times, right main wheel touched and nose wheel twisted, friction and created fire" error, and 3. The recommendations "to stop non type certificate aircraft with special permit in 2004" and "to install more navigation aid at the airport as well as publish holding and go-round pattern" will block "overspeed, high rate of descend during approach resulted flaps not extended" violation.

Accident in 2008

Layer IV - The recommendation "to review the status of the Rescue Fire Fighting Service (RFFS) equipment at Wamena airport & establish an ERP for Wamena airport" will block "No Emergency Respond Plan (ERP) at Wamena airport" failure.

Layer III - No failure stated in the investigation.

Layer II - 1. The recommendation "airline to phase out (not using) Transall C-160 per July 10, 2009" will block "beta light didn't illuminate thrust reverser failure, maximum brake, brake overheat then created fire" failure, and 2. The recommendation "to exercise an ERP for Wamena airport" will block "Rescue Fire Fighting Service (RFFS) arrived at on-fire aircraft ten minutes after aircraft stopped taxiway E" failure.

Layer I - The recommendation "to exercise an ERP for Wamena airport" will block "RFFS commenced applying foam suppressant five minutes after arrived at on-fire aircraft" error.

Accident in 2009

Layer IV - 1. The safety action "airline made own Notification to Airmen (NOTAM) about go around procedure on April 27, 2009" will block "No GO AROUND procedure for Wamena Airport for runway 15" failure, 2. The recommendation "to ensure the documenting and implementation of airlines for the specific training" will block "lack regulator's supervision on the specific training implementation & the Crew Resources Management (CRM) implementation" failure, 3. The recommendation "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "operator should document specific training and implement Crew Resources Management (CRM) program" failure, 4. The recommendation "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "Company Training Manual (CTM) stated about Ground Proximity Warning System (GPWS) but not Enhance GPWS (EGPWS)" failure, and 5. The recommendation "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "No procedure detailing to inhibit terrain features in EGPWS" failure.

Layer III - 1. The recommendations "to implement specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" and "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "crews did not receive Enhanced Ground Proximity Warning System (EGPWS) training stated in Company Training Manual (CTM)" failure, 2. The recommendations "to implement specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" and "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "operator simulator training program did not cover action & responses to EGPWS aural alert & warning" failure, and 3. "This aircraft approved combi operation (cargo-passengers), at accident was cargo flight but used passengers' weight & balance" failure not directly affecting the accidents.

Layer II - 1. The safety action "DGCA made NOTAM to revise Wamena Airport elevation from 5083 feet to 5430 feet on Dec 1, 2009" will block "Wamena Airport elevation was 5083 feet" failure, 2. The recommendations "to implement specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" and "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "Not respond "DON'T SINK" & "TOO LOW TERRAIN" for overshoot on right downwind on second attempt approach & "DON'T SINK", "TOO LOW TERRAIN" , "BANK ANGLE",& "TERRAIN TERRAIN" during base lag turns second attempt approach" failure, and 3. The recommendations "to implement specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" and "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "crews not familiar with EGPWS equipment" failure.

Layer I - "Senior in Command (SIC) concerned about Pilot in Command (PIC) handling the flight (recorded the anxiety)" error and "Nonconformance of operator published operating procedure" violation both have no recommendations and still open, 1. The recommendations "to implement specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" and "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "Enhanced Look-Ahead function appeared to have been inhibited" violation, 2. The safety action "DGCA made NOTAM to revise Wamena Airport elevation from 5083 feet to 5430 feet on Dec 1, 2009" will block "second attempt approach after overshoot join low level downwind 150-350 feet above ground level" violation, and 3. The recommendations "to implement specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" and "to documenting specific training modules for crew response to all warnings and alerts generated from ground proximity warning systems and enhanced ground proximity warning systems fitted to aircraft that it operates" will block "Not respond "DON'T SINK" & "TOO LOW TERRAIN" for overshoot on right downwind on second attempt approach & "BANK ANGLE", "TERRAIN TERRAIN" during base lag turns second attempt approach" violation.

Accident in 2013

Layer IV - No failure stated in the investigation.

Layer III - "150 flights movement per day" failure still open with no recommendation, the recommendations "to ensure that pilots have adequate knowledge and skill to understand and correct implementation of Stabilized Approach" and "to review the procedure in crew coordination in respect to the EGPWS aural warning when activated" will block "recovery action from un-stabilized approach not following ALAR tool" failure.

Layer II - "150 flights movement per day inbound and outbound" and"VFR traffics outgoing & ingoing Wamena" both failures still open with no recommendations, 1. The recommendations "to review the current method of CRM (Crew Resource Management) training" and "to implement the CRM training" will block "lack of between pilots communication" failure, and 2. The recommendations "to ensure that pilots have adequate knowledge and skill to understand and correct implementation of Stabilized Approach" and "to review the procedure in crew coordination in respect to the EGPWS aural warning when activated" will block "recovery action from un-stabilized approach not following ALAR tool kit" failure.
Layer I - "Visibility reported by ATC 4 km" error still open with no recommendation, 1. The recommendation "to ensure that pilots have adequate knowledge and skill to understand and correct implementation of Stabilized Approach" will block "the flight touched down runway 2 deg mis-alignment from runway direction" error, 2. The recommendation "to ensure that pilots have adequate knowledge and skill to understand and correct implementation of Stabilized Approach" will block "After touchdown thrust asymmetric" error, and 3. The recommendations "to ensure that pilots have adequate knowledge and skill to understand and correct implementation of Stabilized Approach" and "to review the procedure in crew coordination in respect to the EGPWS aural warning when activated" will block "The flight didn't meet stabilized approach criteria for visual approach at or above 500 feet (25 seconds after EGPWS altitude call "FIVE HUNDREDS" pilot reported runway insight , the FDR recorded that when aircraft at 5450 feet (± 400 feet AGL) and 5260 (± 200 feet AGL) until the aircraft touched down showed that the pitch varied from 1° down to 5° up and the aircraft rolled to the left and right up to 20°and the heading changed from 140° up to 164°" violation.

Accident in 2015
Layer IV - The recommendation "to develop an airport maintenance program, review and improve the runway inspection system, install VASI on the runway 15" will block "rubber deposit 600 m start from runway threshold" failure.
Layer III - The safety actions "to conduct hard landing phase 1 inspection" and "to establish FOQA or FDA system" will block "trend hard landing not corrected, FDR recorded within 107 hours, 170 lags, 5 times hard landing 2G" failure.
Layer II - 1. The recommendation "to develop an airport maintenance program, review and improve the runway inspection system, install VASI on the runway 15" will block "Visual Approach Slope Indicator at Wamena airport was inoperative" failure, 2. The recommendation "to improve ATCs wind-shear knowledge" will block "gusty wind not (windshear possibility) reported by ATC to pilots" failure, 3. The recommendations "to encourage pilots for go around if un-stabilized approach", "to review SOP of Jayapura to Wamena operation", and "to review ALARS/CFIT training effectiveness" will block "Passing Jiwika 10,000 feet thrust idle, high altitude and over speed, 8000 feet flaps selected to 40°, 25 second after due to flap load limiter moved to 39.9°" failure, and 4. The recommendation "to improve wind-shear/CRM/COM-Stabilized Approach/EGPWS/CFIT training for crews" will block "no speed correction after "CAUTION WINDSHEAR" EGPWS warning" failure.
Layer I - 1. The recommendation "to improve wind-shear/CRM/COM-Stabilized Approach/EGPWS/CFIT training for crews" will block "Pilots unidentified effect of wind shear speed increased 148-154 knots, Thrust N1 reduce from 72% to 38% resulted aircraft touched 35 m from runway with 3.68 G" error, 2. The recommendation "to improve wind-shear/CRM/COM-Stabilized Approach/EGPWS/CFIT training for crews" will block "at 5520 feet aural warning CAUTION WINDSHEAR not responded by pilot" violation, and 3. The recommendations "to review ALARS/CFIT training effectiveness" and "To improve wind-shear/CRM/COM-Stabilized Approach/EGPWS/CFIT training for crews" will block "aural warning "SINK RATE" not responded by pilot" violation.

Accident in 2016
In this accident 2016 NTSC did not make any recommendations due operators' safety actions were considered relevant to block failures.
Layer IV - No failure stated in the investigation.
Layer III - No failure stated in the investigation.
Layer II - 1.The operator safety action "to assess the risks operating to Wamena 5 km visibility, 1000 feet cloud ceiling (AGL)" will block "Fifteen minutes before departure weather destination at Wamena visibility 3 km & cloud bases increasing from 200 to 1000 feet above ground level" failure, and 2. The operator safety action "to encourage pilots for go around if un-stabilized approach" will block "at 7000 feet pilots didn't see visual check point and PM (Pilot Monitoring) advised go around but flight still be continued" failure.
Layer I - "At 7000 feet ATC gave landing clearance to pilots when pilots still can't see the runway" error still open with no recommendation, 1.The operator safety action "to encourage pilots for go around if un-stabilized approach" will block "flight touched down 125 m from runway 15 with 3.25 G" error, 2. The operator safety action "to encourage pilots for go around if un-stabilized approach" will block "at 5700 feet, distance 2 nm, EGPWS aural warning SINK RATE" violation, and 3. The operator safety action "to assess the risks operating to Wamena 5 km visibility, 1000 feet cloud ceiling Above Ground Level (AGL)" will block "Wamena's visibility at when accident happened was 3 km" violation.

CONCLUSION

Structuring investigations process of accidents or incidents comprehensively using HFACS framework will give clearer picture of latent and active failures in each layer to understand why accidents and incidents happened. Understanding the framework if four layers have been penetrated that result in incident or accident, is important. Then

stating failures as the cause of incident or accident in each layer in the investigation report is critical for stake holder to understand, identify and intervened action's strategy blocking them. (accidents in 2008 layer I and III, in 2013 layer IV, and in 2016 layer III and IV, with no failure).

Alternative interventions using HFIX framework of safety recommendations or and safety actions ideally should be given by NTSC as National Safety Committee in accidents or incidents investigation process on each failure of layer to block failures and giving wider impact to National or Global Safety awareness. Accident in 2016 has no recommendations from NTSC due operators' safety actions were considered relevant to block failures.

Letting the latent and active failures to remain open will jeopardize the safety and will cause incidents or accidents in the future (accident in 2002 on layer III and layer II, accident in 2009 on layer I, accident in 2013 layer III, on layer II, and layer I, accident in 2016 layer I, have failures open with no recommendations).

Repetitive latent and active failures which one of the causes in incidents or accidents indicate that root cause hasn't been blocked effectively and comprehensively for each layer by interventions of safety recommendations or actions. In this Wamena accidents study from 2002 until 2016 five of six accidents having "Un-Stabilized Approach" failure and with interventions such as: Human/Crew (accident in 2016, 2015, and 2013), Organizational/Administrative (accident in 2015, and 2013), Task/Mission (accident in 2009), Technology/Engineering (accident in 2002). These indicate the interventions from NTSC's recommendations and safety actions haven't been effectively blocked unstabilized approach failure.

Accident in 2002, 2009, 2013, and 2015 has a failure which intervened by more than one recommendation.

REFERENCES

Chen, J.C., Chi, C. F., Li, W. C., (2013). The Analysis of safety Recommendation and Human Errors Prevention Strategies in Flight Operation. EPCE/HCII, Part II, LNAI 8020, pp. 75-84.

Chen, J. C., Lin, S. C., (2016). Application of a hybrid model for mitigating skill-based errors in military flight operation. ADFA, p.1.

Chen, J. C., Lin, S., Yu, V. F., (2017). Structuring an effective human error intervention strategy selection model for commercial aviation. J. Air Transport. Management. 60, 65-75.

Chen, J. C., Yu, V. F., (2018). Relation between human error intervention strategies and unsafe acts: The role of strategy implementability. J. Air Transport. Management. 69, 112-122.

Daramola, A. Y., (2014). An investigation of air accidents in Nigeria using the Human Factors Analysis and Classification System (HFACS) framework. Journal of Air Transport Management 35, 39-50.

Efthymiou, M., Kelly, D., (2019). An analysis of human factor in fifty controlled flights into terrain aviation accidents from 2007 to 2017. J. Safety. Research. 69, 155-165.

Filho, A. P. G., Souza, C., Siqueira, E., Anderson, M., Vasconcelos, T., (2019). Human Factors and Helicopter Accidents: An Analysis Using the Human Factors Analysis and Classification System (HFACS). AISC 786, 105–112.

Harris, Don., Li, W. C., Yu, C. S., (2008). Routes to failure: Analysis of 41 civil aviation accidents from the Republic of China using the human factor analysis and classification system. Accident Analysis and Prevention 40, 426-434.

Harris, Don., Li, W.C., (2013). Identifying Training Deficiencies in Military Pilots by Applying the Human Factors Analysis and Classification System. International Journal of Occupational Safety and Ergonomics (JOSE), Vol. 19, No. 1, 3–18.

http://knkt.go.id/post/read/laporan-final-penerbangan (retrieved April 15, 2020).

Indonesian Government, Civil Aviation Safety Regulation 830 No. 256, 2014, Transport Department 2014.

KNKT, Aircraft Accidents Investigation Final Report No. /02.12/04.01.012: PT Trigana Air Service Antonov 72-100 ES-NOP, 2002. Wamena Airport Author Republic of Indonesia.

KNKT, Aircraft Accidents Investigation Final Report No. 08.03.06.04: PT Manunggal Air Service Transall-160 PK-VTQ, 2008. Wamena Airport Author Republic of Indonesia.

KNKT, Aircraft Accidents Investigation Final Report No. 09.04.12.01: PT Avia Star Mandiri British Aerospace BAe 146-300 PK-BRD, 2009. Wamena Airport Author Republic of Indonesia.

KNKT, Aircraft Accidents Investigation Final Report No. 13.05.18.04: PT. Deraya British Aerospace BAe ATP Freighter PK-DGI, 2013. Wamena Airport Author Republic of Indonesia.

KNKT, Aircraft Accidents Investigation Final Report No. 15.08.20.04: PT. Cardig Air Boeing 737-300 PK-BBY, 2015. Wamena Airport Author Republic of Indonesia.

KNKT, Aircraft Accidents Investigation Preliminary Report No. 16.09.27.04: PT. Trigana Air Service Boeing 737-300F PK-YSY, 2016. Wamena Airport Author Republic of Indonesia.

Li, W. C., Harris, D., Yu, C. S., (2008). Routes to failure: Analysis of 41 civil aviation accidents from the Republic of China using the human factor analysis and classification system. J. Accident, Analysis and Prevention. 40, 426-434.

Lin, S. C., Chen, J. C., Li, W. C., (2015). The Analysis of Human Error Prevention Strategies in Military Aviation. EPCE, LAAI 9174, pp. 428-435.

Matthews, S., Vandel, R., H., Vogt, C., Phillips, C., N., and Reed, S., D., (2000) "Flight Safety Digest Special Issue Approach and landing Accidents Reduction (ALAR)" November, 2000. Flight Safety Foundation.

Reason, J.T. (1990). Human Error. Cambridge University Press, Cambridge.

Shappell, S. A., Weigmann, D. A., (2003). A human error approach to aviation accidents analysis. The human factor analysis classification system. Ashgate, Aldershot, UK

Shappell, S., Detwiler, C., Holcomb, K., Hackworth, C., Boquet, A., Wiegmann, D.A., (2007). Human error and commercial aviation accidents: An analysis using the human factors analysis and classification system. Hum. Factors 49, 227–242.

Shappell, S., Weigmann, D. A., (2009). A methodology for assessing safety programs targeting human error in aviation. The International Journal of Aviation Psychology, 19, 252-269.

Widyanti, A., Pratama, G. B., Sutalaksana. I. Z., (2018). Incorporating Hofstede' National Culture in Human Factor Analysis and Classification System (HFACS): Cases of Indonesian Aviation Safety. MATEC Web of Conferences 154, 01063.

CONFLICT OF INTEREST

The author(s), as noted, certify that have NO affiliations with or involvement in any organisation or agency with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, jobs, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, expertise or beliefs) in the subject matter or materials addressed in this manuscript.

AUTHOR AND CO-AUTHORS' BIOGRAPHY

Author's Full Name: Aloysius Sigit Haryono
Author's Email: aloysius.haryono@student.sgu.ac.id
Author Professional Bio:
Aloysius Sigit Haryono is a pilot, aviator practitioner who has interest in human factor and aviation safety research, and pursuing master degree in Mechanical Engineering from Swiss German University, Indonesia. He has been in several positions in aviation industry such as Captain, Checkairmen, Chief Pilot, and Director of Flight Operation.

Co-Author's Full Name: Tanika Dewi Sofianti
Co-Author's Email: tanika.sofianti@sgu.ac.id
Co-Author Professional Bio:
Tanika D Sofianti is an associate professor of Industrial Engineering Department of Swiss German University, Indonesia. She obtained her doctoral degree from Industrial Engineering of Bandung Institute of Technology, Indonesia in 2013. Her research interest includes knowledge management, decision science and performance engineering.

Co-Author's Full Name: Dena Hendriana
Co-Author's Email: dena.hendriana@sgu.ac.id
Co-Author Professional Bio:
Dena Hendriana is a head of Master of Mechanical Engineering Graduate Program of Swiss German University, Indonesia. He obtained Bachelor of Science in Mechanical Engineering at Northeastern University of Boston, Master of Science, and Doctor of Science in Mechanical Engineering at Massachusetts Institute of Technology of Cambridge, MA, USA.

Paper Pak Sigit

ORIGINALITY REPORT

12%	12%	3%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

1%

★ Lecture Notes in Computer Science, 2015.

Publication

Exclude quotes	On	Exclude matches	< 10 words
Exclude bibliography	On		