Journal of Public Transportation Community
Vol. 6 No. 1, April 2026, pp. 38-50
Online: https://ejournal.poltekbangsby.ac.id/index.php/jptc/about
e-ISSN :2808-3393

Analysis Of The Malfunction And Handling Of Flap Stuck On A Cessna 172s Trainer Aircraft

Iswahyudi[1], Muhammad Akbar Ansor[2], Ajeng Wulansari[3], Aydin Anar Babayev[4]
[1]Batam Aero Teknik, Indonesia
[2]Politeknik Penerbangan Surabaya, Indonesia
[3]Politeknik Penerbangan Surabaya, Indonesia
[4]Beijing Institute of Technology,China
Correspondence author: Ajeng Wulansari,ajengwulansari89@gmail.com, Indonesia

Abstract

The flap is a secondary flight control component that assists the primary flight control by increasing the aircraft's lift at low speed, so its reliability must be maintained to avoid compromising flight training safety. During the study period, a Cessna 172S trainer aircraft registered PK-BYJ was reported to experience a malfunction on both flaps, which failed to move during ground run up, potentially affecting the performance of the flight control surfaces. This article aims to analyze the cause of the malfunction and document the repair process. The method used was field observation and systematic troubleshooting referring to the Cessna 172S Aircraft Maintenance Manual (AMM) Chapter 27, consisting of disassembly, inspection, servicing, reassembly, and functional test stages. The disassembly and inspection results on the flap motor showed that the component had malfunctioned and could no longer drive both flaps despite receiving an appropriate electrical supply. The repair was carried out by replacing the flap motor in accordance with AMM Chapter 27 procedures, followed by reassembly and a functional test that showed both flaps could move normally again, so the aircraft was declared airworthy for flight training operations. This case study emphasizes the importance of compliance with AMM procedures and technician competence in diagnosing electromechanical component failures in flight control systems to maintain the reliability and operational safety of trainer aircraft.

Keywords: flap stuck, flap motor, secondary flight control, Aircraft Maintenance Manual, Cessna 172S

Article History:
Received: 25 December 2025 ; Reviewed : 9 January 2026; Accepted: 4 February 2026; Published : 1 April 2026
DOI: 10.46491/jptc.v6i1.2851
How to cite : Iswahyudi, Ansor, M. A., Wulansari, A., & Babayev, A. A. (2026). Analysis of the Malfunction and Handling of Flap Stuck on a Cessna 172S Trainer Aircraft. *Journal of Public Transportation Community*, 6(1), 38–50. https://doi.org/10.46491/jptc.v6i1.2851

© 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution Share Alike (CC BY-SA) license (**https://creativecommons.org/licenses/by-sa/4.0/**)

Introduction

Aircraft operational safety is a primary aspect that every Approved Maintenance Organization (AMO) is required to uphold, as regulated under the provisions of the International Civil Aviation Organization (ICAO), which have

been adopted into the national airworthiness system (Candra Susanto & Keke, 2019). One system that determines flight safety is the flight control system, which functions to control the aircraft during flight phases. This system is divided into three groups: primary flight control, comprising the aileron, elevator, and rudder; secondary flight control, comprising the flap, spoiler, and tab, which assist the performance of the primary flight control; and auxiliary flight control, comprising the speed brake and slat.

The flap is one of the secondary flight control components mounted on the wing's trailing edge, functioning to increase the aircraft's lift at low speed, particularly during the takeoff and landing phases. On trainer aircraft such as the Cessna 172S, the flap is driven electromechanically by a flap motor connected to a transmission mechanism leading to both wings. The reliability of the flap motor as an electromechanical actuator (EMA) is critical, given that a failure in an EMA component can directly affect the performance of the flight control surfaces, making the application of fault diagnosis, prognosis, and health management a key element of condition-based maintenance for this system (Yin et al., 2022). Research on model-based condition-monitoring algorithms for flight-control electromechanical actuators with fault-tolerant architecture shows that characterizing failure transients in both the motor and the transmission mechanism is an important basis for designing early-detection strategies before a component truly fails (Di Rito et al., 2021), while the development of sensorless motor-control strategies is also a direction of development for aviation electromechanical actuators, aimed at reducing hardware complexity while improving reliability (Kowalski & Juchmann, 2023). In addition, actuator failure in a flap system can also affect the overall structural dynamics of the flap mechanism if not handled according to procedure (Zhou et al., 2022).

During a flight-training practicum period at the Indonesian Aviation Academy (API) Banyuwangi, technicians from the Aircraft Maintenance Unit received a report that the Cessna 172S trainer aircraft registered PK-BYJ had experienced a malfunction on both flaps, which failed to move during ground run up. This condition had the potential to disrupt the performance of the aircraft's flight control surfaces if not promptly addressed in accordance with the applicable Aircraft Maintenance Manual (AMM) procedure, given that compliance with the AMM and technician competency in diagnosing component failures are primary factors in preventing maintenance errors in the aviation industry (Olaganathan, 2024). This competency is also shaped through direct involvement in handling problems in the field, which has been shown to contribute to the work readiness of aviation vocational technicians (Lubis, 2021) and to the alignment of technical understanding with industry work systems (Darni et al., 2025).

Despite these developments, most existing studies on electromechanical actuators focus on advanced condition-monitoring algorithms, fault-tolerant architectures (Di Rito et al., 2021), and recovery mechanisms for larger transport aircraft (Zhou et al., 2022), whereas documented field troubleshooting of flap actuator failures on small piston-engine trainer aircraft remains scarce. In vocational aviation institutions, where trainer fleets operate intensively and maintenance relies primarily on corrective actions guided by the AMM, practical case records are essential for building technician diagnostic competency and reducing aircraft downtime. This gap underlines the need for a structured case study that links manual-based troubleshooting with the broader literature on actuator reliability (Yin et al., 2022).

This article aims to (1) systematically analyze the cause of the flap stuck malfunction on the Cessna 172S PK-BYJ trainer aircraft, (2) document the handling steps and repair verification carried out in accordance with the AMM, and (3) relate the field findings to the literature on the reliability of electromechanical actuators in flight control systems, so that this study may serve as a reference for troubleshooting practice for similar flap stuck cases on trainer aircraft in the future.

Research Method

This study uses a descriptive qualitative method with a case study approach, as put forward by Baxter and Jack (2008), which systematically describes the process of identifying the cause and handling the malfunction of a single flap motor unit that is part of a trainer aircraft's secondary flight control system, as is commonly used in applied, field-practice-based research in the aircraft maintenance field. This approach was chosen because the problem under study is specific to a single event (single case) and requires a narrative-technical tracing of the root cause referring to the official maintenance manual, rather than hypothesis testing on a large sample. A similar approach has been used in root-cause investigations of a single incident in the technical-services field (Kirchhoff, 2023) as well as in research evaluating airport security technology (Hofer & Wetter, 2012), showing that a descriptive case study is effective for revealing the cause and handling process of a problem in depth for a single unit of study. Data collection techniques were carried out in three ways: direct observation at the incident site, technical inspection referring to the Cessna 172S Aircraft Maintenance Manual (AMM), and documentation of each stage of the tracing and repair process in the form of photographs and field notes.

Data were collected directly at the work site, at the Trainer Aircraft Maintenance Hangar, Indonesian Aviation Academy (API) Banyuwangi, during the period of 1 April-28 June 2024. The object of this study is one flap motor unit

on the Cessna 172S trainer aircraft registered PK-BYJ, based on a report that both flaps could not move during ground run up.

The tools and references used in the troubleshooting process included: the Cessna 172S Aircraft Maintenance Manual (AMM) Chapter 27, Flight Controls, as the reference for disassembly, inspection, servicing, and reassembly procedures; hand tools to open the wing panel and remove the flap motor; and electrical instruments to check the power supply to the flap motor. The AMM was selected as the primary reference based on the requirement that every maintenance, repair, or component-replacement action on an aircraft must refer to the official manual published by the manufacturer, in order to guarantee the aircraft's airworthiness after the repair is carried out.

The troubleshooting stages carried out were as follows: (1) receiving a report that both flaps of the Cessna 172S PK-BYJ could not move during ground run up, indicating a malfunction of the flight control surfaces; (2) carrying out disassembly by opening the wing panel, removing screws, disconnecting the electrical power source, and removing the flap motor in accordance with AMM Chapter 27, page 201; (3) performing a visual and physical inspection of the removed flap motor; (4) based on the inspection results, determining a servicing action in the form of replacing the flap motor in accordance with AMM Chapter 27, page 101, given the unavailability of tooling to perform a bench test on the component; (5) carrying out reassembly by installing the new flap motor on the wing panel, connecting the connector and electrical power source, applying grease, installing the screws, and closing the wing panel; and (6) performing a functional test by testing the movement of both flaps from the cockpit to confirm normal component function before the aircraft was declared return to service.

Results and Discussion

Object Profile and Scope of the Study

The object of this study is one flap motor unit on the Cessna 172S trainer aircraft registered PK-BYJ, operated as a trainer aircraft under the management of the Aircraft Maintenance Unit, Indonesian Aviation Academy (API) Banyuwangi, an Approved Maintenance Organization (AMO) 141 under the Ministry of Transportation. As a vocational aviation education institution operating its trainer aircraft fleet intensively for cadets' flight-practice activities, the reliability of every flight control component -- including the flap system -- is an important factor in maintaining the smoothness and safety of daily flight training activities.

Working Principle of the Secondary Flight Control (Flap)

Functionally, an aircraft's flight control system is divided into three groups. Primary flight control comprises the aileron, elevator, and rudder, which control the aircraft's rolling, pitching, and yawing movement on the three main axes. Secondary flight control comprises the flap, spoiler, and small tabs mounted on the trailing edge of the primary flight control, functioning to assist the performance of the primary flight control, particularly in increasing the aircraft's lift at low speed. Auxiliary flight control comprises the speed brake, slat, and leading-edge slot. On the Cessna 172S, the flap is driven electromechanically by a flap motor connected to a transmission mechanism leading to both wings; when the pilot activates the flap switch from the cockpit, the motor rotates a transmission shaft that moves both flaps symmetrically. As an electromechanical actuator (EMA), the reliability of the flap motor is highly determinative of the overall performance of the secondary flight control system, so a failure in this component -- whether due to mechanical wear, motor-winding failure, or an electrical fault -- can cause the flap to become unresponsive to the pilot's commands (Yin et al., 2022). An explainable machine-learning approach for diagnosing the health condition of aircraft electromechanical actuators, using multi-sensor data such as motor current and vibration indicators, has shown high classification accuracy in recognizing the degradation stage of transmission components before total failure occurs (Abdulsahib et al., 2026).

Problem Identification

During ground run up, the Cessna 172S trainer aircraft registered PK-BYJ experienced a malfunction on both flaps, indicating that the flaps could not move, thereby affecting the performance of the flight control surfaces in an abnormal condition. This condition had the potential to disrupt the safety of flight training activities if not promptly addressed, given that the flap plays an important role in increasing the aircraft's lift during the takeoff and landing phases, which are critical phases of flight.

Diagnosis and Damage Analysis

Diagnosis was carried out in stages in accordance with the method described above, referring to the Cessna 172S Aircraft Maintenance Manual (AMM) Chapter 27. The disassembly stage was carried out by opening the wing panel, removing screws, disconnecting the electrical power source, and then removing the flap motor from the wing panel. After the flap motor was successfully removed, a thorough visual and physical inspection was carried out, and it was found that the flap motor could no longer produce movement despite receiving an appropriate electrical current supply. This kind of failure pattern in a direct-current (DC) motor -- in which the motor is no longer responsive to a normal power supply -- can generally be traced through power-consumption

pattern analysis to identify mechanical defects inside the motor, such as in the windings or the gear-transmission mechanism (Majdi et al., 2021). A dual-sensor diagnostic approach that separates vibration signals caused by bearing defects from disturbances generated by the motor itself also shows that failures in the bearing or other internal mechanical components of a DC motor can occur even when the electrical supply is in normal condition, so physical inspection remains necessary to confirm the exact root cause of the failure (Sim et al., 2026). This staged tracing approach, moving from one measurement point to the next, is also consistent with the principle of failure diagnosis in electrical systems, which combines test data from multiple points to narrow down the source of a fault before repair action is taken (Xiong et al., 2023). A summary of the inspection stages is presented in Table 1.

Table 1 Flap Stuck Inspection Stages and Results

No.	Inspection Stage	Result	Remarks
1	Problem identification during ground run up	Both flaps unable to move	Faulty
2	Disassembly of wing panel and flap motor	Flap motor removed per AMM Ch. 27	Completed
3	Visual and functional inspection of flap motor	Flap motor produces no movement	Damaged
4	Servicing (flap motor replacement)	Flap motor replaced per AMM Ch. 27	Replaced
5	Reassembly of flap motor and wing panel	Motor, connector, and panel installed properly	Completed
6	Functional test of flap movement	Both flaps move normally from cockpit	Normal
7	Return to service	Aircraft declared airworthy for flight training	Normal

Table 1 shows that the root cause of the flap stuck in this case lay in the malfunctioning flap motor, not in the electrical wiring or other transmission mechanisms, so the repair could be focused on replacing the flap motor component in accordance with AMM procedure.

Figure 1 presents a flowchart that summarizes the entire diagnosis and handling process, from problem identification, disassembly, and inspection, through the servicing decision to replace the flap motor, followed by reassembly and a functional test, up to the aircraft being declared return to service.

This finding indicates that a failure in an electromechanical component such as the flap motor can occur even when the electrical wiring and transmission mechanism are in good condition, consistent with research showing that the reliability of electromechanical actuators (EMAs) on aircraft has not yet fully met the demands of practical application, making fault diagnosis, prognosis, and health management key elements in the application of condition-based maintenance for this component (Yin et al., 2022). In addition, actuator failure in

a flap system also affects the overall structural dynamics of the flap mechanism, so proper handling is needed to prevent further impact on other interconnected flight control components (Zhou et al., 2022).

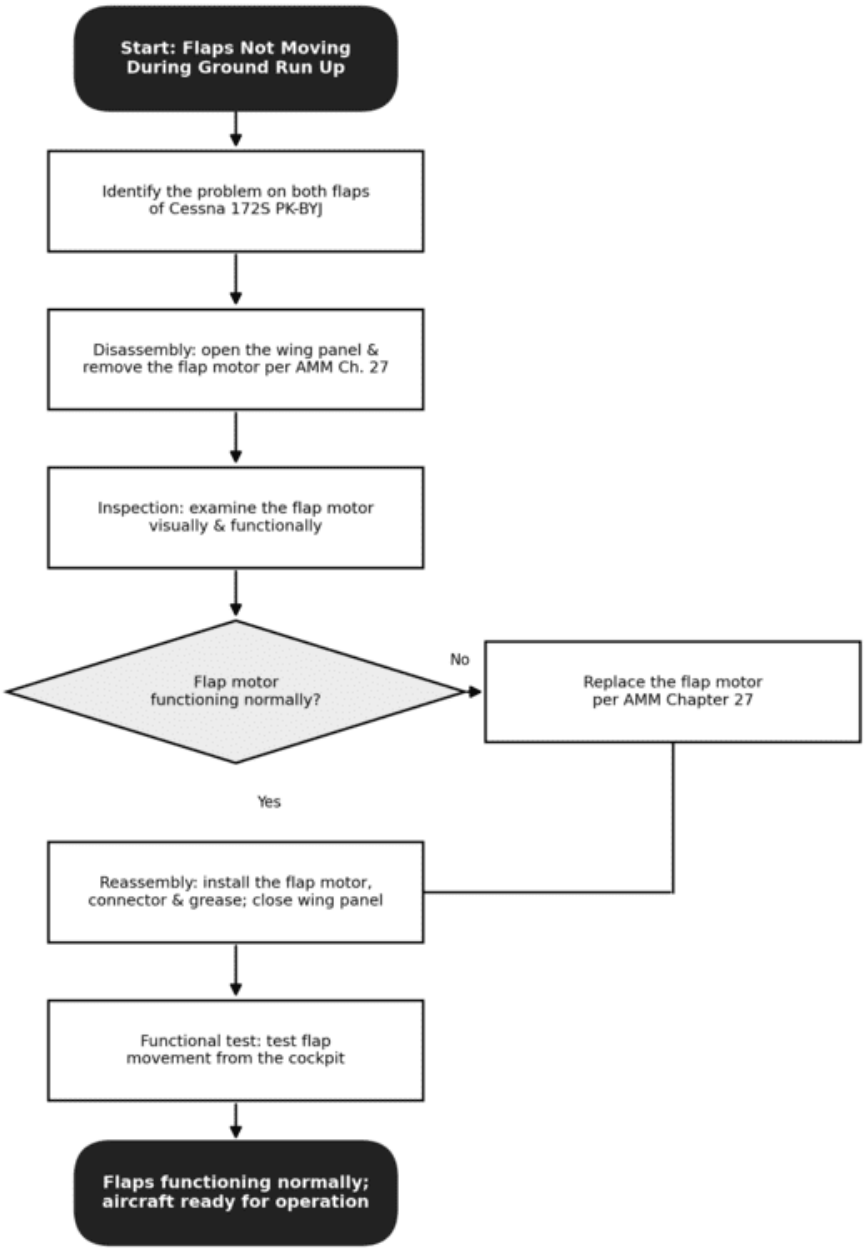


Figure 1 Flowchart of the Flap Stuck Diagnosis and Handling Process on the Cessna 172S Trainer Aircraft (Source: Processed by the Authors, 2025)

Handling and Repair Verification

The repair was carried out through servicing in the form of replacing the malfunctioning flap motor with a new component, in accordance with the Cessna 172S Aircraft Maintenance Manual Chapter 27, page 101, given the unavailability of specialized tooling to perform a bench test on the component. The reassembly

stage was carried out by installing the new flap motor on the wing panel, connecting the connector to the cockpit, reconnecting the electrical power source, applying grease to the mechanical parts, installing the screws, and closing the panel on the aircraft wing, ensuring all components were free of foreign object debris (FOD) that could trigger damage to the flap motor in the future. A functional test was then carried out by testing the movement of both flaps from the cockpit, and the test results showed both flaps could move normally and symmetrically, so the aircraft was declared return to service and airworthy for flight training activities.

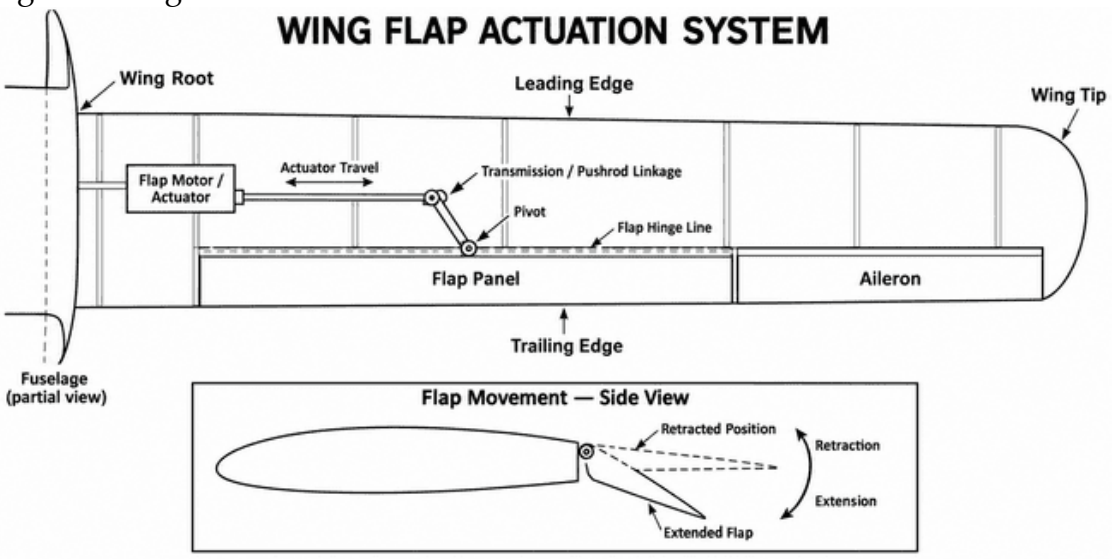


Figure 2 Conceptual Illustration of the Secondary Flight Control (Flap) System on the Cessna 172S Trainer Aircraft

Figure 2 presents a conceptual illustration of the secondary flight control (flap) system on the Cessna 172S trainer aircraft, showing the position of the flap on the wing's trailing edge together with its relationship to the flap motor and the transmission mechanism, as a visual complement to the explanation of the system's working principle described in the previous section.

Comparison with Other Actuator Maintenance Approaches

Replacing the flap motor in this case is a reactive approach (corrective maintenance) carried out after component failure was identified through inspection. This approach differs from a condition-based maintenance strategy, which uses continuous health monitoring of the actuator through vibration, current, or other operational-parameter analysis to predict failure before it actually occurs (Yin et al., 2022). In flap systems on larger transport aircraft, other approaches have also been developed, such as a recovery mechanism -- an inter-connection strut -- designed to reduce the impact of actuator failure on the overall dynamics of the flap mechanism, although its application on small trainer aircraft such as the Cessna 172S remains limited to direct component replacement in accordance with the AMM (Zhou et al., 2022). Determining the optimal

preventive maintenance period has been shown to reduce expected downtime while improving overall equipment reliability (Al-Duais et al., 2022), while an Internet of Things-based monitoring system that enables early detection of faults before they lead to total function failure is also a direction of development for condition-based maintenance strategies across various types of electromechanical equipment (Witczak & Szymoniak, 2024). This difference in aircraft scale and complexity shows that actuator maintenance strategy needs to be adapted to the type and operational function of the aircraft concerned.

Importance of AMM Compliance and Technician Competency

This case study confirms that every disassembly, servicing, or reassembly action on a flight control component must strictly refer to the Aircraft Maintenance Manual published by the manufacturer, given that deviation from official procedure is one of the human-error factors most frequently contributing to aircraft maintenance incidents (Olaganathan, 2024). A case study on performance improvement in an aircraft maintenance environment shows that a mismatch between task execution and official procedures or manuals is one of the most common findings in hazard identification, making the strengthening of a procedural-compliance culture a key element in the continuous improvement of aircraft maintenance systems (Ward et al., 2010). Evaluation of human-error precursors in civil and military aviation accidents also confirms that latent factors such as time pressure and resource limitations can increase the likelihood of procedural deviation if not systematically controlled (Erjavac et al., 2018). Compliance with the AMM needs to be accompanied by strengthening technician competency in diagnosing component failures quickly and accurately, since this competency also determines the aircraft's downtime and the quality of the repair carried out. This competency is shaped, among other things, through direct involvement in handling problems in the field, which has been shown to contribute to the work readiness of aviation vocational technicians (Lubis, 2021) and to the alignment of technical understanding with industry work systems (Darni et al., 2025).

Discussion

This case shows that a failure in the secondary flight control system can originate from a single electromechanical component, namely the flap motor, even when the electrical wiring and other transmission mechanisms are in good condition, so staged diagnosis in accordance with the AMM remains necessary to ensure the accurate identification of the root cause before servicing action is taken. The systematic approach -- disassembly, inspection, servicing, reassembly, and functional test -- proved effective in isolating the root cause in this case and has the potential to become a standard diagnostic pattern for similar flap stuck cases on Cessna 172S trainer aircraft in the field. Given that the flap is part of the

flight control system, which must meet airworthiness standards in accordance with ICAO regulations (Candra Susanto & Keke, 2019), the reliability of this component needs to be maintained through strict compliance with the AMM, strengthening the technical competency of maintenance personnel, and consideration of condition-based maintenance strategies for critical electromechanical components in the future.

Conclusion

The flap stuck malfunction on the Cessna 172S trainer aircraft registered PK-BYJ at the Indonesian Aviation Academy, Banyuwangi, was caused by a malfunction in the flap motor, which could no longer drive both flaps despite receiving an appropriate electrical supply, while the electrical wiring and other transmission mechanisms remained in good condition; staged diagnosis referring to Aircraft Maintenance Manual Chapter 27 -- comprising disassembly, inspection, servicing, reassembly, and functional test -- proved effective in isolating the root cause to the flap motor component as the sole source of the functional failure, and the repair through flap motor replacement and functional testing successfully restored both flaps to normal operating condition, so the aircraft was declared airworthy for flight training activities. This case study confirms that the reliability of the secondary flight control system is also determined by the condition of electromechanical components, which are vulnerable to failure even without signs of damage in their supporting pathways, so strict compliance with AMM procedures and the strengthening of maintenance personnel's technical competency are needed to support the sustainable reliability and operational safety of trainer aircraft.

Acknowledgements

The author expresses gratitude to the agencies, companies, and institutions that have offered support in conducting research and/or writing publications

AI Declaration

The author acknowledges the use of artificial intelligence (AI) tools in supporting the preparation of this manuscript. The author remains fully responsible for the accuracy, originality, and integrity of the research and its findings.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

No funding was received for this work.

References

Abdulsahib, I. A., Hadi, A. S., Ahmed, M. K., Al-Khafaji, A. J. D., & Al-Haddad, L. A. (2026). Explainable machine learning for condition monitoring of aircraft electromechanical actuators under variable loads: Health state diagnosis from multi-sensor dynamic responses. *Frontiers in Mechanical Engineering, 12*, Article 1810983. https://doi.org/10.3389/fmech.2026.1810983

Akademi Penerbang Indonesia Banyuwangi. (n.d.). Profil dan sejarah singkat [Profile and brief history]. Retrieved August 28, 2026, from https://icpa-banyuwangi.ac.id/

Al-Duais, F. S., Mohamed, A.-B. A., Jawa, T. M., & Sayed-Ahmed, N. (2022). Optimal periods of conducting preventive maintenance to reduce expected downtime and its impact on improving reliability. *Computational Intelligence and Neuroscience, 2022*, 1-11. https://doi.org/10.1155/2022/7105526

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report, 13*(4), 544-559. https://doi.org/10.46743/2160-3715/2008.1573

Candra Susanto, P., & Keke, Y. (2019). Implementasi regulasi International Civil Aviation Organization (ICAO) pada penerbangan Indonesia [Implementation of International Civil Aviation Organization (ICAO) regulations in Indonesian aviation]. *AVIASI: Jurnal Ilmiah Kedirgantaraan, 16*(1), 53-65. https://doi.org/10.52186/aviasi.v16i1.23

Darni, R., Harisman, Y., Sukma, D., Fitriana, E., Sulistiobudi, R. A., & Herayono, A. (2025). Work readiness in vocational education: Perception and correlation between measurement level and system integration. *TEM Journal, 14*(2), 1388-1397. https://doi.org/10.18421/TEM142-39

Di Rito, G., Luciano, B., Borgarelli, N., & Nardeschi, M. (2021). Model-based condition-monitoring and jamming-tolerant control of an electro-mechanical flight actuator with differential ball screws. *Actuators, 10*(9), 230. https://doi.org/10.3390/act10090230

Erjavac, A. J., Iammartino, R., & Fossaceca, J. M. (2018). Evaluation of preconditions affecting symptomatic human error in general aviation and air carrier aviation accidents. *Reliability Engineering & System Safety, 178*, 156-163. https://doi.org/10.1016/j.ress.2018.05.021

Hofer, F., & Wetter, O. E. (2012). Operational and human factors issues of new airport security technology-two case studies. *Journal of Transportation Security, 5*(4), 277-291. https://doi.org/10.1007/s12198-012-0096-5

Kirchhoff, R. (2023). Team experiences of the root cause analysis process after a sentinel event: A qualitative case study. *BMC Health Services Research, 23*(1), 1224. https://doi.org/10.1186/s12913-023-10178-3

Kowalski, R., & Juchmann, P. (2023). Sensorless motor control for electro-mechanical flight control actuators. *CEAS Aeronautical Journal, 14*(4), 1007-1018. https://doi.org/10.1007/s13272-023-00682-x

Lubis, M. R. (2021). Pengaruh On The Job Training (OJT) Flight Operations Officer (FOO) terhadap kesiapan kerja [The influence of On the Job Training (OJT) for Flight Operations Officers (FOO) on work readiness]. *SKYHAWK: Jurnal Aviasi Indonesia, 1*(2), 85-91. https://doi.org/10.52074/SKYHAWK.V1I2.14

Majdi, H. S., Shijer, S. S., Hanfesh, A. O., Habeeb, L. J., & Sabry, A. H. (2021). Analysis of fault diagnosis of DC motors by power consumption pattern recognition.

Eastern-European Journal of Enterprise Technologies, 5(113), 14-20. https://doi.org/10.15587/1729-4061.2021.240262

Olaganathan, R. (2024). Human factors in aviation maintenance: Understanding errors, management, and technological trends. *Global Journal of Engineering and Technology Advances, 18*(2), 92-101. https://doi.org/10.30574/gjeta.2024.18.2.0021

Sim, T.-S., Aronwora, N., & Hur, J.-W. (2026). A physics-guided dual-sensor framework for bearing fault diagnosis in PMDC motor drives. *Sensors, 26*(4), 1363. https://doi.org/10.3390/s26041363

Ward, M., McDonald, N., Morrison, R., Gaynor, D., & Nugent, T. (2010). A performance improvement case study in aircraft maintenance and its implications for hazard identification. *Ergonomics, 53*(2), 247-267. https://doi.org/10.1080/00140130903194138

Witczak, D., & Szymoniak, S. (2024). Review of monitoring and control systems based on Internet of Things. *Applied Sciences, 14*(19), 8943. https://doi.org/10.3390/app14198943

Xiong, J., Qian, W., Cen, J., Li, J., Liu, J., & Tang, L. (2023). A fault diagnosis method for building electrical systems based on the combination of variational modal decomposition and new mutual dimensionless. *Scientific Reports, 13*, Article 4567. https://doi.org/10.1038/s41598-022-27031-y

Yin, Z., Hu, N., Chen, J., Yang, Y., & Shen, G. (2022). A review of fault diagnosis, prognosis and health management for aircraft electromechanical actuators. *IET Electric Power Applications, 16*(11), 1249-1272. https://doi.org/10.1049/elp2.12225

Zhou, X. C., Xue, P., Luo, Y. B., Lu, J. G., & Zhang, C. (2022). A recovery mechanism for flap system of large aircraft with actuator failure. *International Journal of Protective Structures, 13*(3), 539-554. https://doi.org/10.1177/20414196221087338