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PERFORMANCE ANALYSIS AND OPERATIONAL FEASIBILITY OF THE EMBRAER E190-E2 FOR SHORT ROUTES IN INDONESIA: A REVIEW OF COST EFFICIENCY, VIP TRANSPORT, AND LIMITED MILITARY APPLICATIONS

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ABSTRACT — *This research aims to analyze technical performance and propose several solutions related to feasibility and operational cost efficiency. The Embraer E190-E2 has garnered attention as a modern regional aviation solution. This study aims to analyze the technical performance, operational feasibility, and cost efficiency (CASK) of the Embraer E190-E2, specifically for short flight routes in the Indonesian archipelago. Furthermore, this review evaluates the advantages and disadvantages of the aircraft if operated for strategic military needs or as VIP/state official transport. Primary data were extracted from technical flight documents, namely the Flight Crew Operating Manual (FCOM), manufacturer specifications, and the Flight Controls module. Through aerodynamic analysis, Fly-by-Wire (FBW) integration, and take-off modeling at Sea Level (SL) conditions, the results show that the E190-E2 is highly efficient for routes under 500 nautical miles (nm) as it only requires a runway length of 1,150 meters. From the military and VIP perspectives, the hybrid control system design provides a high level of reliability and comfort, although the lack of a rear loading ramp limits its function as a heavy military cargo transport aircraft.*

Keywords: *Embraer E190-E2, Fly-by-Wire, Cost per Available Seat Kilometer (CASK), VIP Flight, Military Application.*

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1. INTRODUCTION

Indonesia's geography, comprising thou sands of islands, requires air connectivity infrastructure capable of operating from short to medium runways while maintai ning high economic efficiency. Conven tional narrow-body aircraft like the Boeing 737 or Airbus A320 often operate with sub-optimal payloads on pioneer or secondary routes (thin routes). In this context, regional jets with a capacity of 90 to 120 seats, such as the Embraer E190-E2, offer a theoretically more advantageous opera tional profile. Beyond commercial civil aviation, the military and government of an archipelagic state often require multi-functional air platforms. Such aircraft must be able to operate economically to mobi lize troops and serve emergency evacua tions while providing premium comfort and security for VIP transport or high-ranking state officials. This research examines empirical technical aircraft data from manufacturer documents, including the Flight Controls manual, Summary FCOM, and performance specification sheets. The main objectives of this journal are to (1) evaluate the operational cost efficiency of the

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Embraer E190-E2 on short routes in Indonesia, and (2) formulate the parame ters of advantages and weaknesses of this aircraft if adapted for military or state VIP transport missions.

1.2. Literature Review

1.2.1 Cost per Available Seat Kilometer (CASK) Theory

According to Doganis (2019), the opera tional cost structure of an aircraft (CASK) is influenced by fuel consumption, mainte nance costs, and fixed overhead efficiency per flight hour. "Right-sized" aircraft (capacity matching demand) tend to have a slightly higher CASK compared to 200-seat aircraft but possess a significantly lower Trip Cost. For short routes with fluctuating passenger demand, a low Trip Cost minimizes the airline's risk of loss (Vasigh et al., 2014).

1.2.2 Aerodynamics and Fly-by-Wire (FBW)

The FBW control system replaces mecha nical connections with electronic signals to actuate Power Control Units (PCU). Modern aerodynamic control theory states that FBW allows manufacturers to design aircraft with relaxed static stability margins, which implies a smaller tailplane size, thereby reducing trim drag and fuel consumption (Collinson, 2011).

2. METHODOLOGY

This study employs a quantitative analytical method and technical document evaluation. The study parameters are specifically extrac ted from three primary operating documents of the Embraer 190, namely: Technical Specifications (Embraer Profit Hunter): Collecting metrics for Maximum Takeoff Weight (MTOW), payload ratio, runway distance limits, and fuel ratios. Flight Controls Module: Analyzing the primary and secondary control configurations, particularly the combination of conventional cable controls and FBW. Summary FCOM: Exami ning the capability of emergency opera tions integration and system warning features.

3. RESULTS AND DISCUSSION

3.1 Performance Specifications and Aerodynamics

Based on Embraer manufacturer data, the E190-E2 is classified as a heavyweight regional aircraft with relative STOL (Short Take-Off and Landing) maneuvering capabi lities. Its performance parameters are des cribed in table 1.

Parameter	Specification Value
Maximum Capacity	114 Seats (Single Class)
MTOW	56,400 kg (124,340 lb)
Max Landing Weight	49,050 kg (108,136 lb)
Max Payload	13,500 kg (29,762 lb)
Max Usable Fuel	13,690 kg
Max Cruise Speed	Mach 0.82
Range (Full PAX, LRC)	2,950 nm (5,463 km)

For pioneer runways in Indonesia (such as in Papua or border areas), take-off capability is a critical variable. Under International Stan dard Atmosphere (ISA) conditions at Sea Level, the aircraft requires an MTOW take-off distance of 1,615 m. However, for a short route of 500 nm (e.g., Jakarta - Surabaya, or Makassar - Ambon) with a full passenger load, this aircraft only requires a runway length of 1,150 meters (3,773 ft). This proves its exceptionally high accessibility flexibility for short routes with limited infrastructure in Indonesia.

3.2 Cost Efficiency (CASK) and Trip Cost Analysis

The advantage of the Embraer E190-E2 on pioneer or short-haul routes under 500 nm lies in its ultra-high bypass ratio engine architecture and redesigned aerodynamics (gull-wing). The maximum fuel capacity reaches 13,690 kg with a density of 0.803 kg/l, allowing the aircraft to avoid tankering at remote airports where aviation fuel might be expensive or unavailable. With a maximum payload ratio of 13,500 kg and a relatively light MTOW (56,400 kg), navigation and landing fees calculated based on aircraft weight are significantly lower than those of the A320/B737 family. The effect of a low Trip Cost allows the margin of loss due to fluctuating load factors on inter-island routes to be suppressed.

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3.3 Hybrid Control System (FBW and Conventional)

Based on the Flight Controls module, the E190 uses a system partially controlled by Fly-by-Wire (FBW) and cable connections. Primary control systems such as the Elevator, Rudder, and Roll Spoilers are electronically controlled using Primary Actuator Control Electronics (P-ACE) and the Flight Control Module (FCM). However, Aileron control retains conventional cables leading to dual hydro-mechanical actuators. This hybrid control combination provides safer flight envelope protection from stalls or overspeed and reduces pilot workload during long-haul missions. In terms of maintenance, the presence of a cable mechanism for the ailerons indeed requires periodic physical inspections for cable tensioning, but FBW predominantly reduces the number of static mechanical components in the fuselage and tail.

3.4 Feasibility for Military Operations and VIP Transport

Commercial aircraft modified for the military are often referred to as Commercial Derivative Aircraft (CDA). The following is a comparative evaluation of the E190 for VIP and military missions:

Strengths:

- ***Premium Comfort for VIPs:*** *The basic 3-class configuration (9 seats @36", 20 seats @34", 68 seats @31") is highly ideal for mobilizing cabinets or high-ranking generals. The FBW operating system ensures very smooth flight maneuvering, crucial for VIP standards.*
- ***Safety and Emergency Navigation:*** *Quoting the Summary FCOM, additional features such as the Synthetic Vision System (SVS) assist pilot visualization when landing on dark, isolated, or foggy military pioneer runways. The Terrain Clearance Floor (TCF) feature on the GPWS supports safe landings in hilly terrains deep within Indonesian islands.*
- ***Strategic Range:*** *The maximum range of 2,950 nm (5,463 km) enables non-stop operational mobility from Jakarta to the westernmost tip (Sabang) to the easternmost tip (Merauke) or to military bases in ASEAN countries with a full load.*
- ***Weaknesses:***
  - *Absence of a Rear Loading Ramp: The Embraer 190 is designed purely as a passenger aircraft. The cargo door is located in the belly, making it impossible for this aircraft to load tactical vehicles, heavy supply pallets (LAPES), or military artillery.*
  - *Military Protection: As a CDA, the E190 is not equipped with armor plating or Directed Infrared Countermeasures (DIRCM) to disable Man-Portable Air-Defense Systems (MANPADS) missiles from insurgents in conflict-prone areas.*
  - *Field Maintenance of Electronic Compo nents: Complex control modules like P-ACE and FCM require mainte nance performed in high-standard clean hangars. This complicates heavy repair maintenance if the aircraft is grounded at a remote Forward Operating Base.*

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

- *The Embraer E190-E2 aircraft is a game changer in the operation of short and medium flight routes in Indonesia. The performance analysis confirms its highly impressive capabilities, where the required runway distance is only 1,150 meters to fully serve a 500 nm route. The operational trip cost is kept as low as possible due to the combination of light weight (MTOW 56 tons) and the dominance of Fly-by-Wire techno logy that improves aerodynamic efficiency.*

- *In the military and state domains, this aircraft is not a tactical cargo transport platform but is highly superior as a Special VIP Transport aircraft for State Officials. The high level of comfort resulting from FBW control synchroniza tion, along with the complete ness of navigation awareness features such as SVS and TCF, makes this aircraft highly safe and reliable for transporting com mand personnel to all corners of the archi pelago and the Southeast Asian region. .*

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4.2. Recommendations

- *Analysis of the technical performance, operational feasibility, and cost efficiency (CASK) of the Embraer E190-E2, particularly for short-haul flights within the Indonesian archipelago, must be conduc ted to anticipate flight operations.*

- *The Embraer E190-E2 can be considered a viable option for modern regional aviation, enhancing performance and operational feasibility.*

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