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Aircraft Age Limitation versus Three Indonesian Fatal Air Accidents in HFCAS Perspective

Aloysius Sigit Haryono[1], Hadi Sutanto[2]

[1]Program Studi Program Profesi Insinyur, Fakultas Teknik, Universitas Katolik Indonesia Atma Jaya, Indonesia
[2]Program Studi Magister Teknik Mesin, Fakultas Teknik, Universitas Katolik Indonesia Atma Jaya, Indonesia

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Abstract

An aircraft deemed to be airworthy, not limited by aircraft age but by well maintenance and by the operation of the aircraft. The investigation by KNKT between 2014 -2021 found no statement related of aircraft aging like material fatique or other phrases. The latent errors started with repetitive failures which were not solved as early as possible. Three fatal accidents involved aircrafts with age of 27, 6 and 1 year old, all below the Minister Regulation No. 160 (2015) which stated maximum age was 30 years. The cancelation of Minister Regulation No. 027 (2020) is the correct decision from Indonesian Government as per other countries policy in term of aircraft airworthy not affected by aircraft aging. The cancelation empowers the technology innovation for old aircraft to be remanufactured which is common practise in other countries, latest technology innovation, safe operation, sustainability by reserving raw material of natural resources from scarcity. Incosistency regulations about aircraft age limit which operated since beginning in Indonesian airspace, showed that the regulations were made not based on academic or research approach.

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Abstrak

Suatu pesawat yang layak terbang bukan dibatasi oleh usia pesawat, melainkan oleh perawatan dan cara pengoperasian. Investigasi kecelakaan fatal yang dilakukan KNKT antara tahun 2014- 2021 tidak menemukan pernyataan terkait penuaan pesawat seperti *material fatique* atau ungkapan lainnya. Kesalahan laten dimulai dengan kegagalan berulang yang tidak terselesaikan sedini mungkin. Tiga kecelakaan fatal tersebut terdiri dari usia pesawat dengan usia tertua 27 tahun, 6 tahun, dan 1 tahun, semuanya di bawah Peraturan Menteri Nomor 160 Tahun 2015 yang menyatakan usia maksimal 30 tahun. Pembatalan Peraturan Menteri Nomor 027 Tahun 2020 ini merupakan keputusan yang tepat dari Pemerintah Indonesia sesuai dengan kebijakan negara lain bahwa kelaikan terbang pesawat tidak terpengaruh oleh usia pesawat. Pembatalan tersebut juga memberdayakan inovasi teknologi pesawat tua untuk diproduksi ulang yang juga merupakan praktik umum di negara lain, inovasi teknologi terkini, pengoperasian yang aman, berkelanjutan dengan menjaga bahan baku sumber daya alam dari kelangkaan. Ketidakkonsistenan peraturan batas usia pesawat yang pertama kali beroperasi di wilayah udara Indonesia menunjukkan bahwa peraturan tersebut dibuat tidak didasarkan pendekatan akademis atau penelitian.

*Corresponding author: Aloysius Sigit Haryono
Email address: aloysius.202304070621@student.atmajaya.ac.id

1. INTRODUCTION

1.1 Regulation

Transport Minister Regulation of Indonesia No. 160 of 2015, about fleet rejuvenation in comercial air transport aircraft. The regulation considerations are to improve safety and comfort in air transportation as well as maintaining environmental sustainability. Chapter two stated, transport and normal category aircraft or commuter for passenger transport which is registered and operated for the first time in the territory of the Republic of Indonesia, the maximum age limitation is ten years. For cargo only aircraft or freighter category is fiften years old. Meanwhile all these categories which are operating in the territory of the Republic of Indonesia, limited maximum thirty years old, as stated in chapter three (Transport Minister Regulation of Indonesia, 2015). Afterwards regulation, Transport Minister Regulation of Indonesia No. 07 of 2016, revised the preceeding regulation became 25 years for cargo only aircraft or freighter category to register and operate in the first time in the territory of the Republic of Indonesia (Transport Minister Regulation of Indonesia, 2016a). Transport Minister Regulation of Indonesia No. 155 of 2016 canceled the previous regulations No. 160 and No. 07. And as stated in chapter three, aircraft which is registered and operated for the first time in the territory of the Republic of Indonesia the maximum age limitation is fiften years for transport category, twenty years for non transport category, thirty years for cargo aircraft, and twenty years for helicopter. And the aircrafts which are operating in the territory of the Republic of Indonesia, limited maximum 35 years old for transport category, and 45 years old for non transport, cargo and helicopter as stated in chapter five (Transport Minister Regulation of Indonesia, 2016b). In 2020, there was Transport Minister Regulation of Indonesia No. 27 of 2020 which canceled regulation No. 155 of 2016, and then aircraft age limitation no longer regulated (Transport Minister Regulation of Indonesia, 2020).

1.2 HFACS

Reason (1990) introduced Human Factor framework, shown in Figure 1, known as “Swiss Cheese” Model. The last defence layer is unsafe act where active failures located, in the past air accidents investigation primary targeted this layer and commonly called pilot’s errors. It can be understood by looking this concept that mishaps happened when four layers of defences fail to block the failure making straight line penetrating all layer’s result in incidents or accidents. The unsafe act layer is where the pilots are doing the flying activities and can contribute direct to accident. But as this is the last layer pilots also be able to prevent accident or incident happened by understanding, identifying and then action blocking it. HFACS Framework as shown Figure 2 (Shappell and Weigmann, 2003) developed and defining the “holes” or absent of defenses in the “Swiss Cheese” Model (Reason, 1990) and ideally used by investigators to analyze human factor accidents framework. In this study will analyze the three fatal accidents that happened in Indonesia between 2014 until 2020.

Level 1 Unsafe Acts:

- *Decision error* is "Thinking" errors came from consciousness, goal oriented behavioral mistake, misuse, and misinterpretation relevant information. Poor execution of procedures and choices e.g., inappropriate maneuvers or procedure, systems & procedures inadequate knowledge, exceeded ability, wrong response to emergency.
- *Skill-based error* is practice behavior that occurs with little or no consciousness, a mistake due to a complacent approach instigation. In examples such as inadvertent switches activation, omitted checklist item breakdown visual scan, inadvertent flight control uses

poor technique, airmanship, over controlled of flight, too reliance on automation, prioritize attention failure, overload task, negative habit, distraction, see & avoid failure.

- *Perceptual Error* is when sensory input is degraded, resulting in inaccurate or incorrect action being implemented. In examples such as night flying, poor weather, visually impoverished environment visual illusion, spatial disorientation, vertigo misjudge distance, airspeed, altitude, clearance.
- *Violations* consists of:
  a) Routine Violation "Bending the Rules" can be a habit in nature and are often facilitated by management structure, that accepts these violations to complete a task effectively. In examples such as inadequate flight briefing, unauthorized approach violation training rule, follow ATC radar, SOP, Manual violation orders or regulations.
  b) Exceptional Violation "Breaking the Rules" is an isolated departure from authority neither, typical of the individual or condoned by management. In examples such as unauthorized maneuver, improper take off technique fails doing aircraft performance computation, exceed aircraft limit, accept unnecessary hazard not current or qualified, below regulated altitude.

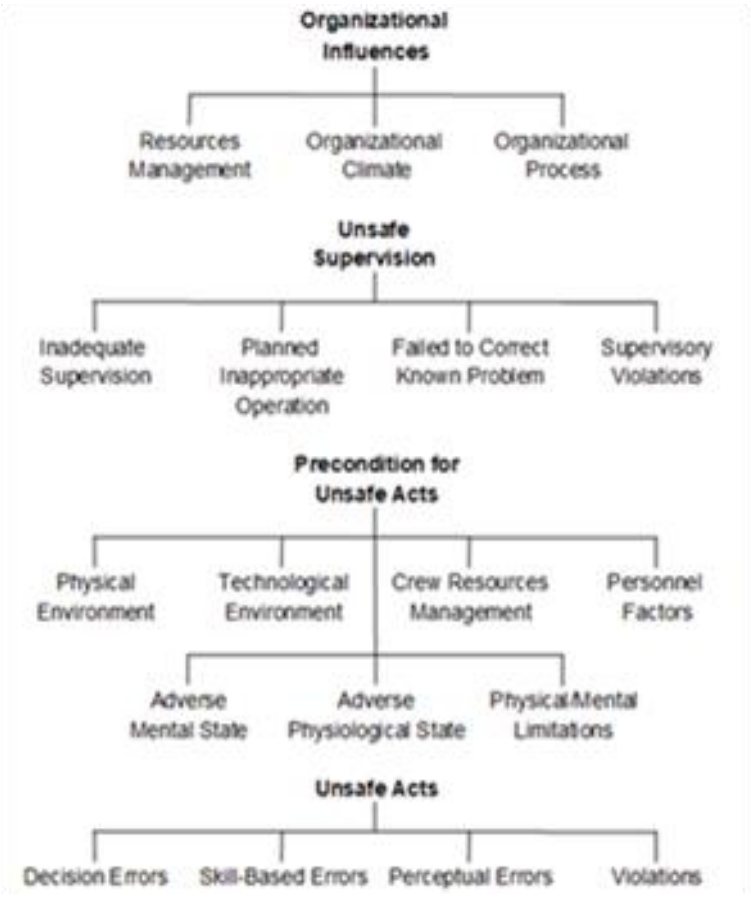

Figure 2.
HFACS Framework (Source: Shappell and Weigmann, 2003)

Level 2. Preconditions of Unsafe Acts:

- Technological Environments categorizes a wide variety of technological issues.
  In examples such as equipment/controls design, automation, checklist display/interface characteristics, task factors.

- Physical Environment categorizes the physical operation setting & ambient environment. In examples such as weather, altitude, terrain & lighting, vibration, heat, toxins.
- Adverse Mental States of acute psychological and/or mental condition, that negatively affect performance. In examples such as mental fatigue, pernicious attitudes, misplaced motivation, stress, overconfidence, loss situational awareness, task saturation, poor flight vigilance, drowsiness, get-home-itis, distraction, channelized attention, and circadian dysrhythmia.
- Adverse Physiological acute medical and/or physiological condition that inhibit safe operation. In examples such as illness, intoxication, motion sickness hypoxia, fatigue, effects of Over the Counter (OTC) medications.
- Physical/Mental Limitation categorized as permanent physical/mental disability that negatively impacts on operational performance. In examples such as vision, strength, intelligence, mental aptitude, general knowledge, chronic mental illness, insufficient reaction time, information overload, inadequate experience for situation complexity.
- Crew Resources Management (CRM) includes a variety of communication, coordination, and teamwork issues that impact performance. In examples such as lack of teamwork, lack of assertiveness, poor communication/coordination pilots/ATC, lack of leadership, lack of adequate briefing, misinterpretation of traffics calls.
- Personal Readiness consideration of off-duty activities that are required to operate effectively. In examples such as sufficient rest, alcohol restriction, poor dietary practise, poor risk judgement, self-medicating, overexertion, inadequate training.

Level 3. Unsafe Supervision

- Inadequate Supervision inappropriate oversight and supervision of personnel and resources. In examples such as training, professional guidance, leadership, current publication, tech data, procedure, accountability lack, perceive authority lack, track performance failure, operational doctrine failure, over-task or untrained supervisor, track qualification, loss of supervisory situational awareness.
- Planned Inappropriate Operation task assignment of known inappropriate operational issues. In examples crew pairing, risk assessment, not adequate crew rest, over workload.
- Failed to Correct Known Problems classified as such when problematic issues are known to management and fail to act accordingly. In examples such as fail to correct inappropriate behaviour, fail to identify risk behaviour & correct safety hazard, fail to initiate corrective action, fail to report unsafe tendencies.
- Supervisory Violations the wilful disregard of procedures, regulation, and policy by management. In examples such as assigned unqualified crews, fraud docs, inadequate docs, violated procedures, fail enforcing rules and regulation, authorized unnecessary hazard.

Level 4. Organizational Influences

- Organizational Climate is viewed as the overall organizational atmosphere regarding culture, policy, & strategic direction. In examples such as Structure (chain of command, communication, supervisor accessibility or visibility, authority delegation, formal accountability of actions); Policies (promotion, hiring, firing, retention, drugs, alcohol, accident investigation); Culture (norms, rules, customs, values, beliefs, attitudes).
- Operational Process categorized as the procedures that are conducted by management to achieve the desired. In examples such as Operation (operational tempo, incentives, quotas, time pressure, schedule); Procedures (performance standards, clearly defined objectives, procedures/instructions about procedure); Oversight (safety program, risk

management program, monitoring & checking of resources, climate, safe work environment ensuring process).

Resources Management, management of assets along with personnel and financial issues to achieve the organization output goal. It can be such as Monetary/Budget Resources (excessive cost cut, lack of funding); Equipment/Facility/Resources (poor aircraft design, buying unsuitable equipment, fail to correct known design flaws).

1.3 Fatal aircraft accidents in Indonesia since 2014

Air Asia Indonesia, Airbus 320-216 Registration PK-AXC, December 28 of 2014.

An Airbus 320-216, Serial Number (SN) 3648, Year of Manufacture (YOM) in 2008 (six years old aeroplane) registration PK-AXC, was airworthy aircraft, operated by Indonesia Air Asia bound for Changi Airport of Singapore from Juanda Airport of Surabaya Indonesia. The flight cruising altitude was 32,000 feet on route M635, with weather partly Cumulus Nimbus (CB) from 14,000 feet till 44,000 feet but not affecting the flight route. Total persons on board were 162 persons, including the six crews with a very experienced Indonesian captain having 20,537 total hours and 4,687 on type hours acting as Pilot Monitoring (PM) . A French pilot with 2,247 total hours and 1,367 on type hours was the co-pilot and acting as the Pilot Flying (PF). The flight had four master cautions triggered by failure of rudder transfer limiter, showing message on Electronic Centralized Aircraft Monitoring (ECAM) "AUTO FLT RUD TRV LIM SYS". The first three messages, crews performed ECAM procedure and solved the problems. The fourth message crews performed a different procedure by pulling the Flight Augmentation Control (FAC) Circuit Breaker (CB) resulted the fifth and sixth message appeared on ECAM "AUTO FLT FAC 1 FAULT' and "AUTO FLT FAC 1+2 FAULT". Following the FAC faults, the auto-thrust and autopilot disengaged, and flight control referred to Alternate Law from Normal Law and lost several protections. The aircraft's rudder deflecting 2^{o} left and rolling 54^{o} angle of bank, then entered a prolonged stall and upset condition, which was beyond the capability of pilots to recover. The plane plunged into Karimata Strait and killed all persons on board (KNKT, 2014).

Lion Air, Boeing 737-8(Max) Registration PK-LQP, October 29 of 2018.

A Boeing 737-8(MAX), Serial Number (SN) 43000, Year of Manufacture (YOM) in 2018 (one year old aeroplane) registration PK-LQP, the plane experienced in previous flight Indicated Airspeed (IAS) Disagree, ALT (Altimeter) Disagree, FEEL DIFF PRESS illuminated, unreported stabilizer Runaway, unreported Activation STAB TRIM CUTOUT switches operation, and unreported stick shaker condition during takeoff and inflight, by previous pilots. Flight LNI610 bound for Depati Amir, Pangkal Pinang from Soekarno Hatta Airport of Jakarta. The intended flight cruising altitude was 27,000 feet, with good weather. Total persons on board were 189 persons, including the seven crews with a 31-year-old Indian captain having 6,028 total hours and 5,176 on type hours acting as Pilot Flying (PF). A 41-year-old Indonesian pilot having 5,174 total hours and 4,286 on type hours was the co-pilot and acting as the Pilot Monitoring (PM). The aircraft impacted the water in Tanjung Karang, Karawang West Java (KNKT, 2018).

Sriwijaya Air, Boeing 737-524 Registration PK-CLC, January 9 of 2021.

A Boeing 737-524, Serial Number (SN) 27323, Year of Manufacture (YOM) May 21 of 1994 (27-year-old aeroplane). The aircraft reported 65 times since 2013 having

> Autothrottle (A/T) problems, and during climbed right thrust level unable to move in climb thrust. Flight SJY182 bound for Supadio Airport, Pontianak from Soekarno Hatta Airport cleared by ATC to cruise 29,000 feet, with good weather. Total persons on board were 62 including 6 crews. The captain 54-year-old Indonesian pilot having 17,904 total hours with 9,023 hours on type as Pilot Flying (PF), and 34-year-old Indonesian pilot with 5,107 total hours and 4,957 hours on type. Due to Autothrottle (A/T) problem the aircraft was uncontrollable and entered upset condition and plunged into water in Kepulauan Seribu district, Jakarta (KNKT, 2021).

Transport Minister Regulation No. 160, No. 07, No. 155 to regulate the age of aircraft to be registered and operated first time then operating in Indonesian Airspace, with one of the reason is to improve safety in air transport. A couple months before the year of regulation implementation No. 160 in 2015, catastrophic air accident of Airbus 320-200 PK-AXC, Air Asia Indonesia Flight QZ-8501 plunged into the Karimata Strait, in December 28, 2014. Boeing 737-8 (Max) PK-LQP, Lion Air Flight LNI 610 was also crashed with fatal accidents in October 29, 2018 in the era of regulation implementation No.155 from 2016 until 2020 before the regulation canceled. Even after all these three regulations were canceled by regulation No. 027 in 2020, in January 9, 2021 Boeing 737-500 PK-CLC, Sriwijaya Air Flight SJY182 also experienced fatal air accident. These three flights which considered operating new young age aircraft relatively, registered and operated firstly less than fiften years old and operating under thirty years in Indonesian territory, and still experienced fatal accidents. The paper purpose is to find relation if any, between aircraft age and air accidents when the plane is considered airworthy, using the Human Factor Analysis and Classification System (HFACS) perspective as one of the method to analyze aircraft accidents.

2. RESEARCH METHODOLOGY

The secondary data used in this analysis were taken from NTSC's incidents/accidents investigation report, focusing on fatal accidents which happened between 2014 until 2021. These reports are available on the National Transport Safety Committee (NTSC) website (http://knkt.dephub.go.id/knkt/ntsc_aviation/aaic.htm). Structuring by study literature, the data investigation report of NTSC's findings using HFACS framework. The author who has 32 years flying experience as pilot in line, training, management, and similar research, structured the data in the framework of HFACS to understand the fatal accidents findings by NTSC caused by aircraft aging, as per Minister Regulations No. 160 (2015), No. 07 (2016), and No. 155 (2016) stated, or some other reasons.

3. RESULTS AND DISCUSSION

NTSC's finding data fatal accidents analyzed then structured using the HFACS framework and divided into IV Layer, III Layer, II Layer and I layer.

Air Asia Indonesia, Airbus 320-216.

There are 54 findings from operation, maintenance, and other findings also five contributing factors stated by NTSC.

Layer IV "Organizational Influence":

Operational Process,

Directorate General of Civil Aviation (DGCA) audit process didn't identify for no-Upset Recovery Training (UPRT) and maintenance process for trouble shoot the tech faults, no clear procedure of repetitive defects in maintenance department.

Layer III "Unsafe Supervision":

Failure to correct known problems,

23 events Rudder Travel Limiter Unit (RTLU) problems since January 2014 untill December 27 didn't solve completely only resetting the Circuit Breaker (CB) on ground, solder of Channel A and B Computers resulting loss of electrical continuity the led to RTLU failures.

Inadequate Supervision,

No-UPRT Training of the crews.

Layer II "Precondition of Unsafe Act":

Environmental Factor,

Technology: when FAC CB tripped out losing normal law fly by wire control to alternate law and stall protection.

Personal Factor, Crew Resources Management (CRM):

Both left and right sidesticks input continuously active, no command "I HAVE CONTROL", non-standard call out "PULL DOWN" instead standard call "PITCH" "PITCH".

Layer I "Unsafe Act":

Skill Based Error

Co-pilot unable to do stall recovery.

Decision Error,

Resetting FAC2 CB inflight by pilot based on witnessing of engineer trouble shoot on the ground.

Exceptional Violation,

Leaving pilot seat and resetting Flight Augmented Computer (FAC)2 CB which located behind co-pilot seat on fourth RTLU failure.

Perceptual Error,

Co-pilot experienced spatial disorientation even though entering stall kept pulling his sidestick 24^o until 48^o up conversely the captain pushing his sidestick down.

Lion Air, Boeing 737-8(Max).

89 findings and nine contributing factors found by NTSC in the final investigation report.

Layer IV "Organizational Influence":

Organizational Climate,

Boeing policy didn't give information about installing the MCAS due to assumption of common technology and already complied with Federal Aviation Administration (FAA) guidance.

Operational Process,

The definition of an aircraft repetitive problem was different between Lion Air CMM and BAT AMOQSM.

Resources Management,

Equipment, Mis-designed MCAS by Boeing, 100 pounds in column forces if maximum failure faced instead of 75 pounds.

Layer III "Unsafe Supervision":

Supervisory Violation,

Boeing didn't submit the required documentation to FAA, and the FAA flight control systems specialists were not aware of the design change.

LNI043 pilots didn't write the details failure in the tech log as stated in company manual but only the WARNING MSG.

Previous MCAS activations or Flight Control failures were considered serious incidents but were not written in hazard reports and weren't investigated by Safety Dept and NTSC.

Failure to correct known problems/failures,

IAS DISAGREE, ALT DISAGREE on the PFDs, and Feel Differential Pressure light, stick shaker during takeoff happened in previous sectors before the accident.

At Denpasar, engineers replaced the Angle of Attack (AOA) sensor, but the problem still existed.

Layer II "Precondition of Unsafe Act":

Environmental Factors,

Technology Maneuvering Characteristics Augmentation System (MCAS) mis-designed by Boeing, Functional Hazard Analysis (FHA) and actual behavior was not the same as the design in failure condition.

Personal Factor-Crew Resources Management (CRM),

Previous pilots on LNI043 experienced the same failure, but the issues weren't shared to accident's pilots.

The absence of PAN 3X or MAYDAY 3X declaration from pilots, both accident pilots preoccupied with their individual tasks no optimum teamwork.

Layer I "Unsafe Act":

Skill Based Error,

Inability of the co-pilot to perform memory items action and Non-Normal Checklist (NNC) in timely manner of the WARNING MSG.

Sriwijaya Air, Boeing 737-524.

There are 64 findings and six contributing factors found by NTSC in the final investigation report of this accident.

Layer IV "Organizational Influence":

Organizational Climate,

No detail training requirement included for prevention of an upset condition Nationally in Civil Aviation Safety regulation (CASR) or other DGCA publications described; Not effective Safety Management System (SMS) implemented only average data of 28.1% (majority by ground personal) from The Flight Data Analysis Program (FDAP) established by the Sriwijaya Air retrieved, Quick Access Recorder (QAR) data unable to be analyzed as it did not have the correct data frame file and in the period of Oct to Dec 2019 no QAR data retrieved due to lack of human resources and equipment).

Layer III "Unsafe Supervision":

Inadequate Supervisions (No detail UPRT training given to pilots every 24 months); Failure to correct known problems (Since 2013, 65 A/T failures and 69 A/P failures have been reported and recorded); Supervisory Violation (Sriwijaya Air did not ask for a NTO (No Technical Objection) from the aircraft manufacturer nor was the DGCA consulted for the modification from Boeing 737 QRH required the PM to call out attitude, airspeed and altitude throughout the recovery into callout "upset brown" then "May Day 3x, SJY___ Upset").

Layer II "Precondition of Unsafe Act":

Environmental Factor-Technology,

Changed the A/P mode into V/S and HDG SEL because of weather condition resulted Autothrottle (A/T) changed from N1 to MCP SPD then the power reducing, but right engine remained fixed (tough friction on mechanical system) and left engine reduced continuously; even the aircraft complied with FAA Airworthiness Directive (AD) 2000-23- 34 to address asymmetric thrust events when the flight spoiler deflects greater than 2.5° for a minimum of 1.5 seconds., by the incorporation of the Cruise Thrust Split Monitor (CTSM) but it was fail.

Adverse of Mental State,

Loss of Situational Awareness due to fixation of Autopilot (A/P) complacency.

Personal Factors-Crew Resources Management (CRM),

Due to fixation of A/P complacency, failures to do effective communication, teamwork, and coordination between pilots and ATC.

Layer I "Unsafe Act":

Skill Based Error, both pilots experienced fixation (A/P complacency) with conditions of thrust asymmetric, aircraft rolling, turning, and descending no action taken, the plane entered into upset with no proper recovery by pilots.

4. CONCLUSION

An aircraft when deemed to be airworthy, is not limited by age of firstly the aircraft manufactured but how it is maintained well and comply on the Service Buletin (SB) and Airworthiness Directive (AD) and how the aircraft is operated. In this paper the conclusion are:

- NTSC findings which grouped and structured into HFACS analysis, no finding found related in aircraft aging with statements like material fatigue or other phrases.
- The latent errors started with repetitive failures which didn't solve earliest possible.
- These three fatal accidents between 2014 until 2021 consist aircrafts age with the oldest one 27 years old, 6 years old, and less than one year old, all below the Minister Regulation No. 160 Year 2015 which maximum was thirty years old.
- The cancelation of Minister Regulation stated in No. 027 (2020) is a correct decision from Indonesian Government, in term of aircraft airworthy not affected by aircraft age.
- The cancelation also empowering the technology innovation for old aircraft to be remanufactured which is common practise as well in other countries, innovation which still adapting latest technology, safe operation, sustainable by reserving the raw material of natural resources from scarcity.
- The inconsistency regulations about aircraft age limit, Minister Regulation No. 160 (2015), No. 07 (2016), No. 155 (2016) showed that the regulations were made and not based on academic or research approach.
- The future regulation should incorporate in the area of technology implementation such as: Automatic Dependant Surveliance Contract (ADS-C), Required Navigation Performance (RNP), Low Carbon Emission Engine, Electric Aircaft, and etc.
- The paper didn't analyze the area for the regulation which probably due to operators' competition and regulation industrialization to monopolize the industri from a strong player operator.

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