Model for determining the requirement of aircraft N219 on non-pioneer routes in Indonesia

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Abstract The mode of air transport (aircraft) in Indonesia is divided into two kind namely commercial aircraft and pioneer aircraft. Both aircraft are used to carry passengers, but the difference is in the routes that they have. In 2017, PT Dirgantara Indonesia made its inaugural flight of its new product namely Aircraft N219. This aircraft is designed for 19 seats. From various commercial and pioneer routes, the aircraft tries to fix commercial routes. This study attempts to analyze the need for N219 aircraft in non-pioneer routes in Indonesian territories. This analysis of N219 requirement will be divided into several regions such as Java, Sumatra, Kalimantan, Nusa Tenggara and Papua. This division is made because maximum flight distance of N219 aircraft that is no more than 1500 km. The requirement of N219 in Indonesia serve non pioneer route of 23 units, Java requires 4 units, Papua requires 14 units, Sumatra requires 2 units, Kalimantan requires 1 unit, and NTB and NTT area need 2 units.

Keywords : aircraft, block time, utility, routes

1. Introduction
All people in the world always want their activities to be supported by everything that can help them. Not infrequently its activities require people to move to various locations both near and far. Especially Indonesia which is an archipelagic country, its citizen will more often travel between island, whether it is big or small island. There are five major islands in Indonesia namely Sumatera, Java, Kalimantan, Nusa Tenggara and Papua. Furthermore, there are small islands such as Bali and Nusa Tenggara. In all islands, there are airports for aircraft that serve commercial route (non-pioneer route) or pioneer routes. Therefore, the aircraft is needed and considered by people. According to Indonesian domestic flight data released by the Air Transportation Department in 2015, 4.4% of commercial routes are serviced by aircraft with less than 30 seats. This percentage increases continuously because the people who travel to somewhere with small aircraft increase too. Therefore, many aircraft companies in different countries are trying to meet demand by making an innovation small aircraft.

The transport industry, in particular air transport is one sector that significantly contributes to socio-economic development as well as growth and improvement of living standards [7]. The day-to-day
challenge for airlines industry is quality service to customers. The airline industry should respond the
customer requirements, in order to higher passenger satisfaction. One of the decisions to meet customer
satisfaction is the determination of the best aircraft [8]. The airline industries currently high level
competition and operate under a small profit margin. Airlines try to develop a profitable flight schedule
that maximizes their revenue and exploits their available resources [2]. Various optimizations and
improvements have been done by aircraft manufacturers for the satisfaction airline industry.

One of the aircraft manufacturers in Indonesia is PT Dirgantara Indonesia. The latest product from
PT Dirgantara Indonesia is N219. In 2017, N219 conducted its inaugural flight test. This aircraft is
designed for 19 seats. Initially, the aircraft was only developed to serve pioneer routes. But due to the
large number of consumer demand for small aircraft on commercial routes, the N219 tries to enter
commercial route. At the beginning production of N219, PT Dirgantara Indonesia needs to calculate the
number of aircraft that need in Indonesia. This calculation will have an effect to determine how many
aircraft to produce. In the previous study the calculation the requirement of aircraft using block time
related to the speed of the plane, while in this study we used regression analysis and correlation of the
block time that has been obtained from the flight test of N219. It will analyze the requirement for N219
aircraft to serve non-pioneer routes, which small aircraft still possible to serve on the route. In this study,
we used the block time and utility of the N219 aircraft to calculate the number of aircraft required that is
serve its region. This division is due to the maximum distance of N219 aircraft that is no more than 1500
km. So it would be better if the island serve as a division of groups.

2. Literature Review

Setting Block Time (SBT) is an important component of flight scheduling activity that has been
known to have a significant direct impact on the performance and cost of the flight operations [9]. Block
time is divided into three parts: taxi-out time, air time, and taxi-in time. Taxi-out time starts from the plane
out the door, including the time when it runs on the runway and the time when it waits. Taxi-out time
ends when the plain is in the air. Taxi-out time is the travel time of an aircraft from the gate to take off on
the runway without interference from other traffic [11]. Airtime is begun when the plane take off to the
destination and the time when it queues up in the air waiting for a landed permit. Airtime ends when plane
land to the ground. Taxi-in time is begun when the plane lands and ends when it reaches the arrival gate.

Figure 1. Illustration of Block Time

In the research conducted by Gunawan and Sukhairi the calculation of the block time for determined
the number of aircraft requirement is calculated based on the following formula:

$$\text{Block Time} = \frac{\text{Speed}}{\text{Distance}} + 0.5 \text{ hour}$$  \hspace{1cm} (1)

An additional 0.5 hours is an airplane time in Apron. In this study the block time will be assumed
from the regression that equation obtained from N219 flight test have result block time and distance.

Correlation analysis is an analysis to know the level of closeness of relationship between two
variables. Level of relationship can be divided into three criteria, which have a positive relationship, a
negative relationship and no relationship. Correlations only reflect that consumer preferences for one
attribute related to their preference for another attribute [6]. In this research, Spearman Correlation
Coefficient is used to test the correlation hypothesis of the research. Correlation Coefficient shows the
relationship between variables [1].
To find out how close the relationship between variables, we required a measure that states the "strength" of the relationship. In statistics, the measure is obtained through a correlation analysis. A correlation analysis aims to measure how strong or degree of proximity of a relation that occurs between variables. A correlation analysis is an important method in finding the existence of relationship between independent and bound variable. After knowing the strength of relationship between variables, we used regression model which in this study will be search the block time of each route regression model.

3. Model Framework

There are three steps to determine the requirement of N219 aircraft. The first is to find the regression equation for block time and distance. Block time (known as gate-to gate time) is the time that takes for an airplane to travel from the arrival gate at the original airport to the arrival gate at the final airport. Block Time calculation is used to find the distance between routes. Regression models are widely used to deal with interesting scientific questions about associations among a set of variables [4]. Regression analysis is one of the statistical techniques that used to estimate the relationship between independent variables with dependent variable. Linear regression models are often used to explore the relationship between sustainable outcomes and independent variables [10]. The general equation of the regression line for simple linear regression is:

\[ y = a + bx \]  

Where:
- \( y \) = block time
- \( a \) = intercept
- \( b \) = slope
- \( x \) = distance (nm)

The formula for determining the intercept:

\[
a = \frac{\sum y - b \sum x}{n}
\]  

The formula for determining the slope:

\[
b = \frac{n \sum xy - \left( \sum x \right) \left( \sum y \right)}{n \sum x^2 - \left( \sum x \right)^2}
\]

After finding the block time of each known route using the regression equation, the next step is to determine the utility of each route. The formula is:

\[ Route \text{ utilization} = 2x \text{Block Time x frequency} \]

In this study, the calculation of aircraft requirement is grouped by region or island. Furthermore, the route utility is summed from their respective groups. There are 5 groups in this study, namely: Java, Sumatra, Kalimantan, Nusa Tenggara, and Papua. After the utilization of the group has been determined, the next step is to determine the number of N219 aircraft needs per group. The formula is:

\[ \text{The number of aircraft} = \frac{\text{Total of route utilization}}{\text{Utilization of N219}} \]

Utilization of N219 is 1200 hours per year. So the number of utility routes each group will be divided by 1200 and will be found the requirement of N219 aircraft in each region.
4. Result

Before determining the block time of each region, we must find the relationship between two variables: block time which is obtained from the test result N219 aircraft and distance of each route with regression and correlation analysis. Table 1 shows the results of excel calculation for the regression equation. From the table 1 we can conclude that the relationship between two variables have very strong relationship (perfect relation) because the results are close to 1.

Table 1. Regression statistics by Excel

|                |            |
|----------------|------------|
| Multiple R     | 0.999995763 |
| R Square       | 0.999991526 |
| Adjusted R Square | 0.99998701 |
| Standard Error | 0.003162278 |
| Observations   | 5          |

Table 2. Analysis of Variance (ANOVA)

|                |          |          |          |          |          |
|----------------|----------|----------|----------|----------|----------|
| df             | Regression | Residual | Total    |          |          |
|                | 1        | 3        | 4        |          |          |
| SS             | 3.54025  | 3E-05    | 3.54028  |          |          |
| MS             | 3.54025  | 1E-05    |          |          |          |
| F              | 354025   |          | 1.04692E-08 |          |          |
| Significance F |          |          |          |          | 1.04692E-08 |

Table 2 shows the Analysis of Variance. From the table 2 we can conclude that two variables have a linear relationship.

Table 3. Slope and Intercept for the regression

|                | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95.0% | Upper 95.0% |
|----------------|--------------|----------------|--------|---------|-----------|-----------|-------------|-------------|
| Intercept      | 0.233        | 0.003316625    | 70.25214329 | 6.35587E-06 | 0.22244502 | 0.244 | 0.22244502 | 0.24355498 |
| X              | 0.00595      | 1E-05          | 595    | 1.04692E-08 | 0.005918176 | 0.006 | 0.005918176 | 0.005981824 |

Table 3 shows the slop and intercept of regression analysis. From the Table 3 we can conclude that the regression equation between the distance and block time is as follows:

\[
\hat{y} = 0.233 + 0.006x
\]

Where:

\[
\hat{y} = \text{block time}
\]

\[
X = \text{distance (nm)}
\]

After having the regression equation between block time and distance, then block time of each route can be determined from a known distance. In the distance regression equations used nautical mile (nm), then:

1 nm = 1.852 km

Here is an example of calculating each route:

(BIL) – Nabire = 181 km
181 km = \frac{181}{1.852} \approx 98 \text{ nm}

Block Time = (0.006 \times 98) + 0.233
= 0.82 \text{ hour}
= 49 \text{ minutes}

To determine route utility for a year, the block time is multiplied by the frequency of the aircraft. Here is an example of calculation:

\text{Block time (BIL) – Nabire} = 0.82 \text{ hour}
\text{Utility} = 0.82 \times 12
= 9.8 \text{ hours}

The calculation of the number of aircraft is grouped by region or island. As described earlier, this group is based on the ability of small aircraft which is capable serving at close range. So, in determining the number of aircraft per area, the utility of each route is summed, than divided by N219 aircraft utility (1200 hours per year). Table 4 shows the results of the calculation for N219 requirement aircraft in Indonesia.

- Papua
  The number of aircraft = \frac{\text{Total of route utilization}}{\text{Utilization of N219}} = \frac{16675.7}{1200} = 13.89
  = 14 \text{ Units}

| Zone          | Route Utilization (hours per year) | Aircraft N219 Requirement |
|---------------|------------------------------------|---------------------------|
| Java          | 4407.6                             | 4                         |
| Papua         | 16676                              | 14                        |
| Sumatera      | 2159.4                             | 2                         |
| Kalimantan    | 1505.9                             | 1                         |
| Nusa Tenggara | 1936.3                             | 2                         |
| **Total**     | **23**                             |                           |

5. Conclusion

Block Time is affected by the distance on each flight of the aircraft, so to calculate the block time of each route can use regression analysis where the regression equation for block time is \( y = 0.233 + 0.006x \). Where \( y \) is the block time in hours and \( x \) is the distance in units of nautical mile (nm). The requirement of N219 serve non pioneer route in Indonesia is 23 units. It is divided into several parts, namely in Java requires 4 units, Papua requires 14 units, Sumatera requires 2 units, Kalimantan needs 1 unit, and Nusa Tenggara region requires 2 units. In this study only shows the need for N219 aircraft in general regardless of needs and utility in year.

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