Demand analysis at Tanah Grogot Airport East Kalimantan

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Abstract. Tanah Grogot Airport is an airport proposed by the Paser Regency Regional Government to facilitate the people's movement. During this time, the people of Paser Regency have to travel long distances with long travel time between regions. The airport's presence is expected to be able to have shorter travel time between regions because the transportation access between regions is already equipped with air transportation. If there are people or foreign tourists who want to travel quickly, they can use air transportation at this airport. Thus, it is necessary to analyze whether Tanah Grogot Airport has sufficient demand, which will affect the continuity of the airport's operations. The analysis in this research considers the following variables, i.e., the land and air accessibility based on travel time, vehicle operating costs, the flight network, market share value, and analysis of demand from the existing airports to Tanah Grogot Airport. The method uses stated preference and binary logistic regression. The outcome of this research is the estimation of demand at Tanah Grogot Airport East Kalimantan.

1. Introduction

Along with the increasing economic growth in Indonesia, the need for safe, comfortable, and inexpensive transportation is higher to support the mobility of the people who are also increasing day by day. Several choices of transportation modes, land, sea, and air transportation are also increasingly improving facilities and performance to provide the best service for passengers. Air transportation as a mode of transportation widely used by the public because it can connect long distances quickly is also improving in terms of safety and comfort for its users. One particular concern is the airport as the main supporting facility for the public to use air transportation modes, namely airplanes. In Indonesia, there are 298 airports, of which PT Angkasa Pura I and PT Angkasa Pura II manages 13 airports each. The private sector, the TNI, Udata Airport Operational Unit, and Regional UPT/Regional Government manage the remain airports.

Tanah Grogot Airport is an airport proposed by the Paser Regency Regional Government to facilitate the movement of the people to and from Paser Regency. During this time, the Paser Regency community must travel to Balikpapan City if necessary and use the mode of aircraft to go to other cities. The Indonesia government accelerates the development of 20 airports spread across the regencies/cities in Kalimantan, including airports in the border region. Figure 1 shows the location of airports in East Kalimantan.
There are several airports in Kalimantan that will compete to get the same passengers due to the close area of services that will be shared with other airports around. The airline is likely to assign flights to each airport by considering each airport's characteristics and the demand patterns. The decision of the airline will lead to a competitive relationship between these airports in Kalimantan. Therefore, the construction of Tanah Grogot Airport also needs to consider the air travel requests from neighboring cities and at the nearest airport.

Besides, all this time, the people of Paser Regency have to take a long time to travel between regions. To make the trip, the people of Paser Regency can only use land transportation such as cars, motorbikes, and buses or can also use sea transportation such as ferries and speed boats. Moreover, if they have to travel outside the island, such as Java Island, the people of Paser Regency are required to go to the nearest airport, requiring a long travel time. For example, to go to Balikpapan is around 5 hours by driving, and the travel time to go to Banjarmasin is around 8 hours. The presence of this airport will help to support the faster travel time between regions. The short travel time will be applicable for transportation access between regions due to air transportation availability. However, in preparing the development of an airport, one thing that needs to be available in the airport's demand. Therefore, this study aims to determine the level of demand at Tanah Grogot Airport, Paser Regency, East Kalimantan.

2. Study Area Data
An area can have more than one airport, especially in the metropolitan area, which is influenced by higher demand. Productive activities that occur between two or more adjacent airports in a region raise a form of Multiple Airports Regions (MAR). Therefore, the concept of Multiple Airport Regions (MAR) is a practical starting point for air transportation research. The MARs concept was introduced in the 1990s: MARs are based on groups of two or more major commercial airports in the metropolitan area. MARs in large-scale studios are often determined by spatial distance metrics to estimate airport catchment areas, ranging from 50 km to 250 km [1].

![Figure 2. Concept of development catchment area between airports (source : Yang et al., 2016).](image-url)
Figure 2 shows the model’s concept that explains the factor of land use development around the airport. The land use development is a determining factor on the land side because it forms a catchment area and the flight network [2].

The market share measured the coverage area, taking into account factors such as access to the airport, airline ticket costs, fees access time to the airport, and time charges in the air. The market share determines the pattern of airport selection by passengers and the competition that occurs between airports in the region. However, within MARs, air passengers can indeed choose between different airports not only based on the location of the airport that is in the vicinity but also a series of other airport service level (LOS) attributes. In general, airline ticket prices are the most important factor and are called the LOS attributes of major airports [3].

![Demand curve](source: Raisová and Ďurčová, 2014).

Demand also depends on the type of customer, type of trip, destination, competitors, flight network, market behavior, and price & income elasticity in specific markets. The demand curve can be seen in figure 3 [4]. The purpose of estimating demand is to meet passenger needs, create appropriate sales strategies, maximize profits, and offer optimal ticket pricing structures in a reservation system. Accessibility has a close relationship with demand. One of the essential factors in demand growth is accessibility. If the value of accessibility has increased, then demand will also increase [5].

3. Methods
Several things need to be reviewed in the demand analysis at Tanah Grogot Airport. The methodology aims to determine the market demand for the airport and solve the problems that need to be done in several work stages. These stages include the problem of identification, literature study, and data collection. An analysis of the land and air accessibility is carried out, as well as an analysis of demand shifts from the existing airports to Tanah Grogot Airport.

3.1 Analysis of Land and Air Accessibility
Land accessibility will be calculated based on the closest distance to the road network from the origin point to the airport. This land accessibility is illustrated by travel time between the origin i and the departure airport j [6]. Therefore, the distance will be calculated, as well as the travel time from the passenger’s area of origin based on the airport service radius in East Kalimantan. Furthermore, airport air accessibility will be analyzed using a formula developed by Yang, et al (2016). The formula is as follows:

\[
A_{\text{air}}^x = \text{Num}_x^{0.949(19.1)} \times \text{Freq}_x^{0.851(21.4)} \times N_{\text{AirRoute}}^{0.218(4.5)}
\]

Where,
\[
A_{\text{air}}^x = \text{Air Accessibility x}
\]
\[
\text{Num}_x = \text{Number of airports with direct connections x}
\]
\[
\text{Freq}_x = \text{Airport flight density x}
\]
NAirRoute\text{in use} = \text{Airport flight network length } x

After land accessibility and air accessibility are obtained, the next step is to calculate the accessibility of the regional airport air transportation ($Access_x$) to the existing airports and after the addition of Tanah Grogot Airport with the following formula.

\[ Access_x = A_c^{air}_x \times Pop_x \times \sum_{i=1}^{m} \frac{1}{(A_c^{land}_ix \times Pop_{ix})} \] (2)

Where,

- Access$_x$ = Accessibility of regional air transportation $x$
- $i$ = Traffic zone code (origin)
- $j$ = Airport code
- $A_c^{land}_ix$ = Land accessibility
- $Pop_x$ = Population in the airport catchment area
- $Pop_{ij}$ = Population in zone $i$ in the airport catchment area $j$
- $m$ = Number of traffic zones
- $\beta$ = Effect of land transportation resistance on flight accessibility, use value 1

Henceforth, the calculation follows the formula as follows if there are multiple airports in an area.

\[ Access = \sum_{x=1}^{n} \frac{Pop_x}{Pop} \times Access_x \] (3)

Where,

- $n$ = Number of airports
- Pop = Total regional population

### 3.2 Analysis of Demand Movements from Existing Airport to Tanah Grogot Airport

The data used in this study are primary data obtained through direct interview surveys in the field with respondents. Determination of the Number of sampling that will be used in this analysis is only a portion of the population taken. It is used to determine the nature and characteristics of a population. The number of samples will be calculated using the Slovin method with the following formula [7].

\[ n = \frac{N}{1 + Ne^2} \] (4)

Where,

- $n$ : minimum number of samples
- $N$ : regional population
- $e$ : error margin (the maximum error that can be tolerated)

In this study, the analysis technique used is a logistic regression model using the binary logit model. This model can be used to determine the percentage of passengers who are willing to move from an existing airport and can also be used to determine the factors that influence the respondents to move. The model used in binary logistic regression is as follows:

\[ \log \left( \frac{P}{1 - P} \right) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \ldots + \beta_nX_n \] (5)

Where $p$ is the possibility that $Y = 1$, and $X_1$, $X_2$, $X_n$ are independent variables, and $\beta$ is the regression coefficient.

The Aircraft Operating Cost method (AOC) will be used to determine the flight ticket rates. AOC is the value of aircraft operating costs per passenger and can also be interpreted as a plane ticket fare per passenger. The calculation of AOC is based on the revision of KM 26 of 2010.
4. Results and Discussion

4.1 Land and Air Accessibility

This analysis reviewed Tanah Grogot Airport and several other airports, including Sepinggan International Airport Balikpapan, Kalimarau Airport Berau Regency, APT Pranoto Samarinda Airport, Melalan Airport West Kutai Regency, Batulicin Bersujud Airport Tanah Bumbu Regency, and Warukin Airport Tabalong Regency. These airports were chosen for review because the airport area has a short distance from Tanah Grogot Airport, which means the potential of overlapping catchment areas. The overlapping catchment areas will give rise to potential market share values (market share scores) with Tanah Grogot Airport. The depiction of the radius of service from Tanah Grogot Airport can be seen in figure 4, adjusting to PM 39 of 2019 in the Kalimantan Island region of 60 km.

![Tanah Grogot service radius](image)

Figure 4. Tanah Grogot service radius.

Examples of travel time data from several sub-districts to the Tanah Grogot Airport can be seen in table 1. The calculation of travel time in table 1 can also be called land accessibility. This analysis aims to determine travel time from the area of origin to the existing departure airport and planning. The travel time results can also be called the value of land accessibility from which this result data will then be used for further analysis, namely, air accessibility.

| Regency          | Sub-Regency | Travel Time (hour) | Distance (km) | Velocity (km/hour) |
|------------------|-------------|--------------------|---------------|-------------------|
| Penajam Paser Utara | Babulu      | 2.47               | 105.0         | 42.6              |
|                  | Penajam     | 3.88               | 164.0         | 42.2              |
|                  | Sepaku      | 5.27               | 199.0         | 37.8              |
|                  | Waru        | 3.47               | 143.0         | 41.3              |
| Paser            | Batu Engau  | 1.50               | 57.1          | 38.1              |
|                  | Batu Sopang | 1.55               | 58.8          | 37.9              |
|                  | Kuaro       | 1.27               | 46.2          | 36.5              |
|                  | Long Ikis   | 1.97               | 75.9          | 38.6              |
|                  | Long Kali   | 5.27               | 224.0         | 42.5              |
|                  | Muara Komam | 4.00               | 143.0         | 35.8              |
|                  | Muara Samu  | 2.17               | 76.4          | 35.3              |
|                  | Paser Belengkong | 1.08     | 26.7          | 24.6              |
Regency | Sub-Regency | Travel Time (hour) | Distance (km) | Velocity (km/hour) \\
--- | --- | --- | --- | --- \\
Tanah Grogot | 1.42 | 39.3 | 27.7 \\
Tanjung Harapan | 4.17 | 115.0 | 27.6 \\

Airport air accessibility is the accessibility of an airport in terms of its flight network. The variables needed include the number of airports that can be reached directly (Num\(_x\)), frequency (Freq\(_x\)) and length of the flight network (NAirRoute\(_\text{in use}\)). The calculations and results can be seen in Table 2.

**Table 2.** Value of air accessibility.

| Airport | Code | Num\(_x\) | Freq\(_x\) (weeks) | NAirRoute (10,000 km) | Air Accessibility (weeks) |
|---------|------|-----------|-------------------|----------------------|--------------------------|
| APT Pranoto | AAP | 10 | 127 | 126,34852 | 1019.38 |
| Kalimarau | BEJ | 3 | 69 | 24,72143 | 157.02 |
| Sultan Aji Muhammad Sulaiman Sepinggan | BPN | 18 | 526 | 389,121.79 | 16685.66 |
| Melalan | MLK | 2 | 18 | 3.073,51 | 63.14 |
| Tanah Grogot | TNG | 5 | 76 | 14.281,28 | 624.75 |

After land accessibility and air accessibility are obtained, the next step is to calculate the accessibility of the regional airport air transportation (Access\(_x\)) to the existing airports and after the addition of Tanah Grogot Airport which can be seen in Table 3 and Table 4.

**Table 3.** Regional air transport accessibility at existing airports.

| Airport | Total Population Catchment Area | Accessibility of Air Transportation | (Popx/Pop)\(^x\)Access |
|---------|---------------------------------|-----------------------------------|------------------------|
| APT Pranoto (AAP) | 1.377.493 | 431.922,62 | 117.565,44 |
| Kalimarau (BEJ) | 703.839 | 13.356,24 | 1.857,56 |
| Sultan Aji Muhammad Sulaiman (BPN) | 1.951.050 | 1.463.228,54 | 564.111,66 |
| Melalan (MLK) | 1.028.376 | 2.370,35 | 481,67 |
| Total | 5.060.758 | 1.910.877,74 | 684.016,32 |

**Table 4.** Regional air transport accessibility with the addition of Tanah Grogot Airport.

| Airport | Total Population Catchment Area | Accessibility of Air Transportation | (Popx/Pop)\(^x\)Access |
|---------|---------------------------------|-----------------------------------|------------------------|
| APT Pranoto (AAP) | 1.377.493 | 431.922,62 | 117.565,44 |
| Kalimarau (BEJ) | 703.839 | 13.356,24 | 1.857,56 |
| Sultan Aji Muhammad Sulaiman (BPN) | 1.951.050 | 1.463.228,54 | 555.257,55 |
| Melalan (MLK) | 1.028.376 | 2.370,35 | 474,11 |
| Tanah Grogot | 80.699 | 4.004.544,17 | 62.853,99 |
| Total | 5.141.457 | 5.915.422 | 736.134,21 |
| Addition (%) | | | 7.62% |

In Table 3, the value of the accessibility of regional air transportation in East Kalimantan Province to the existing airports is 684,016.32. On the other hand, in Table 4 with the addition of Tanah Grogot Airport, the accessibility value of regional air transportation increased by 7.62% with a value of 736,134.21.
4.2 Analysis of Demand Movements from Existing Airport to Tanah Grogot Airport
The methodology was previously explained to determine the Number of samples needed for conducting surveys in the field using the formula of Slovin theory. The population of Paser Regency in 2019 is 279,975 based on data from BPS (Statistics Indonesia) and the margin error value used is 10%. Calculation of the Number of samples is as follows:

\[ n = \frac{N}{1 + Ne^2} \]

\[ n = \frac{279975}{1 + (279975 \times (10\%)^2)} \]
\[ n = 99.9643 \]
\[ n = 100 \text{ samples} \]

The interview survey was conducted directly in Paser Regency for 3 days. Respondents who were the targets of conducting the survey were the respondents who relatively frequently traveled in and out of the district of Paser where these respondents would later become potential passengers of Tanah Grogot Airport. The interview succeeded in getting as many as 103 respondents who had been surveyed from the conditions in the field.

Before analyzing binary logistic regression, a Chi-Square test (bivariant selection) will be conducted to select variables that can be entered into the multivariant stage of binary logistic regression. In the Chi-Square test, a selection is made between only two variables in the survey results, the dependent variable (WTM) and the independent variable (age, gender, education, employment, income, origin, destination, purpose, frequency, vehicle, travel time, travel costs, and ticket costs). The WTM variable is a willingness to move.

**Table 5. Chi-Square Test results.**

| Information       | Chi-square | df | P value  | Result          |
|-------------------|------------|----|----------|-----------------|
| WTM * Age         | 0.694      | 1  | 0.405    | Not a Candidate |
| WTM * Gender      | 2.224      | 1  | 0.136    | Candidate       |
| WTM * Education   | 5.12       | 1  | 0.024    | Candidate       |
| WTM * Employment  | 0.576      | 1  | 0.448    | Not a Candidate |
| WTM * Income      | 3.535      | 1  | 0.06     | Candidate       |
| WTM * Origin      | 13.716     | 1  | 0        | Candidate       |
| WTM * Destination | 0.002      | 1  | 0.962    | Not a Candidate |
| WTM * Purpose     | 0.036      | 1  | 0.85     | Not a Candidate |
| WTM * Frekuency   | 2.712      | 1  | 0.1      | Candidate       |
| WTM * Vehicle     | 9.378      | 1  | 0.002    | Candidate       |
| WTM * Travel Time | 3.441      | 1  | 0.064    | Candidate       |
| WTM * Travel Cost | 22.044     | 1  | 0        | Candidate       |
| WTM * Ticket Cost | 0.001      | 1  | 0.993    | Not a Candidate |

From table 5, it can be seen that eight variables become variable candidates to be multivariate variables in the binary logistic regression stage (Pvalue <0.25), namely gender, education, income, origin, frequency, vehicle, time, and travel costs. Furthermore, binary logistic regression analysis of the multivariate variables from the previous result is obtained. The control of the results of this analysis is to pay attention to the aspects of Sig (Pvalue) <0.1. If it does not meet, it must be re-analyzed by eliminating one variable with the most significant Sig (Pvalue) value. After the re-analysis, the next thing to control is to pay attention to changes in Oddratio / Exp (B) \[ Δ\text{Exp (B)} \] <10%. Suppose some variables do not meet these requirements. In that case, the eliminated variable can be re-entered or replaced by eliminating another variable with the next largest Sig (Pvalue) value. This multivariate analysis process is carried out repeatedly until it is obtained a suitable variable that meets the (significant) requirements. The results of all binary logistic regression tests were analyzed 9 times. The selected multivariate results can be seen in table 6.
Table 6. Binary logistics multivariate regression results.

| Variables in the Equation | B     | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I. for EXP(B) |
|---------------------------|-------|------|------|----|------|--------|---------------------|
| Step 1^                  |       |      |      |    |      |        |                     |
| Income                   | .377  | .330 | 1.304| 1  | .253 | 1.458  | .763 - 2.784        |
| Origin                   | 1.055 | .522 | 4.077| 1  | .043 | 2.872  | 1.031 - 7.996       |
| Vehicle                  | .407  | .183 | 4.976| 1  | .026 | 1.503  | 1.051 - 2.149       |
| Travel Cost              | 1.017 | .325 | 9.768| 1  | .002 | 2.766  | 1.461 - 5.234       |
| Constant                 | -5.270| 1.328| 15.748| 1 | .000 | .005   |                     |

^Variable(s) entered on step 1: Income, Origin, Vehicle, Travel Cost.

Even though there is one variable whose value is sig (Pvalue) >0.1, it can still be used for further calculation. This variable is called the confounding variable. From table 6, the following equation is obtained.

\[
\log \left( \frac{P}{1 - P} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n
\]

\[Y = -5.270 + 0.377 X_1 + 1.055 X_2 + 0.407 X_3 + 1.017 X_4\]

Where;

\[Y = \text{Logit (p/1-p)}\]
\[X_1 = \text{Income}\]
\[X_2 = \text{Origin}\]
\[X_3 = \text{Vehicle}\]
\[X_4 = \text{Travel Cost}\]

Table 7. Result of probability.

| Number of Responden | Income (X_1) | Origin (X_2) | Vehicle (X_3) | Travel Cost (X_4) | Logit (p/1-p) | Probability (p) |
|---------------------|--------------|--------------|---------------|-------------------|---------------|-----------------|
| 1                   | 2            | 1            | 1             | 2                 | -1.020        | 0.2689          |
| 2                   | 1            | 1            | 1             | 2                 | -1.192        | 0.2315          |
| 3                   | 1            | 1            | 1             | 2                 | -0.989        | 0.2689          |
| J                   | 100          | 2            | 3             | 5                 | 3.523         | 0.9707          |
| 101                 | 1            | 2            | 4             | 2                 | 0.879         | 0.7109          |
| 102                 | 1            | 1            | 4             | 1                 | -1.192        | 0.2315          |
| 103                 | 1            | 2            | 4             | 1                 | -0.138        | 0.4750          |

Probability of WTM from existing airport = \( \frac{0.6741}{67.41\%} \)

From the results in table 7, the probability of willingness to move from the existing airports to Tanah Grogot Airport is 67.41% (average of all probabilities). The calculation of Aircraft Operating Cost (AOC) is based on the revision of KM 26 of 2010 regarding the analysis and evaluation of the formulation mechanism of the calculation and determination of passenger fares for economy class. The aircraft studied is the ATR72 aircraft, which is following the planned aircraft for Tanah Grogot Airport. The calculation of AOC includes direct and indirect costs, as can be seen in table 8.
Table 8. Aircraft operating costs.

| Number | Aircraft Operating Cost Components | % | Range Flight 1 Hours (Rp/hour) |
|--------|------------------------------------|---|-------------------------------|
| 1      | Fixed Direct Operating Costs       |   |                               |
| 1      | Depreciation of aircraft           | 18.7 | 9.100.000                     |
| 2      | Insurance premium                  | 7.57 | 3.683.333                     |
| 3      | A fixed salary for a airplane crew | 4.1  | 1.993.333                     |
| 4      | A fixed salary for a technician    | 2.67 | 1.300.000                     |
| 5      | Training Cost                      | 0.56 | 270.833                       |
|        | **Sub-Total**                      | 33.6 | 16.347.499                    |
| 1      | Variable Direct Operating Costs    |   |                               |
| 1      | Use of fuel (avtur)                | 21.54 | 545.600                       |
| 2      | Use of Lubricants                  | 0.56 | 10.481.419                    |
| 3      | Flight Crew Allowances             | 2.49 | 2.426.278                     |
| 4      | Airplane overhaul & maintenance    | 13.63 | 13.265.417                    |
| 5      | Airplane services                  | 0.63 | 447.036                       |
| 6      | Ground handling                    | 3.67 | 1.784.444                     |
| 7      | Catering                           | 2.35 | 1.141.233                     |
|        | **Sub-Total**                      | 44.88 | 30.091.427                    |
|        | **Total Direct Operating Costs**   | 78.48 | 46.438.926                    |
|        | **Indirect Operating Costs**       |   |                               |
| 1      | General and organization           | 4.24 | 2.062.500                     |
| 2      | Marketing & sales (agent commission)| 8.19 | 3.985.648                     |
|        | **Total indirect operating costs** | 12.43 | 6.048.148                     |
|        | **Total operating costs before profit** | 90.91 | 52.487.074                    |
|        | **Profit margin 10%**              | 9.09 | 5.248.707                     |
|        | **Total Aircraft Operating Costs** | 100.00 | 57.735.781                    |

Table 8 shows the operational cost value of the ATR72 type aircraft in a 1-hour flight operation with a total of Rp. 57,732,781 per hour. The flight route was chosen based on the survey results of the destination’s origin, with the most destinations: Tanah Grogot Airport, the city regency of Paser - Balikpapan Sepinggan Airport. The distance between the two airports is 99.24 km, with a travel time of 23.26 minutes. The calculation of operational costs for one flight in determining ticket prices is as follows:

\[
\text{Aircraft Operating Cost (route)} = \frac{\text{AOC}}{\text{1 jam}} \times \text{travel time} \\
= \frac{\text{Rp.}57.735.781}{1 \times 60 \text{ minutes}} \times 23,26 \text{ minutes} \\
= \text{Rp.}22.382.238
\]

\[
\text{AOC per unit of output} = \frac{\text{Number of aircraft seats}}{\text{Aircraft Operating Cost (route)}} \\
= \frac{52}{\text{Rp.}22.382.238} = \text{Rp.}430.428 \text{ per passenger}
\]

From the calculation that has been done, the value of AOC per unit of output is Rp. 430.428, per passenger. The AOC value per unit of output is the value of aircraft operating costs per passenger or can also be interpreted as a plane ticket rate per passenger.

5. Conclusion

The development of Tanah Grogot Airport has an influence on the accessibility of regional air transportation to the surrounding airports. Before the operations of this airport, the value of regional air transportation accessibility in East Kalimantan Province was 684,016.32. With the Tanah Grogot Airport, the accessibility value of regional air transportation has increased by 7.62% to 736,134.21. This increasing value means that the development of Tanah Grogot Airport can increase regional accessibility in terms of land and air accessibility in the East Kalimantan region. One of the essential factors in
demand growth is accessibility. If the value of accessibility has increased, then demand will also increase.

From the interview survey results that have been analyzed by binary logistic regression statistics, the results are obtained in the form of a large percentage of the probability of transfer of demand from the existing airports to Tanah Grogot Airport, which amounted to 67.41%. Variables that affect, among others, namely the variable level of income, the variable origin of the trip, the variable vehicle commonly used, and the variable cost of travel.

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