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OPTIMIZATION MODELS OF PIONEER ROUTES IN PAPUA PROVINCE

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ABSTRACT: The province of Papua has a very varied topography, ranging from swampy lowlands, hills, and plateaus up steep hills. The total area of land is 319,036,05 km², which consists of 28 counties and one city, 524 districts, and 5,225 villages. The population of Papua Province in 2017 was 3,911,726 with an average growth of 1.95% per year. The transportation services are still minimal, especially in the mountainous region, which is isolated and could only be reached by an air transportation mode. The purposes of this study are to determine (1) the characteristics of pioneering air transport infrastructure and services in the current province of Papua, (2) the cost of transportation of basic needs and price disparities in the Central Highlands of Papua, (3) the acceleration of development of connectivity system in the region The Central Highlands of Papua, and (4) the model of the optimization of pioneer aviation routes and routes in the Central Highlands of Papua. The research is non-experimental and qualitative and quantitative descriptive, which is a case study with survey and direct observation in the field that gives an idea of the object being studied and its development in the future. The optimization analysis tools Solver uses in Microsoft Excel and LINGO 17. The results of the research indicate that the high prices that occur in the central mountains of Papua are not only caused by the high cost of transportation but too much profit taken by traders with an average gross profit margin of 130-366%. The results of route optimization analysis using Solver on Microsoft Excel and LINGO 17 can save transportation cost by 15.85%.

Keywords: Optimization, Flight Schedules, Pioneer Flight Route, Papua.

1. INTRODUCTION

Province of Papua is divided into 5 (five) customary territories, namely: Mamta, Saireri Lapago, Meepago, and Animha. Lapago Traditional Territory has a steep and descending hilly topography condition. Until now air transportation has become a mainstay in this region. The region's dependence on air transport modes is enormous, resulting in very high transportation costs, which of course has an impact on the high prices of consumer goods in these areas.

One of the biggest challenges of development implementation in Papua Province is the limited transportation infrastructure which is smooth and cheap, allowing people and government to carry out their activities effectively and efficiently.

There are several things that are often mentioned as the reason for poor transportation infrastructure in Papua. First, the extent of Papua Province especially when compared with its residents who live in isolated and scattered. Secondly, the costly cost of building Papua's transport infrastructure is particularly linked to the very difficult geophysics of Papua - in particular, the steep mountains of central Papua and the swamps and peatlands of the South. Third, the policy of development of unfair and unfair communications infrastructure so far, for example between coastal areas and inland/mountains.

Fig. 1 Map of Papua

Papua's natural wealth potential is huge, especially in mining, forestry, plantation, fishery, energy, and tourism sectors. But ironically, this great natural resource does not bring prosperity to the people in Papua. This is due to the limited number of infrastructure and transportation facilities which resulted in low accessibility of the region and the isolation and impact on the price of goods and the price of basic needs in the province is relatively much more expensive than the price in other areas in Indonesia due to the very expensive

transportation costs. In 2015, in Papua Province, there are 73 pioneer aviation routes financed from APBN funds totaling Rp145.702.193.999,00. The number of routes and pioneering air subsidy funds is always increasing from year to year. More details can be seen in Figure 2.

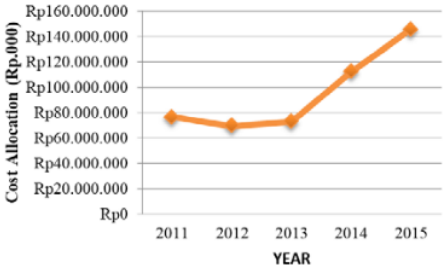


Fig.2 Graph of Development of Pioneer Air Transportation Subsidy in 2011-2015

2. LITERATURE REVIEW

The transport or transfer of goods and passengers from the place of origin to the destination will create the utility of the goods transported. The utility of transportation infrastructure especially for freight transportation is basically 2 (two) kinds namely place utility and time utility. Both of these uses mean that the transport infrastructure provides services to a community called transportation services (Morlok, 1995, 35-36). In general, the price of an item will be expensive because of the cost of transport is very expensive.

Transportation is a major component for the functioning of a community activity. Transportation is directly related to the pattern of community, local and regional life or the area of influence of production and social activities and goods and services that can be consumed. The life of the advanced society is characterized by high mobility due to the availability of adequate transportation facilities, on the contrary, it is the unfavorable area of the transportation system that causes the society's economic condition to be in a static state or in an immobility stage (Jinca, 1999; 6).

Based on the hierarchy service, the flight route consists of major flight routes, feeders, and pioneers. (Regulation of the Minister of Transportation No. KM 49 the Year 2005). The main route is the route that connects the central airport deployment. The feeder route is a route that links between a central airport dispersal with an airport that is not a deployment center. Pioneer route is a route that links the airport rather than a dispersal center with an aerodrome rather than a dispersed center located in an isolated (lagging) area.

Pioneer air transport is a commercial air transport that serves networks and aviation routes to connect remote and inland areas or areas hard to contact by other modes of transport, and covertly not profitable for airlines. (Law No. 1 the Year 2009 About Aviation).

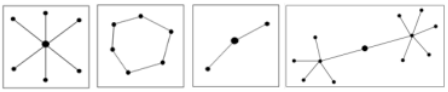
Air transport activities on pioneer routes shall be made using aircraft with capacity under 30 (thirty) seats. In addition, because most of the pioneer airports have a short runway that can only be landed by small aircraft.

Pioneer Air Transportation is the provision of transportation services where there is government interference in the form of subsidy because there is an imbalance between demand and supply. This pioneering air transport occurs in remote areas where the purchasing power (effective purchasing power) of the community is under the current rate of transportation services. Currently, the policy of subsidizing pioneer air transport is based on only one criterion: operational criteria (operating income less than operational cost).

As mentioned above that pioneer aviation operations receive government interference in the form of subsidies. The subsidy is based on the following considerations:

a. Meet the criteria for the implementation of pioneer air transport
b. The airport is capable of serving pioneer air transport flights
c. The airline is ready for operation
d. Availability of funds from the Central Government and/or Local Government.

Some types of travel routes can be expressed, ie (a) resembling chicken claws, (b) spider web, (c) is a straight line and (d) a combination of chicken claws and straight line models. (Adisasmita, S. A., 2013. Mega City & Mega Airport). Some of these types of flight routes are shown in the following figure:



Chicken Feet Sipder web Straight Line Combination

Fig. 3 Flight Route Pattern

The scope of this study is limited to the subject of pure flight operations flight schedules with known Origin-Destination (OD), various types of aircraft, fleet size, and data-related costs. Although the scheduling process in practice is closely related to aircraft maintenance and ship crew scheduling processes, this process is generally separated to facilitate troubleshooting.

2.1 Overview of Solver Program

The program solver is an add-in program under

the excel program. This solver program contains the commands that serve to perform analysis of optimization problems. When installing Microsoft excel is not automatically this solver is installed, so it must be installed specifically after the excel program installed on the computer. The Excel Solver is a product developed by Frontline Systems for Microsoft. OpenSolver has no affiliation with, nor is recommend by, Microsoft or Frontline Systems.

The program solver can be used in Windows 98, Windows 2000, Microsoft XP, Millennium, Windows Vista, Windows 7, Windows 8 and Windows 10.

2.2 Descriptive Statistics

The descriptive statistical analysis is used to describe and capture the factual condition of the existence of public transportation infrastructure and public housing in Lapago area, where the description is based on the perception of the farmer (demand side) who directly observe and feel the benefits of the infrastructure development. Farmers' perceptions are spelled out using a Likert Scale consisting of four or five statements for example strongly agree, agree, neutral, strongly agree and strongly disagree. Or it may also be an adequate statement, sufficient, inadequate, inadequate, and so on. Likert scale is also used to assess the understanding and knowledge of SKPD about the existence of public transportation and housing infrastructure that can support the productivity of leading commodity farmers.

In descriptive statistics also used the size of the proportion calculated by dividing a value of a certain object with a total value. This proportion if applied in grouped data is called the relative frequency distribution, whereas for a single data commonly called a contribution value. Each value of the proportion is measured in the following manner:

$$\mathbf{P = \frac{x_i}{\Sigma x_i}\ x\ 100\ \%} \quad \text{..... (1)}$$

P is the proportion and Xi is the object of observation to i.

2.3 Model Profit Margin

Profit margin derived from the formula calculate the selling price when compared with the purchase price as follows:

PrM = (P–M) / (M/100) .....(2)

PrM: profit margin obtained

M: capital or purchase price

P: selling price

2.4 Linear Programming

Linear programming is a branch of mathematics that can be applied to various scientific fields such as economics, technology, pharmacy, transportation, industry, etc. With linear programming will facilitate business actors to determine the right product composition in order to maximize profits or minimize costs. Likewise for transportation problems in terms of route determination. With LINGO17 program and solver on Microsoft excel very easy for the perpetrator is looking for problem-solving than manual counting. Linear programming for transportation problems can be described as in Figure 4 below.

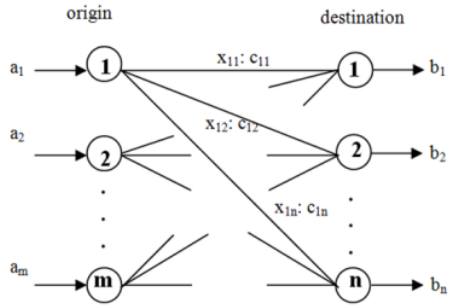


Fig.4 Route optimization with LINGO and solver on excel

The terms of completion with the transport model are the model in a balanced state, namely: Total supply = total demand

$$\sum_i a_i = \sum_j b_j \quad \text{..... (3)}$$

Thus if $\sum_i a_i = \sum_j b_j$ then all the existing supply will be distributed out, and all the request of the destination. Then the source constraints and goal constraints become in the form of equations. Models of transportation of the problem:

o.d $\min Z = \sum_i \sum_j c_{ij} x_{ij}$

d.c : $\sum_j x_{ij} = a_i \; i = 1,2, \ldots m$ ..... (4)

$\sum_i x_{ij} = b_j \qquad j = 1,2, \ldots n$ ..... (5)

$\sum_i a_i = \sum_i b_j$ ..... (6)

$x_{ij} \geq 0 \qquad i = 1,2, \ldots m \quad j = 1,2, \ldots n$

1. RESEARCH METHODS

3.1 Types and Research Design

Based on the objectives and problems studied, this study is non-experimental, descriptive

quantitative and qualitative, which is a type of case study with survey and direct observation in the field that gives an overview of the object under study.

3.2 Research Location

This research was conducted in Papua Province especially in the Central Highlands Region of Papua which is now known as Lapago Traditional Region.

3.3 Method of Collecting Data

The type of data used in this study includes primary and secondary data that is obtained from data and related institutions either through print media or by electronic media.

4. RESULT AND DISCUSSION

4.1. Price of Basic Needs in Lapago Region

The prices of basic commodities in Lapago region, as a whole, in 16 commodities in 7 districts can be said to be the highest in Papua Province. When compared with the situation of commodity prices in Jayapura City as the capital of Papua Province. The districts of Nduga and Yalimo both have the highest average food commodity prices, where the largest contributor to food prices in both areas is the highest price of chicken meat at a price of Rp. 250,000 per head in Nduga District, and Rp. 95,000 per head in Yalimo District. In Kabupaten Pegunungan Bintang, some of the highest commodities are vegetables, kerosene, gasoline, and cement, for Nduga regency the highest price lies in the commodity of sugar, rice, coffee, chicken meat and chicken eggs, then in Kabupaten Yahukimo the highest price in commodity flour and beef / pork, while for Yalimo regency the highest commodity prices are on cooking oil, tea and beef / pork commodities. While Lanny Jaya District, appears to have the price of basic necessities in Lapago region is relatively lower for the 16 commodities. For all districts in Lapago area, the price of cement is very striking, even tends to be irrational because the price can reach more than Rp. 500.000 per sack. Where the highest in Pegunungan Bintang and Yalimo regencies, each of Rp. 2,000,000 per sack and Rp. 1.500.000 per sack, and the lowest in Yahukimo Regency Rp. 200,000 per sack.

If the average gross profit margin obtained by traders in Lapago area seems very irrational because for every basic necessity sold by merchants traders can earn an average gross profit margin of between 130-366%. And if the assumed logistic cost of goods procurement at the location of each regency market location is 100%, it is seen that net profit margin received by a trader in Lapago area is still big, reaching 30 - 266%. The district in Lapago region with the highest profit margin Netto is Pegunungan Bintang, reaching 265.67%, which means for every purchase of staple goods from the city of Jayapura of Rp. 1,000 per unit, it will be sold by a trader in Pegunungan Bintang Regency to local people around:

$P = M + [(M \times PrM)/100] = 1000 + [(1000 \times 265,67)/100] = 3656,70$

Thus the net sales profit enjoyed by traders in Pegunungan Bintang Regency for every purchase price from Jayapura City is Rp. 3,656.70 - Rp. 1,000 = Rp. 2,656.70 per unit of goods after deducting logistics costs.

A profit margin of more than 200% can be said to be highly irrational if viewed from an economic theory that is normally set on the basis of a comparison between marginal revenue and marginal cost for perfectly competitive markets, and a typically high 50% mark-up price for the monopoly market.

According to the traders in Lapago area mark up prices that could reach more than 200% is due to the logistics distribution costs for this area is very high compared to other areas in Papua Province, which is more dominant influenced by noneconomic factors such as disturbance of security and order society, landslide disaster, long distances, and so on, which ultimately affects the selling price of traders to consumers.

Economically such a situation is a normal thing because the determination of the retail sale price must also take into account the logistics costs, which according to Setijadi (2012) average logistics costs in Indonesia about 20-25% of the formation of selling prices. However, the factual condition in Lapago Area, when simulated logistics costs reached 100% (4 times higher logistics costs in Indonesia), net profit of traders still seems irrational. Even for some districts if simulated logistics costs up to 200%, traders' profits are still above normal. For example, in Kabupaten Pegunungan Bintang, if the logistic cost is 200%, net profit margin obtained by traders is 165.67%, while in Nduga Regency it reaches 68%. Considering the behavior of traders in determining the selling price of basic commodities that appear irrational, it can be said there is an indication of the traders in Lapago Area utilizing topography, geography, transportation, security disturbances, and other non-economic factors as an excuse to get huge profits from the people in Lapago Region.

Table 1 Profit Margin Received Traders Basic Needs In Lapago Area According to Buyer Price Year 2017

Kommodity	Jayapura - Nasional	Jayawijaya - Jayapura	Peg. Bintang - Jayapura	Yalimo - Jayapura	Nduga - Jayapura	Yahukimo - Jayapura	Tolikara - Jayapura	Lanny Jaya - Jayapura
Sugar	17.46	46.67	166.67	66.67	233.33	100.00	66.67	66.67
Rice	0.38	88.68	135.85	88.68	230.19	135.85	135.85	88.68
Flour	32.99	66.67	66.67	108.33	83.33	150.00	66.67	66.67
Cooking oil	43.00	92.31	207.69	323.08	284.62	284.62	53.85	53.85
Coffee	21.95	66.67	100.00	66.67	233.33	100.00	66.67	66.67
Tea	20.97	33.33	100.00	300.00	233.33	100.00	33.33	33.33
Vegetables	18.18	15.38	-	30.77	-	30.77	15.38	15.38
Beef / Pork	8.02	128.57	185.71	171.43	614.29	42.86	157.14	157.14
Chicken meat	-	34.00	20.00	40.00	50.00	40.00	80.00	40.00
Fish	-	0	240.00	100.00	0	0	150.00	200.00
Kerosene	0.00	700.00	1,500.00	700.00	500.00	400.00	900.00	700.00
Chicken eggs	66.79	112.80	140.00	152.70	299.00	166.00	139.40	139.40
Fuel	0.00	163.16	492.11	228.95	294.74	163.16	228.95	228.95
Instant noodles	16.28	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Cemen	41.67	488.24	1,664.71	1,076.47	605.88	135.29	841.18	841.18
Profit Margin Bruto Average	22.13	142.43	365.67	236.92	268.72	129.90	202.34	186.53
Logistik Cost*	14.08	100.00	200.00	100.00	200.00	100.00	100.00	100.00
Profit Margin Netto Average	8.05	42.43	165.67	136.92	68.72	29.90	102.34	86.53

Source: data processed
* The percentage of logistics cost of 100% is a simulation number

If we assume that the procurement of all the staple goods in the Lapago area comes from Jayapura City with prices according to Jayapura standards, then it can be measured how much profit margin enjoyed by traders in Lapago Region when compared to the base price in Jayapura City. The profits obtained by the traders are very large and above the fair price, so the price to be paid by the people in the highlands of Papua is very high. This has resulted in the low level of welfare of the community

By using the calculation formula for profit margin as in formula (2), profit margins can be measured from merchant merchants in the Lapago area for each commodity, as shown in Figure 5 in the following.

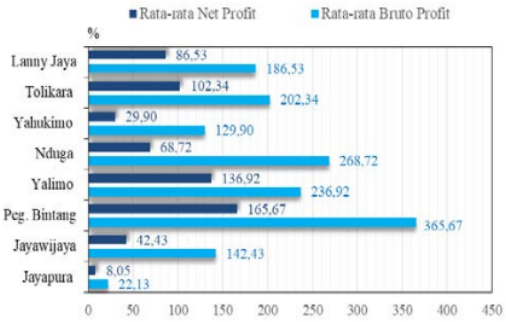


Fig.5. Graph of Margin Acquisition Benefits of Traders in Lapago Region and Jayapura City

4.2 Optimization of Pioneer Flight Routes in the Central Highlands of Papua

Based on the Decree of the Director General of Civil Aviation Number: KP.233 Year 2017 on the Route and Operation of Air Transportation Pioneer Cargo and Air Transportation Subsidized Cargo as well as Provider of Air Transportation Subsidy Transportation (BBM) Aircraft For Air Transportation Pioneer Cargo as Implementing Air Bridge Program 2017, The central government through the Ministry of Transportation provides the allocation of funds for cargo transportation to 12 districts in the interior of Papua as in table 2 below:

Table 2 Minimum Target of Cargo Air Transport in 2017

NO.	AIRPORT HUB	ROUTE			MINIMUM TARGET	
					MOVEMENT PER WEEK	CARGO CALLED PER WEEK (Kg)
1	TIMIKA	Timika	-	Ilaga	4	2000
		Ilaga	-	Timika	4	0
		Timika	-	Sinak	4	3200
		Sinak	-	Timika	4	0
		Timika	-	Kenyam	3	2250
		Kenyam	-	Timika	3	0
		Timika	-	Beoga	3	1500
		Beoga	-	Timika	3	0
2	WAMENA	Wamena	-	Mugi	1	500
		Mugi	-	Wamena	1	0
		Wamena	-	Mamit	1	500
		Mamit	-	Wamena	1	0
		Wamena	-	Mapenduma	1	500
		Mapenduma	-	Wamena	1	0
		Wamena	-	Enggolok	1	500
		Enggolok	-	Wamena	1	0
3	DEKAI	Dekai	-	Anggruk	3	2400
		Anggruk	-	Dekai	3	0
		Dekai	-	Silimo	3	2400
		Silimo	-	Dekai	3	0
		Dekai	-	Korupun	4	1600
		Korupun	-	Dekai	4	0
		Dekai	-	Ubahak	4	2000
		Ubahak	-	Dekai	4	0

Source: KP.233 Year 2017

Table 3 Optimization Results Using Solver in Microsoft Excel

NO.	AIRPORT HUB	ROUTE			MINIMUM TARGET	
					MOVEMENT PER WEEK	CARGO CALLED PER WEEK (Kg)
1	TIMIKA	Timika	-	Ilaga	4	2000
		Ilaga	-	Timika	4	0
		Timika	-	Sinak	4	3200
		Sinak	-	Timika	4	0
		Timika	-	Beoga	3	1500
		Beoga	-	Timika	3	0

2	WAMENA	Wamena	-	Kenyam	3	2250
		Kenyam	-	Wamena	3	0
		Wamena	-	Mugi	1	500
		Mugi	-	Wamena	1	0
		Wamena	-	Mamit	1	500
		Mamit	-	Wamena	1	0
		Wamena	-	Mpduma	1	500
		Mpduma	-	Wamena	1	0
		Wamena	-	Enggalok	1	500
		Enggalok	-	Wamena	1	0
		Wamena	-	Angggruk	3	2400
		Angggruk	-	Wamena	3	0
		Wamena	-	Silimo	3	2400
		Silimo	-	Wamena	3	0
		Wamena	-	Ubahak	2	950
		Ubahak	-	Wamena	2	0
3	DEKAI	Dekai	-	Korupun	4	1600
		Korupun	-	Dekai	4	0
		Dekai	-	Ubahak	2	1050
		Ubahak	-	Dekai	2	0

In accordance with KP. 233 the Year 2017, there are 3 Airport Hub namely Timika Airport, Dekai Airport and Wamena Airport. Each airport serves 4 small airports (spoke). The hub and spoke routes can be seen in Figure 6 below.

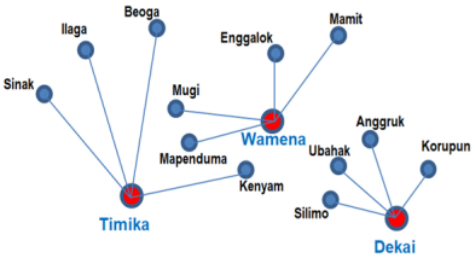


Fig. 6 Without Optimized Route

Before being optimized, the cost required for air cargo transportation is Rp186.190.000,00 per week, while after optimizing the required cost to Rp156,680,000.00 per week so there are a cost savings of 15.85% per week.

The optimization results as described in the hub and spoke route are as shown in Figure 4 below, which shows that there is a change in the number of airports spokes for each hub airport, ie Timika Airport originally 4 to 3, Dekai Airport was originally 4 to 2 and Wamena Airport was originally 4 to 8.

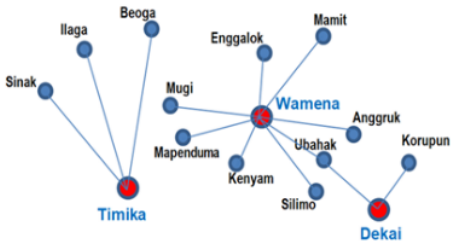


Fig. 7 Result Optimization Route

To optimize the allocated funds for cargo transportation subsidy from optimization result with solver of 15.85% or Rp29.510.000,00, then the addition of new route by choosing one of the villages in Nduga District which is Regency with IPM (Human Development Index) the lowest in Papua Province. The chosen village is Kampung Yuguru, because, in addition to the reasons mentioned above, Yuguru Village also has a pioneer airfield with a runway length of 500 m. From the optimization result with the addition of the route as shown in Figure 5, the addition of Timika - Yuguru route with the number of goods transport each week is 2,100 kg, the required subsidy fund is Rp185,870,000.00, still lower than the government-provided subdivision fund every week of Rp186. 190.000,00. The route after the optimization and addition of new routes can be seen in Figure 8 below.

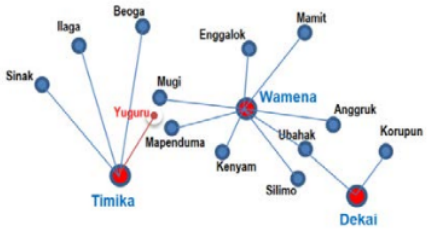


Fig.8 Addition of New Routes After Optimization

5. CONCLUSION

1. The price of basic necessities in Lapago Traditional Territory is very high when compared to prices in other regions of Indonesia. The high price is due to two dominant factors namely transportation costs and profit margin (profit margin) is very high. From the analysis, it is known that the price in Lapago Traditional Territory is more influenced by the profit factor of the trader compared with the transportation cost.
2. Accessibility of areas dominated by air transport by small aircraft to be one of the disparity factors that caused the level of overpriced in Lapago region to be the highest in Indonesia.
3. Optimization result of pioneer flight route in Lapago Traditional Territory can save logistics transportation cost equal to 15,85% or equal to Rp29,510.000,00 every week. The savings result can be used to add a new route of Timika - Yuguru with logistic transportation of 2,100 kg every week.

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