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MODEL OF RISK FACTORS IDENTIFICATION: A QUALITATIVE APPROACH TO MITIGATE PILOT ERRORS IN INDONESIA

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ABSTRACT

Pilot errors accounts for 80% of accidents and 50% of serious incidents, thus identifying the risk factors is crucial to mitigation strategies. The research aimed to develop a model of pilot errors' risk factors identification and mitigation by conducting a Focus Group Discussion (FGD) with stakeholders in Indonesia. This was a qualitative analysis by conducting hybrid FGD, divided into four groups of experts consisted of officials from the Directorate General Civil Aviation, human factors experts, active pilots and investigators from the National Transport Safety Committee, from 28 to 29 August 2024. The data was collected by transcribing verbatim transcript, then analysed using the Steps for Coding and Theorization and Content Validity Index. model was developed, consisted of pilots' risk factors, divided into three themes, 16 sub-themes, grouped into internal and external factors, which can be identified by four activities and can be mitigated by three activities. The factors contributed to aviation safety are multifactorial and interrelated. The complexity of pilots' risk factors involves a continuous assessment of identification and mitigation, emphasizes the adaptive collaboration among stakeholders. A significant contribution in aviation human factors data for the Safety Management System implementation in Indonesia.

Keywords: aviation safety; identification and mitigation; pilot error; risk factors

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INTRODUCTION

Human errors have been known to be responsible for 70-80% of aviation accidents and serious incidents (Hooper et al. 2013; O'Connor 2008; Wang et al.2020) In regard to human errors, Li et al. 2000 stated that the contribution of human errors to accidents in aviation was mostly derived from pilot error, which accounts for 80% of accidents and 50% of serious incidents in the United States (Li et al. 2006; Li et al.2007). Pilots hold considerable value in aviation safety as they contribute notably in managing flight operational tasks. In analysing the human factors that contributed to aircraft accidents and serious incidents, specifically the risk factors to pilot error, it is essential to consider the multifactor interaction among human itself and technology, procedures and environment (ICAO Doc 9806. 2006; ICAO Doc 10151

2021). One of the models that has been widely implemented is the Human Factor Analysis and Classification System (HFACS). Wiegmann and Shapell developed the HFACS to identify the human factors that contribute to human error. The HFACS has been applied to understand the human factor elements associated with aircraft accidents and serious incidents. The HFACS is a structured and practical tool to classify human factors that contribute to accidents and serious incidents in aviation. The HFACS allows the identification of multiple contributory factors that generate failure in aviation accidents or incidents, not only by enumerating the human errors, but evaluating forward to the higher cognitive process which is the preconditions, then highlighting the supervisory deficiencies and the organizational factors (Tyavarnas et al. 2008; Wiegmann et al. 2003). Li et al., 2006 stated that safety commitment should start from the highest level, which is the organizational influences, then the commitment progresses linearly to the next level, unsafe supervision, precondition of unsafe acts, and the unsafe acts of the operator (Li et al. 2006).

According to the HFACS, the highest level, the Organizational Influences consist of Resource Management, Organizational Climate and Operational Process. The Third layer or the Unsafe Supervision comprises Inadequate Supervision, Planned Inappropriate Operation, Failed to Correct Problem, and Supervisory Violation. The next layer or the second layer is the Precondition of Unsafe Acts that encompasses the Physical Environment, Technological Environment, Adverse Mental State, Adverse Physiological State, Physical Mental Limitation, Crew Resource Management and Personal Readiness. The last layer or the first layer is the Unsafe Acts that involve Errors and Violation. Errors comprises Decision Error, Skill-based Errors and Perceptual Errors. While Violation comprises Routine and Exceptional Violation (Wiegmann et al. 2001; Wiegmann 2003).In identifying the human factors, specifically the risk factors to pilot error, it is important to understand the multifaceted contribution of human factors to errors, which is a cumulative interaction of psychological, physiological and psychosocial factors of human capabilities and limitations. The human interaction is complex and multifactorial that not only attributes by internal factors but also external factors. The internal risk factors is dominated by psychological and physiological attribution that includes cognitive function and medical condition. However, the external risk factors includes interaction of pilot with software, hardware and environment, that may be considered to be an indication of how the organization and its work climate influence pilots in decision making and even medical condition (Gaur et al. 2005).

Aviation safety, specifically in terms of pilot errors, is a major concern in Indonesia. Indonesia is an archipelagic country with a geographically strategic, allowing stakeholders in aviation, including regulator and operator to support 201 airports (33 of them are international airports), 61 commercial airlines, and 30 charter and commuter airlines. In addition, connectivity by air transport is highly active and important for our economic growth. For example, at Soekarno-Hatta International Airport in Cengkareng, the average number of aircraft activities is 80 aircraft movements per hour. Additionally, the National Transport Safety Committee (NTSC) recorded that human factors accounted for 66 out of 69 accidents and serious incidents investigation reports from 2014 to 2023 in Indonesia (PM 27 tahun 2017; PR-KNKT 1 Tahun 2023). Ultimately, the high air transport activities and the responsibilities for pilots to create an atmosphere of aviation safety in Indonesia, requires multisector collaboration between stakeholders that consisted of regulator, the Directorate General of Civil Aviation (DGCA); operators, which are airlines and pilots; and independent organization in investigation, the NTSC, specifically to implement human factor scientific based safety management system in Indonesia. This is a pilot study in developing a model to analyze the pilots' risk factors that contribute to aviation accidents and serious incidents, and how to identify and mitigate the risk factors to support aviation safety and implementation of

Safety Management System in Indonesia. The study aimed to analyze, identify and mitigate the pilots' risk factors to prevent accidents and serious incidents in Indonesia.

METHOD

Procedures

This was a qualitative analysis study, and data the was collected by conducting Focus Group Discussions that involved multiple expertise in aviation human factors. The Focus Group Discussion (FGD) was divided into four groups of expertise, that was held in two days with two sessions of discussion each day, from 28 to 29 August 2024. The inclusion criteria for each of the expert was having a magister educational degree and work experience in aviation safety, specifically in human factor for at least 3 years.

The first group was the Organization and Regulation, represented the regulator of aviation safety in Indonesia, consisted of six government officials in the DGCA. The second group was the Precondition and Human Factors, represented the medical condition and psychosocial interaction of human, consisted of four aviation medicine specialist doctor, two psychiatrist, and also two psychologist. The third group was the Aircraft Operation and pilot risk factor represented the aircraft operation challenges and benefit in human factor perspective from pilots, consisted of two pilot from Commercial operation, two pilots from Charter Commuter operation and one from General Aviation operation. Lastly, the fourth group was the Investigation group, represented the human factor investigation, consisted of three investigators from the National Transport Safety Committee of the Republic of Indonesia.

The discussion was held hybrid, provided the preference for participant to join the discussion offline at the Aviation Medical Centre or online trough virtual meeting platform. The discussion started with a presentation on the aims, the process of discussion, and the consent from each expert to participating in the discussion. The experts were asked to answer 5 questions and each word that was delivered in the discussion was typed in verbatim. The questions for the experts were: (1) what were the pilots' risk factors that could contributed to aviation accidents and serious incidents? (2) how to identify the risk factors? (3) what factor is the priority for mitigation measures in aviation safety? (4) how to mitigate the risk factors? (5) what is/are the most feasible measures to be taken in Indonesia for safety management system? The experts answered each question in turn and the discussion elaborated with further questions and answers until reaching a saturated discussion.

Analysis

Once all the discussions have been completed, the verbatim transcript and audio video recording were analysed by comparing the verbatim with the audio video recording then editing the verbatim transcript to have the exact transcribe as its recorded audio. This phase can be repeated for several times until finding the exact verbatim that matched the audio. The verbatim narratives then was analysed using the Steps for Coding and Theorization (SCAT) analysis, consisting of four coding steps by editing transcripts that have been segmented through the following (1) Focused on words in the transcript. (2) Find words outside the transcript that can be replaced with words in the transcript, (3) Words that explain the meaning in numbers 1 and 2 above, and (4) Categorizing into themes and constructs, including the process of writing the concept and theory that unites these themes and constructs (Otani et al. 2008). The analysis was completed by reviewing the theme and constructs from the beginning of the process to avoid overlapping theme and to finalized the established theme. The analysis also included the content validity that was applied by distributing the model from SCAT analysis to the experts who participated in the FGD. Then, each expert was asked to state the degree of relevance of each element to each factor. Content validity was analyzed using the Content Validity Index (CVI), which were the Items-Content

Validity Index (I-CVI) for items and Scale-Content Validity Index (S-CVI) for scales (Yusoff et al. 2019). Lastly, the last step in analyzing the FGD was to publish the result.

RESULT

The results of the qualitative analysis can be seen in Figure 1, the Model for identification, risk factors and mitigation strategies. The model starts from the identification measures. Identification measures of the contributing factors to aviation accidents and serious incidents in Indonesia is carried out through the function of both the regulatory and operatory bodies. The risk factors can be identified when the regulator and operator conducting their function, which consisted of four activities, which were providing an assistance, monitoring, administration, and investigation duties.

The activities for Identification measures consist of four activities. First, the assistance activities, could identify contributing factors through the activities of (1) verifying the submitted application for aircraft certification, training manuals and syllabus by flight schools; (2) delivering aviation safety and health promotion in a discussion or meeting; (3) analyzing pilots' medical condition for medical recertification or for a consultation between AME and pilot. Second activity is the monitoring activities, which can be performed internally that carries out by the management of airline, or externally that carries out by regulator, could identify the contributing factors through monitoring the documents of the operational flight activities. Third activity is the administration activities, which could identify the contributing factors through (1) developing regulation/ procedures in accordance with national and international law; (2) issuing the certification of airworthiness and air operation; (3) verifying documents for personnel licensing; (4) issuing the medical certificate; and (5) developing preflight check and proficiency check procedure. Lastly, the fourth activity in identification measures, is the investigation activities, which can identify contributing factors through interviews, and data analysis of the Voice Cockpit Recorder (VCR), and Flight Data Recorder (FDR).

The classification of the contributing risk factors of pilots that has been identified, were analyzed and classified into themes and sub-themes based on the SCAT analysis of verbatim transcripts. There are three themes that have been identified as the risk factors, consisted of organizational factors, supervision and preconditions which then, grouped into internal and external factors. Internal factors are factors or conditions that originate from the pilot as an individual, that also part of precondition factors. The precondition factors consist of three sub-themes in the internal factors and four sub-themes in the external factors, which are the psychological conditions, physical mental limitation, and habits that affect health. External factors are the psychosocial aspect or factors that originate from the pilot's interaction with his environment, his flight assignments, and interpersonal relationships with co-workers, management and his family. External factors include three themes, consisted of the organizational factors, supervision and preconditions. The precondition, as the imminent layer prior to error, divided into four sub-themes which are personal readiness, physiological condition/ fatigue, crew resource management, psychosocial/ well-being, environment and technology.

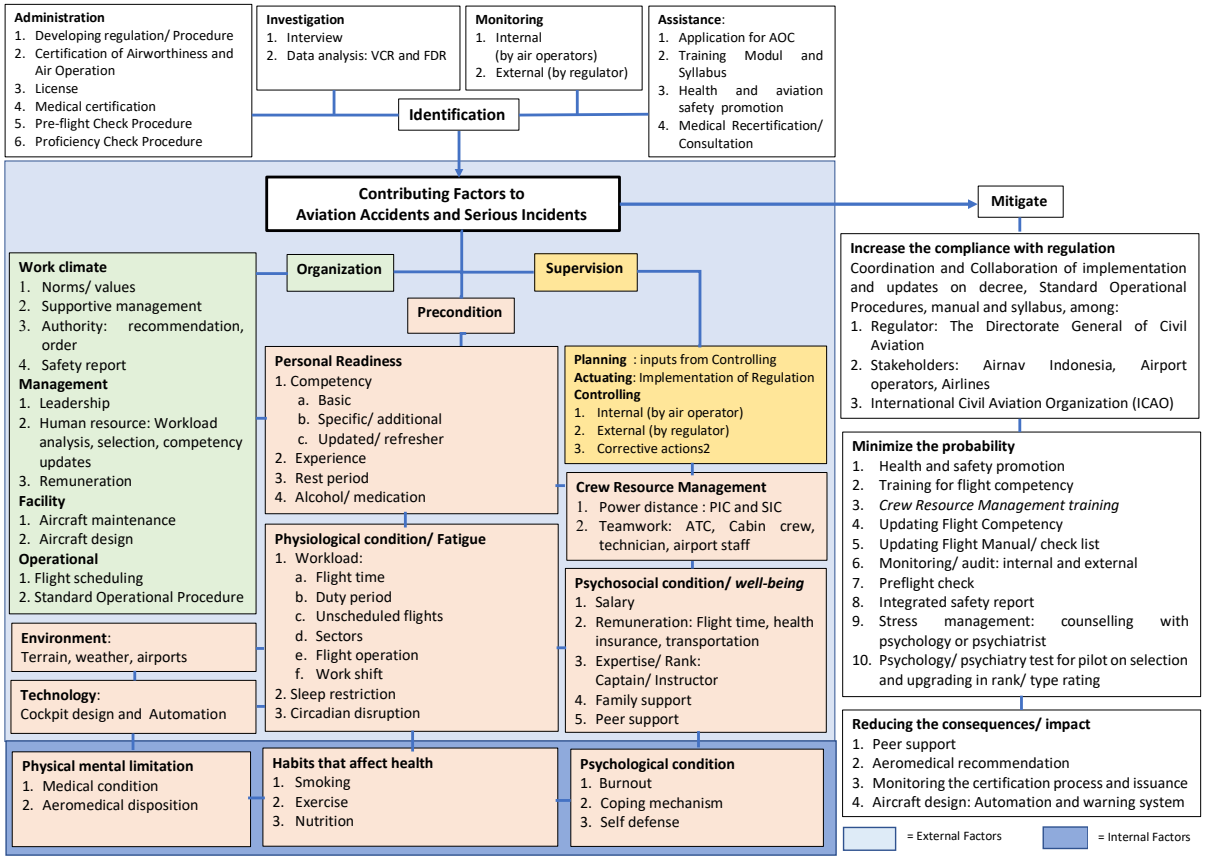

Figure I. Model of Identification and Mitigation of Pilots' Risk Factors in Indonesia

The priority for organizational factors is the management, because management is the driving power of work climate, and has responsibility to manage human resources, facilities, and finances. The priority for supervision factors is planning because it is the basis prior to implementation and supervision. In addition, supervision activities deliver a recommendation that could act as inputs for planning. The priority for internal precondition factors is medical conditions because medical conditions are basic need to carry out work and personal responsibilities. The priority for external precondition factors is fatigue because fatigue is a physiological condition that could compromises pilot performance, due to workload, sleep restriction, and circadian rhythms disruption. Each factor is interrelated with and influences by each other.

The factors that contributes to accidents and serious incidents need to be mitigated. The mitigation strategies are divided into three purposes, which were (1) to minimize the probability; (2) to reduce the consequences/ impact; or (3) to improve compliance with regulation. First, the mitigation strategies aimed to minimize the probability includes health and safety promotion, training, updating flight competency and flight manual/ checklist, monitoring/ audit, preflight check, integrated safety report, stress management and psychiatric/psychological counseling, and examinations during selection or promotion of human resource. Second, the mitigation that aimed to reduce the consequences/impacts can be achieved by peer support, aeromedical recommendation, improving aircraft design and monitoring for pilot medical condition. The third strategy in mitigation aimed to improve compliance in regulation, can be achieved by coordination and collaboration between stakeholders consisted of the regulator and operators, and the International Civil Aviation Regulation (ICAO).

The analysis of qualitative research results is carried out by assessing the validity and reliability of the data. The reliability is carried out by considering the credibility of the expert

educational background and expertise, persistence of observation while having discussion until all data were well saturated, and triangulation by cross checking the data for validity. The validity carried out by analyzing the content validity. Content validity is a process of assessing the degree of suitability of the elements with the construction of the instrument or whether the construction or selected factors are representative or relevant to the purpose of its implementation. The content validity was applied by distributing the theme and sub-theme in the figure 1. to the 22 experts who participated in the FGD. Then, each expert was asked to state the degree of relevance of each element to each factor (covering 56 items). Content validity was analyzed using the Content Validity Index (CVI), which were the Items-Content Validity Index (I-CVI) for items and the Scale-Content Validity Index (S-CVI) for scales. Table 1. showed the results of the CVI calculation for both items and scales. The minimum threshold value to achieve a good level of satisfaction for content validity of more than nine experts FGD is 0.78.

Table 1.
Content Validity

Content Validity Index	Value
I-CVI (*item-level content validity index*)	I-CVI = 0.91
S-CVI/Ave (*scale-level content validity index based on the average method*)	S-CVI/Ave = 0.99
S-CVI/UA (*scale-level content validity index based on the universal agreement method*)	S-CVI/UA = 0.80

DISCUSSION

Safety commitment should start from organization. Every organization create a work climate that holds the norms or values to be adopted. It is essential for organizations in aviation to emphasizes on aviation safety as their highest value, and it has to be supported by the management with its authority as the driving power of human resource. Management also responsible for delivering a model leadership for operational procedure, finance and managing assets for both facilities and human resource. The climate that is create in the organization should encourage safety report to be the responsibility of all employee as a unity. In terms of aviation safety, it is essential to consider how each risk factor influences safety outcomes. Based on the context of aviation safety principles, organizational culture or work climate has the highest contribution to accidents and incidents in Indonesian aviation due to its profound impact on all aspects of safety, from communication to decision-making. Then, managerial support is instrumental in shaping and reinforcing a positive safety culture. Addressing these factors is essential for improving safety outcomes in Indonesian aviation. Not only the organization and its safety culture, supervision has a crucial role due to its relevant in supervising the implementation of regulation. Even a single deviation in the implementation might requires a strong recommendation for corrective action and it should be regarded as the input for planning of the future supervision. Thus, the activities of supervision run synchronously. The responsibility of supervision not only lies within the regulator, but has shared responsibility within the operators, as their internal monitoring.

Managing the assets of organization and supervision in aviation should place safety as their core responsibility. The modifying factors in aviation safety is human, especially pilots due to their role in controlling the operation of aircraft. Thus, it is a valuable to understand the risk factors of pilots that could compromises their performance in aviation safety. In addition, the ICAO strongly recommended each of contracting state, including Indonesia, to adopt the human factor in implementing the Safety Management System (SMS). In this research, the modifying risk factors of pilots are the preconditions that the pilot might be exposed to and contributed to their performance.The preconditions do not stand on their own but interrelated with other risk factors in the preconditions and also in the organization and supervision

factors. For example, an organization of airline deliver a schedule for pilots without considering the flight and duty time limitation, and knowing this, the pilots might feel reluctant to submit a safety report on this matter in to their system. The pilot's decision of not reporting the safety issue as part of their responsibility in SMS, might because of pilots have the perception that organization does not support aviation safety as part of their work climate. Reporting for any misconduct in aviation safety is challenging and regrettably might not be regarded as safety concern, on contrary, regarded as being not capable for flight du ty. This condition could lead to the physiological precondition or fatigue and if the condition goes in chronic state, could compromises the psychological condition, which is burnout (Helmreich et al. 2010; Keebler et al. 2023). Without good coping mechanism or peer support, the condition could force pilots into developing habits that could affect health such as smoking and drinking alcohol, which may cause physical mental limitation. Chronic stress could cause metabolic syndrome, that progressively causes cardiovascular disease, neurological disease or adverse mental state such as mood disorder, anxiety and depression (Rezaimenesh et al 2024; Wang et al. 2021). Thus, each risk factor in the precondition interrelated and affect one another continuously like a cycle.

Other than the above condition, an organization that has lack of compliance in operational procedure and workload analysis, might have less attention on the number of pilots and the training requirement for pilots' competency to meet the operation necessity. In addition, if the organization does not have a thorough supervision on training and workload analysis, this condition could compromise the pilots' competency and Crew Resource Management (CRM). Without managerial and peer support, pilots might have the perception that aviation safety is not a priority for the organization. The preconditions of pilots have their direct and indirect impact on pilot performance, decision-making, and overall aviation safety. While, technology primarily serving as a safeguard rather than a risk factor. As part of Safety Management System, the mitigation program in Indonesia, requires to adapt these procedures to the unique challenges of the region, enhancements in CRM, fatigue management, weather awareness, and the integration of advanced technology into training that are crucial for further improving safety. By continuously refining these procedures and fostering a strong safety culture, the aviation industry in Indonesia can effectively reduce the risk of accidents and incidents.

CONCLUSION

In Indonesia, the factors contributed to aviation accidents and serious incidents are multifactorial, interrelated to and affected by one and or the other. It is crucial to identify the factors with the collaboration among the stakeholders, including the regulator, the DGCA, and the operators including the National Transport Safety Committee, the airlines and pilots. The complexity of pilots' risk factors involves a continuous assessment of identification and mitigation strategies and emphasizes the need for effective collaboration among stakeholders.

REFERENCES

Hooper BJ, O'Hare DPA. Exploring Human Error in Military Aviation Flight Safety Events Using Post-Incident Classification Systems. Aviation, Space, and Environmental Medicine. 2013 Aug 1;84(8):803–13.

International Civil Aviation Organization. International Civil Aviation Organization Document 10151. manual on Human Performance (HP) for regulators. First edition (Advanced unedited), 2021. International Civil Aviation Organization; 2021.

Joseph R. Keebler, Elizabeth H. Lazzara, Katherine A. Wilson, Elizabeth L. Blickensderfer. Human factors in aviation and aerospace. Third edition. United Kingdom: Academic Press, an imprint of Elsevier; 2023.

Kementerian Perhubungan. Peraturan Keselamatan Penerbangan Sipil bagian 830 Nomor PM 74 Tahun 2017 tentang Civil Aviation safety Regulation part 830 tentang prosedur investigasi kecelakaan dan kejadian serius pesawat udara sipil. 2017.

Komite Nasional Keselamatan Transportasi. Peraturan Ketua Nomor PR-KNKT 1 tahun 2023 tentang Panduan Manual Kebijakan dan Prosedur Komite Nasional Keselamatan Transportasi. 2023.

Muhamad Saiful Bahri Yusoff. ABC of Content Validation and Content Validity Index Calculation. Malaysian Association of Education in Medicine and Health Sciences. 2019 Jun 28;Volume 11 Issue 2 2019.

Rezaeimanesh N, Abbasi Kasbi N, Saeedi R, Sahraian MA, Razeghi Jahromi S, Naser Moghadasi A. Investigating the Correlation Between Cognitive Function and Fasting Blood Sugar, Fasting Insulin Level and Insulin Sensitivity in Patients With Multiple Sclerosis. Endocrinol Diabetes Metab. 2024 Oct 7;7(6):e70006.

Wang X, Ji L, Tang Z, Ding G, Chen X, Lv J, et al. The association of metabolic syndrome and cognitive impairment in Jidong of China: a cross-sectional study. BMC Endocr Disord. 2021

Wang Z, Lu Y, Fu S. A Multidimensional Method for Pilot Workload Assessment and Diagnosis. Aviation, Space, and Environmental Medicine. 2020 Dec 1;91(12):932–9.