Comparison of the Effectiveness and Efficiency on Cessna 208 with DHC 6-300 Twin Otter for Flights in Inland Papua

R F Nanda, M P Nugraha, C An, D E Cahyanti

Institute of Transportation and Logistic Trisakti, Jakarta, Indonesia

*Email: ranifebriananda@gmail.com

Abstract. Aircraft selection is very important aspect to increase the productivity and profitability of an airline company. However, there are still many airlines that are unaware of how a right selection of aircraft type can influence operational costs. Therefore, calculating the operating cost of the aircraft is necessary so that airline companies can maximize profits and can compete with highly competitive conditions. The purpose of this study is to estimate the calculation of operational costs for the type of aircraft Cessna 208 and DHC 6-300 Twin Otter which have already been used for flights in the inland area of Papua. This study is also aimed to find out what type of aircraft is more effective and efficient in terms of operating costs. The method used in this study was qualitative with a descriptive and explorative research technique. The results of this study shows that the DHC 6-300 Twin Otter type aircraft were more effective and efficient. Consequently, the airline can consider which type of aircraft is to be used in rural Papua.

1. Introduction
The rapid growth of air transportation can reflect the direct economic growth in Indonesia. Consequently, transportation now plays an important role and become a strategic sector. Transportation also significantly contributes to grow tourism in Indonesia [1] as well as making a number of aviation industries to pay attention to flights in Papua, as one of the islands that have remote areas. Flights operating in remote areas, can generally be referred as a pioneer flight, that is based on law No. 1 of 2009 on flight article 1 [c] [2] that the pioneer air freight is a commercial air freight Serving network and flight routes to connect remote areas and hinterland or areas that are difficult to contact by other modes of transport are commercially unprofitable. With the air transportation as a pioneer flight, the people of Papua hinterland can be highly assisted in supporting their economy [3] and can also be assisted in connecting between other regions [4], this has been one of the successes of the Pioneer Flight [2], since Papua's hinterland has a very minimal road infrastructure that is difficult to reach by other modes of transport, especially land transportation [5].

The government's participation in supporting Pioneer flight plays a crucial role in the development. Supportive efforts from the government for the pioneer flights is even officially declared [6]. It is seen at the presidential decree No. 65/2011 on accelerating development of Papua Province and West Papua province in [7] that increased accessibility in order to reduce territorial isolation should be supported by the development of equitable and adequate transportation infrastructure services to the entire district. Although the area in Papua, one of them in Jayawijaya Regency belongs to the strategic area in
promoting remote areas in the central mountains of Papua [8] one of the airports in Jayawijaya district, Wamena Airport, has the equitable and Adequate infrastructure [9]. Therefore, air transportation remains a key point in improving regional developments even though air transportation requires more operational costs than other types of transport modes [10], where the operating costs are influenced by utilization factor and load factor [11]. Viewed from the length of travel time, air transportation is also superior with only 55 minutes – 1.5 hours which is relatively shorter than sea transportation, which takes 6.5-19.5 hours and land transportation that is about 3.5-9.5 hours [12].

Nevertheless, not all aircraft can operate in Papua region with its extreme geographical contours as well as less supporting facilities such as insufficient runway. Concerning to extreme geography, “more than 71% of the Papua region is a difficult stretch because it consists of steep valleys and high mountains, and some of the mountains are covered by snow” [9]. Moreover, According to Wijaya and Lisi [9] that uncertain weather can harm the safety of the flight in operation so that the flight can be cancelled due to the weather factor, it can be said that inland areas Papua is very extreme in the aviation world.

Currently, there are two types of aircraft that are commonly used for inland flights in Papua. They are the Cessna 208 and DHC 6-300 Twin Otter aircraft. DHC 6-300 Twin Otter is a reliable airplane that fly the inland terrain. This aircraft belongs to the type of STOL (Short Take-Off Landing) aircraft. This type of aircraft is very well-qualified and popular among remote communities and people living in regions such as Papua. In addition, Cessna 208 aircraft is quite reliable in navigating the terrain in the Papua region. Smaller aircraft are rated more effectively for use in the hinterland of Papua, where the inland region of Papua has a very extreme geographical condition. Smaller aircraft which is easier to fly and is the favourite from the airline is the Cessna 208 aircraft. Since airline must use the appropriate aircraft for pioneer flights in the remote areas of Papua, the airline must perform aircraft selection due to Juliater Simarmata, Charles, & Rizaldy (2014) and Pitfield, Caves, & Quddus (2010) in [13] that the selection of the right aircraft type is important for airlines along with the economic growth, exchange rates, fuel costs, regulations, and so on, because these substantial aspects can give an impact on a flight fee. As fleet planning is a strategy that must be applied by airlines to compete with other industries, deciding the right aircraft can make operating costs be more efficient and effective [14]. Moreover, the right aircraft selection can also be seen from the operational cost for airline consideration [15].

Hence, there are several questions arisen, namely: how is the condition of Wamena Airport and Mulia Peak Airport, what is the specifications of the type of Cessna 208 aircraft and DHC 6-300 Twin Otter, and which aircraft type is more effective and efficient to be operated in rural Papua.

2. Research Method
This study was conducted to find out the type of aircraft that are effective and efficient on flights operated in inland Papua. The research methods used in this research were qualitative methods; this type of research method was used because it is more systematic, specific, and structured. And this method is also well-planned, from the beginning of the process to determining the conclusion of the research, where we used the research techniques in a descriptive and exploratory.

3. Result and Discussion
The tables below describe about two airport conditions in Papua, there are Wamena Airport and Mulia Peak airport as one of the flight routes in Inland Papua, specifications of the two aircrafts and also the calculation on flight time, Total Operating Cost, fuel as well as selling prices.

3.1 Specification of Wamena Airport [16] and Mulia Peak [17]

| Table 1. Airport Specification |
|--------------------------------|
| Description | Wamena Airport, Papua | Mulia Peak Airport, Papua |
| IATA | WMX | LII |
| ICAO | WAVV | WAJM |
| Elevation | 1,549.60 msl | 1,760.94 msl |
Based on table 1.1 above, it can be seen that the runway in Wamena has a length of 2.175 m x width of 45 m with a elevation of 1,549.60 MSL and PCN 44F/C/X/T. Wamena Airport also has two apron where the apron size is 356 m x 50 m and 180 m x 45 m with each PCN are 20F/C/X/T and 25F/C/X/T. While the Mulia Peak Airport has a long runway of 800 m X 18 m with an elevation of 1,760.94 MSL and PCN 5 F/C/Z/U. Mulia Peak Airport also has an apron with a size of 72 m X 88 m without any known PCN. In table 1, It also shows that flights in the inland of Papua can only be traversed by small aircraft that are one of the size of the runway, especially at Mulia Peak Airport.

3.2 Specification of Cessna 208 (EastWest Aircraft Sales, 1949) in [18] (The Aircraft Owners and Pilots Association, 1939) in [19] and DHC 6-300 Twin Otter (Global Aviation Navigator, 2019) in [20] (Global Aviation Navigator, 2019) in [21] (Viking Air, 1959) in [22] (Viking Air, 1959) in [23]

| Table 2. Aircraft Specification |
|---------------------------------|
| Description                      | Cessna 208 | DHC 6-300 Twin Otter |
| DOW                              | 2,143 kg   | 3,346 kg             |
| MZFW                             | 3,538 kg   | 5,670 kg             |
| MTOW                             | 3,629 kg   | 5,670 kg             |
| MLW                              | 3,538 kg   | 5,579 kg             |
| Tank Capacity                    | 1,009 kg   | 1,665 kg             |
| Fuel Consumption/Hour            | 183 kg/hour| 231.1 kg/hour        |
| Optimum Speed                    | TAS = 175 kts / M.27 | TAS = 150 kts / M.23 |
| Max. Speed                       | TAS = 186 kts / M.29 | TAS = 170 kts / M.26 |
| Max. Ceiling Altitude            | 25,000 ft  | 25,000 ft            |
| Seat Capacity                    | 14 Y       | 20 Y                 |
According to table 2.1, it can be seen that the results are not immediately obtained but based on the calculations that have been made and based on the data according to the types of aircraft, as well as in the table also shows the difference of the aircraft, in terms of the heavy feasibility that can be accommodated by both types of aircraft, the speed of both aircraft types to the size of both types of aircrafts themselves. These differences can be helpful in choosing the type of aircraft that are eligible to operate in the remote areas of Papua. One of them differentiate the fuel consumption on both aircraft types, because according to Park & O'Kelly [13] that fuel consumption can influence the DOC (Direct Operating Cost) which leads to a decision of selling price.

3.3 Comparison of Aircraft

| Description | Cessna 208 | DHC 6-300 Twin Otter |
|-------------|------------|----------------------|
| OAT         | 30°C       | 30°C                 |
|             | 30°C       | 30°C                 |
| TAS         | 183 kts    | 183 kts              |
|             | 156 kts    | 156 kts              |
| GS          | 173 kts    | 193 kts              |
|             | 146 kts    | 166 kts              |
| Flight Time | 22'        | 20'                  |
|             | 26'        | 24'                  |

| Description | Cessna 208 | DHC 6-300 Twin Otter |
|-------------|------------|----------------------|
| Trip Fuel   | 67.1 kg    | 100.14 kg            |
|             | 61 kg      | 92.44 kg             |
| MFR         | 433.1 kg   | 562.34 kg            |
|             | 427 kg     | 554.64 kg            |
| DUF         | 494.1 kg   | 654.78 kg            |
| Payload Allowable | 9 Y | 18 Y |
| Cargo Allowable | 338 kg | 409.22 kg |

| Description | Cessna 208 | DHC 6-300 Twin Otter |
|-------------|------------|----------------------|
| Total Operating Cost | $538,10 | $489,18 |
|                | $538,10 | $489,18 |
| Profit Margin | $53,81 | $48,92 |
|                | $53,81 | $48,92 |
| Selling Price | $591.91 | $538.10 |
|                | $591.91 | $538.10 |
| Selling Price/Seat | $65,77 | $42,28 |
|                | $65,77 | $42,28 |
| Trip Fuel | $66,26 | $60,24 |
|                | $66,26 | $60,24 |

Table 3. Calculation of Flight Time

Table 4. Calculation of Fuel, Payload Allowable and Cargo Allowable

Table 5. Calculation of Total Operating Cost and Selling Price per Seat
In the table above, it can be seen that the results are not immediately obtained, but based on the calculations that have been made on the basis of the specifications of the aircraft type respectively. Thus, table 3 shows detailed comparison of both types of aircraft, in terms of flight time where the type of aircraft Cessna 208 have shorter flight time than DHC 6-300 Twin Otter. Table 5 shows more details of the two types of aircraft in terms of price based on “Total Operating Cost (TOC) consisting of direct cost or Direct Operating cost and Indirect cost” (Agusanto P and Suksmahadji, 2009) in [24]. Therefore, Total Operating Cost on the type of Cessna 208 aircraft for 1,467.54/hour in utilization 100 hours per month, where “Direct Operating Cost is the whole direct cost with the operation of the aircraft…” (Widiastuti R, Honggowibowo AS and Indrianingsih Y, 2012) in [15] covers aircraft value, “the cost of the crew based on Block Hour” (Yusmar T and Pakan W, 2014) in [25], maintenance, aircraft insurance, fuel, route navigation fee, parking fee, landing fee, ground handling and crew training as well as Indirect Operating Cost (Source: Trigana Air Service). Consequently, Cessna 208 offers a slightly higher price, as in table 5 that this type of Cessna 208 aircraft can transport 14 passengers at the price offered of $42.28/seat & $38.44/seat and if the aircraft carries 9 passengers then it can offer a price with $ 65.77/seat & $ 59.79/seat as well as allowable payload that can transport 968 kg cargo.

Meanwhile, Total Operating Cost of the aircraft type DHC 6-300 Twin Otter for 1,842.08/hour in utilization 100 hours per month, where “Direct Operating Cost is all direct costs with the operation of the aircraft…” (Widiastuti R, Honggowibowo AS and Indrianingsih Y, 2012) in [15] covers aircraft value, “the cost of the crew based on Block Hour” (Yusmar T and Pakan W, 2014) in [25], maintenance, aircraft insurance, fuel, route navigation fee, parking fee, landing fee, ground handling and crew training and Indirect Operating Cost (Source: Trigana Air Service), which means, DHC 6-300 Twin Otter offers a slightly lower price, as in table 5 that the type of aircraft DHC 6-300 Twin Otter can transport 20 passengers at a price offered $43.9/seat and $40.53/seat and if the aircraft carries 18 Passengers can then be offered a price of $48,78/seat & $45,03/seat as well as allowable payload that can transport 1669.22 kg cargo which is almost doubled in size than the Cessna 208.

Table 4 also shows that cargo allowable on Cessna 208 when transporting 9 passengers is 338 kg and when transporting 14 passengers then the cargo Allowable becomes 0 kg, therefore the aircraft type cannot transport cargo regardless of the weight or size because it can result in an accident for being overload. Unless this type of aircraft does not carry passengers and baggage at all or in other words, the aircraft type only transports cargo with a weight that has been specified according to the allowable payload weight. Thus, the cargo allowable on the DHC 6-300 Twin Otter when transporting 18 passengers is 409.22 kg and when transporting 20 passengers, the allowable cargo can be transported is 269.22 kg. It means, that with this type of aircraft although it can be Transporting more passengers than the appropriate Cessna 208 capacity but this type of aircraft is still available for cargo space where a note that the charge cannot exceed the specified weight.

4. Conclusion
It can be deduced from this research with the route Wamena –Mulia Peak – Wamena which corresponds to the specifications of both airports of the size of the runway, elevation, PCN and such that can affect the choice of aircraft type that the aircraft is more effective and is DHC 6-300 Twin Otter. In the current route, DHC 6-300 Twin Otter can transport more passengers in terms of the sale price Per Seat which only has a difference of more than one to two USD dollars compared with Cessna 208 in one flight. Moreover, DHC 6-300 Twin Otter also has a bigger payload so that it can maximize the cargo sales. Thus, the difference between the selling prices per seat can be optimized from the result of cargo sales.

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