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Analysis Of Maximum Range And Operational Cost Of Airbus A320-200 And Boeing 737-800 Aircraft From Dhoho Kediri Airport For Domestic Flights

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ABSTRACT

Dhoho Kediri Airport is a new domestic airport that has more limited facilities compared to large international airports. This can affect the operational costs associated with using Narrow-body aircraft where operational costs are cheaper. Airlines operating from this airport must consider various factors including fuel costs, maintenance, and airport fees to ensure efficient operations. Airbus A320-200 and Boeing 737-800 aircraft are frequently used in Indonesia for domestic flights. To determine the maximum travel distance and runway capacity, it is necessary to consider the technical specifications of aircrafts. Airline's planning and operational strategy, analyzing the maximum range and operating cost of the aircraft is key to determining the most suitable aircraft type. This data-driven analysis is expected to provide a strong empirical basis for airlines to select the most efficient aircraft to suit their operational needs. Based on the results of the maximum distance calculation obtained with the same capacity for both aircraft, 180 passengers and 20 kg cargo weight and 7 kg cabin baggage weight per passenger, the maximum distance of the Airbus A320-200 aircraft with a maximum takeoff weight of 78,000 kg and 17,940 kg fuel is 4,193.52 km with a travel time of 5 hours 14 minutes. For the Boeing 737-800, the maximum distance with a maximum take-off weight of 79,015 kg and fuel of 20,410 kg is 4,503.32 km with a travel time of 5 hours 33 minutes. It is stated that both aircraft can perform domestic flights to all regions in Indonesia. For the study case, maximum range on domestic flights in Indonesia with the destination Jayapura is 3,289.17 km. With the results of the calculation of Airbus A320-200 operational costs amounting to IDR 406,921,692. While the Boeing 737-800 amounted to Rp427,869,708.

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INTRODUCTION

Dhoho Airport was initiated by the business entity PT Gudang Garam through its subsidiary, PT Surya Dhoho Investama. The operation of Dhoho Airport is carried out with a Joint Operation (KSO) scheme between Angkasa Pura Airports and PT Surya Dhoho Investama with the aim of increasing operational efficiency and quality by involving parties with different strengths and expertise. Dhoho Airport officially operated on April 5, 2024, with specifications in the form of a 3,300 meter runway with a width of 45 meters. This airport is able to accommodate 1.5 million passengers in the initial stage and around 10 million passengers when fully operational. In the aviation industry, choosing the right type of aircraft is very important to ensure operational efficiency and customer satisfaction. The Airbus A320-200 and Boeing 737-800 are two types of narrow-body aircraft that are often used in domestic flights worldwide.[1]

The concept of the maximum range of a domestic aircraft refers to the furthest distance an aircraft can travel from the departure airport without requiring additional refueling. This maximum range is influenced by several factors, including runway specifications, aircraft type, fuel capacity, and payload. Maximum range is important for planning efficient routes and ensuring that aircraft can reach their destinations without having to land for refueling. Understanding maximum range helps airlines plan flight schedules, optimize operations, and meet passenger needs in different regions.[2]

In the aviation industry, selecting the right aircraft type is critical to ensure operational efficiency and customer satisfaction. Dhoho Kediri Airport, as one of the domestic airports in Indonesia, plays a vital role in regional connectivity. To meet the growing demand for domestic flights, airlines must select aircraft that not only meet the required range and capacity but also offer optimal operating costs. The Airbus A320-200 and Boeing 737-800 are two types of narrow-body aircraft that are frequently used in domestic flights worldwide.

Dhoho Kediri Airport is a domestic airport that has more limited facilities compared to large international airports. This can affect the operating costs associated with using narrow-body aircraft that have lower operating costs. Airlines operating from this airport must consider various factors including fuel costs, maintenance, and airport charges to ensure efficient operations. As part of an airline's planning and operational strategy, analyzing the maximum range and operating costs of the aircraft is key to determining the most suitable aircraft type. Therefore, understanding the differences between the Airbus A320-200 and Boeing 737-800 in the context of domestic flights from Dhoho Kediri Airport will provide valuable insights for airline decision making.

This study analyzes the differences in range and operational costs of the two types of aircraft, namely the Airbus A320-200 and the Boeing 737-800. As well as evaluating the implications which means assessing or examining the impact or consequences that may arise from an action, decision, policy, or event on domestic flight operations. Numerical calculations are performed using linear interpolation, linear interpolation is a technique used to estimate the value of a function between two known values. This method often uses certain relationships and experimental results in a range of values to predict other values. Interpolation is very useful in estimating values at points that are not listed in the data table.

METHODS

Linear interpolation is a mathematical method used to select a value between two known data points. In the context of aircraft performance data, linear interpolation can be applied to reflect the aircraft's performance value at a specific condition or time that is not recorded in the original data. In mathematics, it is considered a way to "fill in the gaps" in data presented in tabular form. The linear interpolation approach is to draw a straight line connecting two known data points in the vicinity of the point to be estimated. [3]

$$Y = Y1 + \left[\frac{(X - X1)}{(X2 - X1)} \times (Y2 - Y1) \right] \quad (1)$$

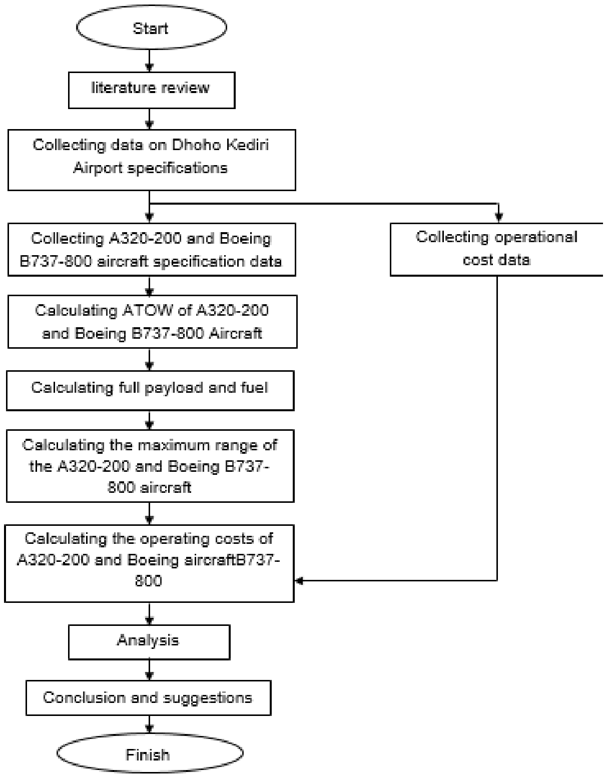

Figure 1 Research flowchart

This research begins with a literature study, namely collecting, reading, recording, and managing materials related to the problem being studied shown in Figure 1. Furthermore, data collection was carried out on the specifications of Dhoho Kediri Airport and the specifications of the Airbus A320-200 and Boeing 737-800 aircraft used in the study. In addition, airport operational data was also collected to support the calculation of operational costs. After the data was obtained, the ATOW (Allowable Takeoff Weight) calculation was carried out for the two aircraft that could operate from Dhoho Airport. This study also includes calculations of full payload and fuel requirements, as well as estimates of maximum range using a linear interpolation formula based on data from the FCOM (Flight Crew Operating Manual). Furthermore, operational costs for both aircraft were calculated to compare their efficiency. Further analysis was carried out on both aircraft based on the results of these calculations. Finally, this study was concluded by compiling conclusions and suggestions based on the findings obtained.

The International Civil Aviation Organization (ICAO) requires each airport serving commercial flight operations to publish a pavement classification number (PCN) in its own aeronautical information publication. This number is defined as a number that expresses the carrying capacity of the pavement for unrestricted operations[4] The code at Dhoho Kediri Airport is 89/F/C/X/T [5] which means that: 89 Is the value set for pavement strength, F Is a pavement type code, where F is Flexible, C Is the layer under the pavement, where C is low, X Maximum Tire pressure that the pavement can accept, where X is Medium, limited to 1.50Mpa (218psi), T Represents the way the PCN value is calculated, where T is Technical evaluation[6]. The Aircraft Clasification Number (ACN) is a number that expresses the relative effect of an aircraft on a pavement for a specified standard "subgrade" category[7]

Tabel 1 Aircraft classification Number Airbus A320-200[8]

Aircraft	Weight Max/Min(kN)	Tire Pressure (MPa)	*Flexible*				*Rigid*			
			High A	Medium B	Low C	V.Low D	High A	Medium B	Low C	V.Low D
A320-200	759	1,44	41	42	47	53	46	49	51	53
	441		22	22	24	28	24	26	27	29

Tabel 2 Aircraft classification Number Boeing 737-800[8]

Aircraft	Weight Max/Min (kN)	Tire Pressure (MPa)	*Flexible*				*Rigid*			
			High A	Medium B	Low C	V.Low D	High A	Medium B	Low C	V.Low D
B737-800	777 406	1,47	44 21	46 21	51 23	56 26	51 24	53 25	56 26	57 27

Tabel 3 Specifications Airbus A320-200[9] and Boeing 737-800 [10]

Airbus A320-200 Specification	
Maksimum Take-off weight	78.000kg/171.960lb
Operating empty weight	42.600 kg/ 93.916lb
Maksimum landing weight	64.500 kg
Average cruise Speed	863km/h (466mph)
Cruise altitude	29.000ft to 39.000ft
Maximum Fuel capacity	23.860l/6.300gal
Kecepatan jelajah	Mach 0,78 (750 km/jam)
Max speed	486 kts/ 900,72 km/jam
Passangers	180
Boeing 737-800 Specification	
Maximum Take-off weight	79.015kg/174.200lb
Operating empty weight	41.145kg/90.710lb
Maximum Fuel capacity	26.025l/6.875gal
Kecepatan jelajah	Mach 0,78 (750 km/jam)
Maksimum landing weight	66.350 kg/146.300lb
Engines	2×CFM56-7B26
Cruise altitude	33.000 to 41.000ft
Average cruise speed	853km/h (530mph)
Pasangers	180

‘

RESULT AND ANALYSIS

Allowable Maximum Takeoff Weight (ATOW)

ATOW (Allowable Maximum Takeoff Weight) is the maximum weight allowed for takeoff, which is applied based on the calculation of PCN (Pavement Classification Number) and ACN (Aircraft Classification Number) values. If the MTOW value is greater than the PCN, the PCN value is used. Conversely, if the MTOW value is smaller than the PCN, the MTOW value is used.[11] The calculation is carried out using linear interpolation, where finding ATOW uses the Pavement classification number value of the runway and the aircraft classification number value of the aircraft. Calculation of MTOW based on ACN limitations Table 1 and using interpolation produces ATOW value for Airbus A320-200 Aircraft The results of the calculation state that MTOW based on PCN limitations on the DHX airport runway for Airbus A320-200 aircraft is 136,698 kg. where the value of MTOW 78,000 kg and PCN 136,698 kg states that the value used for the calculation is 78,000 kg, because the MTOW specification value is smaller than PCN. While the MTOW calculation based on the ACN limitations **Table 2** and using interpolation Produces the ATOW value for the Boeing 737-800 Aircraft The results of the calculation state that the MTOW based on the PCN limitations on the DHX airport runway for the Boeing 737-800 aircraft is 130,656 kg. Where the value of MTOW 78,000 kg and PCN 136,698 kg states that, the value used for the calculation is 79,015 kg, because the MTOW specification value is smaller than the PCN.

Payload

Payload basically refers to the amount of cargo or passengers paid for by the customer. Pilots are not paid to carry fuel, so the weight of fuel is not included in the payload. The total weight of the cargo carried by the aircraft, including passengers, baggage, and other cargo. The more cargo the aircraft carries, the more capacity it can carry. In theory, payload can be calculated using the Maximum Takeoff Weight (MTOW) minus the Operational Empty Weight (OEW) and fuel.[12] Here is the payload calculation formula:

$$Payload = jumlah\ seat \times (Berat\ penumpang + Berat\ cargo) \tag{2}$$

$$MTOW - OEW - full\ payload = Fuel \tag{3}$$

Maximum takeoff weight (MTOW) is the maximum takeoff weight, including fuel, including the weight of empty aircraft and cargo and crew. Maximum takeoff weight is measured by weighing all parts of the aircraft and calculating the total.. Operating Empty Weight (OEW) is the weight of the aircraft without cargo or empty weight of the aircraft, weighing is carried out after emptying the fuel, cargo, and crew of the aircraft. Calculation of the payload of Airbus A320-200 and Boeing 737-800 aircraft which was carried out using specifications with the same aircraft load, namely with a number of seats for 180 passengers, with a passenger weight of 70 kg, cargo weight per passenger of 20 kg with cabin baggage of 7 kg with a full payload result of 17,940 kg. Continuing the calculation with formula 4 which produces the maximum amount of fuel for an Airbus A320-200 aircraft of 17,940 kg, while the maximum fuel used for a Boeing 737-800 aircraft is 20,410 kg.

Fuel

Aircraft fuel has components that are carried during the flight, namely: Taxi fuel, Holding fuel, alternative, and Tripfuel.[8] Contingency fuel is the amount of fuel needed to anticipate unexpected conditions, which is usually 5% of the planned Trip Fuel for the flight.[13] Calculation of fuel contingency can be done using the following formula

$$Contingency\ fuel = 0{,}05 \times trip\ fuel \tag{4}$$

to calculate the maximum range of the Airbus A320-200 aircraft requires the following specification MTOW 78,000 kg, MLW 64,000 kg, OEW 42,220 kg, Full Payload 17,460 kg. The stage of calculating the maximum range that must be determined first is the amount of aircraft taxi fuel, which is 140 kg, alternate fuel of 1,686.5 kg, also calculating holding fuel of 1,196.5 kg, contingency fuel of 710 kg where the calculation is carried out using interpolated FCOM data and produces a maximum range of the Airbus A320-200 aircraft of 2,264.32 nm with a travel time of 5 hours 14 minutes. Next, to calculate the maximum range of the Airbus Boeing 737-800 aircraft, the following specification MTOW 79,015 kg, MLW 66,350 kg, OEW 41,145 kg, Full Payload 17,460 kg. The stage of calculating the maximum range that must be determined first is the amount of aircraft taxi fuel, which is 250 kg, alternate fuel of 1,727 kg, also calculating holding fuel of 2,465.9 kg, contingency fuel of 760.33 kg where the calculation is carried out using interpolated FCOM data and produces a maximum range of the Airbus A320-200 aircraft of 2,431.6 nm with a travel time of 5 hours 33 minutes

Estimated operating costs

Flight operating costs are the costs required to operate and maintain an aircraft. Operational costs are an important aspect of charter operations management and the economy of the airline industry as a whole. Therefore, operational management is an important element in aircraft flight planning. Operational costs are calculated on a flight basis, as follows:

1. Crew cost

Crew costs that vary based on aircraft usage include travel costs (especially reimbursement of daily living expenses and other additional costs), overtime costs, and wages for hourly or part-time crew members. For example, a narrow-body aircraft with more than 160 seats has a rate of $ 1,152 per block hour

$$cost\ per\ minute = \frac{hourly\ rate}{60} \quad (5)$$

The flight taken is a domestic flight with a maximum range that is close to the maximum range of the aircraft, namely the flight to Jayapura using an A320-200 and a Boeing 737-800. The estimate is made using the same data, because both aircraft have the same number of passengers. The first thing to do is to determine the travel time, using the distance/speed formula, where the distance can be seen on Google Maps which we can see the distance from Dhoho Airport to Jayapura as far as 3,289.17 km with a speed of 750 km/hour, so the travel time on this flight is 4 hours 38 minutes. Then calculate the crew cost with Equation 5 which produces a cost for the crew of $ 5,337.6 or if in rupiah it is worth Rp83,715,772.

2. Aircraft maintenance costs

The calculated costs vary depending on the aircraft and flight time. For narrow-body aircraft maintenance of more than 160 seats, the cost is set at $718 per block hour [14]. Maintenance costs for Airbus A320-200 and Boeing 737-800 aircraft can be estimated using Equation 5 which produces a total Maintenance Cost of $3,324.88 or if converted to rupiah it becomes Rp. 52,147,949.90.

3. Parking fee

Aircraft parking costs at Dhoho Airport, Kediri, are calculated based on the aircraft weight MTOW and parking duration. Based on the data, the parking rate for domestic flights is around Rp1,404/ton per hour after the aircraft has been placed for more than 1 hour, less than 1 hour is exempt from the placement fee.

$$Parking\ fee = Price\ per\ ton \times MTOW \quad (6)$$

The calculation is based on formula 6 where the MTOW for the Airbus A320-200 aircraft is 78 tons, then the parking price is Rp109,512. The estimated parking fee for a Boeing 737-800 aircraft with an MTOW weight of 79.015 tons is Rp110,937.06.

4. Landing fee

Based on data to carry out landing, placement, and storage services for air passengers on domestic flights in Indonesia. Landing fee with weight

up to 40 tons = Rp5,449,- per ton
20 to 40 tons = Rp108,980 + Rp6,420,- per ton
40 to 100 tons = Rp237,380 + Rp7,062,- per ton
>100 tons = Rp661,100 + Rp7,768,- per ton

Which is chosen to carry out the calculation of landing fee at a weight of 40 to 100 tons. Based on MTOW Airbus A320-200 the landing fee charged is Rp505,736. While for Boeing 737-800 aircraft it is Rp512,903.93.

5. Fuel cost

Calculations are made to determine the fuel costs incurred in one flight with the maximum distance traveled. With the fuel price set by Pertamina in the Kediri area, which is Rp15,081 per liter [16]

$$Waktu = \frac{maximum\ distance}{Aircraft\ speed} \quad (7)$$

$$Total\ fuel = Fuel\ consumption\ per\ hour \times Time \quad (8)$$

$$Fuel\ cost = total\ fuel \times fuel\ price \quad (9)$$

The fuel used in flights with a maximum flight range is 15,456.76 kg for the Boeing 737-800 aircraft where the figure is obtained from the total Trip Fuel and Taxi Fuel. The price of fuel at Dhoho Airport is IDR 15,456.76 per liter (as of September 1 to 30, 2024) [16] The first step taken is to convert fuel from kg to liters with a fuel density of 0.8 kg / L which produces 19,320.95 liters then calculate the total price which produces fuel costs for the Boeing 737-800 of IDR 291,382,145. while for the Airbus A320-200 aircraft the fuel cost is 14,346 kg where the figure is obtained from the total trip fuel and taxi fuel which is converted into liters to 17,932.5 liters. so, the total fuel cost for the Airbus A320-200 aircraft is IDR 270,442,722.4. Table 4 shows the results of the analysis of the maximum range and operating costs of the Airbus A320-200 and Boeing 737-800 aircraft.

Tabel 4 Analysis results

aircraft specifications		
	Airbus A320-200	**Boeing 737-800**
Max Speed	750 km/jam	750 km/jam
MTOW	78.000 kg	79.015 kg
Full Payload	17.460 kg	17.460 kg
Maximum Range	4.193,52 km	4.503,32 km
Fuel	17.940 kg	20.410 kg
operational costs		
Crew Cost	Rp83.715.772,42	Rp83.715.772,42
Maintenance Cost	Rp52.147.949,90	Rp52.147.949,90
Landing Fee	Rp505.736	Rp512.903,93
Parking Fee	Rp109.512	Rp110.937,06
Fue cost	Rp270.442.722,4	Rp291.382.145
Total	Rp406.921.692,72	Rp427.869.708,31

excellent less excellent same advantage

Based on **Table 4** shows the results of the comparison between the specifications and operating costs of Airbus A320-200 and Boeing 737-800 aircraft. In terms of specifications, both aircraft have the same cruising speed of 750 km/h, and a full payload capacity of 17,460 kg. However, Boeing has an advantage in terms of maximum range which reaches 4,503.32 km, a longer range than Airbus which is 4,193.52 km. Boeing has an MTOW (Maximum Take-Off Weight) of 79,015 kg which is higher than the Airbus which has an MTOW of 78,000 kg. In terms of fuel usage Airbus is more efficient, requiring only 17,940 kg, while Boeing 20,410 kg. In terms of operating costs, the Airbus A320-200 appears to have better efficiency than the Boeing 737-800. Crew cost, parking fee, and landing fee are relatively the same for both aircraft, but the fuel cost of Airbus A320-200 is lower, at Rp270,442,722.4 compared to Boeing 737-800 which reaches Rp291,382,145. Maintenance has the same cost so through comparative analysis of existing data, the total operating cost of the Airbus A320-200 is Rp406,921,692.72, cheaper than the Boeing B737-800 which reaches Rp427,869,708.31. The following is a comparison chart of the specifications and operational costs of the Airbus A320-200 and Boeing 737-800 aircraft shown in Figure 2.

The Airbus A320-200 is superior in terms of cost efficiency and fuel consumption, making it more suitable for companies that prioritize affordable operating costs and can reduce expenses. Meanwhile, the Boeing B737-800 excels in maximum range and weight capacity, making it more ideal for longer routes or operational needs with heavier payloads. The choice between these two aircraft should be tailored to the airline’s operational priorities and specific needs.

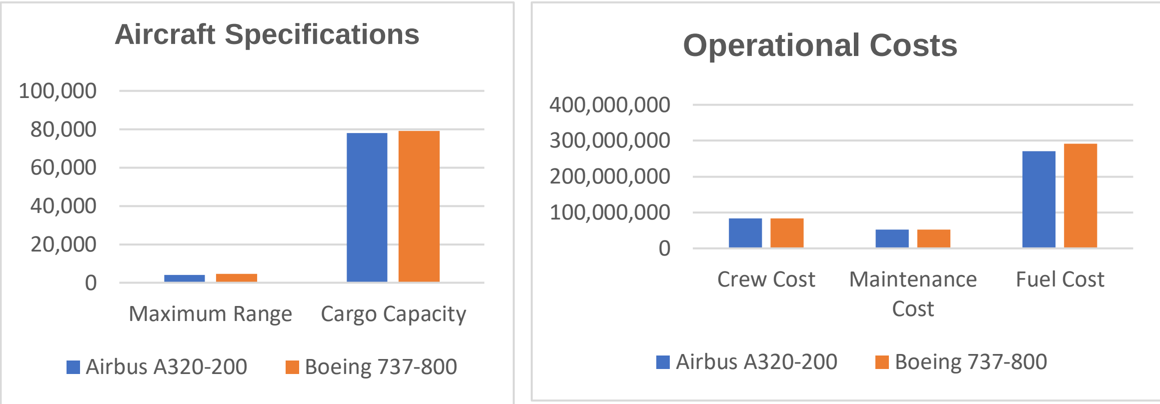

Figure 2 Comparison Aircraft Specification and Operational Cost Airbus A320-200 and Boeing 737-800

CONCLUSIONS

Maximum range distance on Airbus A320-200 aircraft from Dhoho Kediri airport is 2,264.32 nm or equal to 4,193.52 km with a travel time of 5 hours 14 minutes, while Boeing 737-800 aircraft Maximum range distance from Dhoho Kediri airport is 2,431.6 nm or equal to 4,503.32 km with a travel time of 5 hours 33 minutes. The domestic route with the maximum range distance on the flight of both aircraft is Jayapura with a distance of 3,289.17 and a speed of 750 km / h and a travel time of 4 hours 38 minutes. Total estimated operating costs that include the calculation of Crew cost, maintenance cost, parking fee, landing fee, and fuel cost. On the Airbus A320-200 aircraft, it is IDR 406,921,692.72. While the total estimated operating cost for the Boeing 737-800 aircraft is Rp427,869,708.31.

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