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Analysis of Airport Optimal Location in Papua Province as a Support for Logistics Center Distribution Development

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Abstract

Papua is the largest province in Indonesia. It covers an area of 316,552.6 km^2. Papua Province consists of 28 regencies and one city, with a population of 4.03 million in 2020. The main mode of transportation as a link between regions in this province is air transportation, in addition to the development of sea transportation through the Sea Toll program and land transportation with the construction of the Trans Papua Road. This study takes the point of view of the transportation network, especially for air transportation, as the mode of choice backbone of the logistics distribution in the Papua area. Considering these conditions, this study considers that the airport is a logistics node, so it is necessary to inventory the number of airports in Papua Province. The method of this study was the shortest path which was included in a network model for determining the shortest and various routes. It analyzed the answers to questions such as which one will be the shortest, fastest, or cheapest route to go to a location and determined locations for logistics facilities, such as distribution centers and warehouses. The study's results were the object of this research is the airport listed on the website. Analysis of the shortest route between airports in the Instrument Flight Rules (IFR) Route Papua area network produced a distance matrix between airports. It resulted four scenarios of the number of airports and their respective service areas.

Keywords: *Air transportation, Logistic, Airport Location, Instrument Flight Rules*

INTRODUCTION

The province of Papua is located in the eastern part of Indonesia. Before being named Papua, it changed its name several times, namely Irian (1946), West Irian (1969-1973), and Irian Jaya (1973-2002). The replacement of Irian Jaya into Papua is based on Law No. 21 of 2001 concerning Special Autonomy for Papua. It covers an area of 316,552.6 km2 and is the largest province in Indonesia. Administratively, Papua Province consists of 28 regencies and one city, with a population of 4.03 million in 2020.

Until now, the main mode of transportation as a link between regions in this province is air transportation, in addition to the development of sea transportation through the Sea Toll program and land transportation with the construction of the Trans Papua Road. A quote from https://bisnis.tempo.co (2019), said that the government will build ten airports, namely Ewer Airport, Kepi Airport, Ilaga Airport, Oksibil Airport, Nabire Baru Airport, Mopah Airport, Rendani Manokwari Airport, Waisai Airport Raja Ampat, Wasior Airport New, and the New Siboru Fak-fak Airport. For land transportation, the Trans-Papua Road has been built which is included in the National Strategic Project (PSN) and the National Medium-Term Development Plan (RPJMN) 2020-2024. In terms of sea transportation, the government will build several ports, namely Depapre Port,

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Nabire Port, Pomako Port, Moor Port, and Serui Port for Papua Province and Kaimana Port in West Papua Province.

By paying attention to the transportation node development program above, this study takes the point of view of the transportation network, especially for air transportation, as the mode of the choice backbone of the logistics distribution in the Papua area. Logistics distribution in Papua still has significant challenges in various factors, such as limited network infrastructure and transportation services, population distribution patterns that are scattered in large areas, geographical conditions, topography, and weather (Humang, 2016). For example, it takes a maximum of fifteen days to distribute logistics from Java Island to the Central Mountains area of Papua Province. It must enter from the southern part of Papua through the Timika Pomako Port, pass through the loading and unloading stage, and be transported to Mozes Kilangin Airport using land transportation. The goods are then transported via air using pioneering Twin Otter, Pilatus and Caravan aircraft to the Central Mountains area (Humang, 2016).

Government policies implemented related to logistics and air transportation in Papua include the following: 1) Construction and development of Nop Goliat Airport, Dekai, Yahukimo Regency, is intended as a logistics distribution center for the central mountainous region of the ProvincePapua, which was previously centered through Wamena Airport, then distributed via river and land transportation to each destination (http://dephub.go.id, 2020); 2) A news from Berita Satu's youtube channel (https://www.youtube.com/watch?v=RbogZIo9xA0) said that an air toll roads, namely providing operational subsidies for logistics flights from Timika, Merauke, Sorong airports to the regions interior; 3) Establish 99 pioneer air transportation routes in the Papua region, by making eight airports as the origin of pioneer flights, namely Nabire Airport, Elelim Airport, Sentani Airport, Wamena Airport, Timika Airport, Merauke Airport, Tanah Merah Airport and Dekai Airport (DGAT, 2019); 4) Planning Mopah Airport in Merauke Regency to be a liaison for inter-district logistics movements in Papua Province (Berita Satu, 2021).

Considering these conditions, this study considers that the airport is a logistics node, so it is necessary to inventory the number of airports in Papua Province. Information on the website of http://server-application.dephub.go.id stated that there are 83 airports in various classes. According to data from the website of https://aimindonesia.dephub.go.id, there are a total of 213 airports in various classes in Papua Province. The transportation network is a relationship between nodes and links. In an air transportation network, an airport is a node and then connected to the other airport by links based on the Instrument Flight Rules (IFR) Route. IFR Route is a rule set by the aviation authority for a condition when a flight using the Visual Flight Rules (VFR) Route is unsafe, for example, due to limited visibility when weather disturbances (FAA, 2012). Using the IFR Route means that the flight is guided by the instruments on the flight deck, meaning that navigation uses electronic signals (FAA, 2012). The IFR Route for the Papua can be seen in Figure 1.

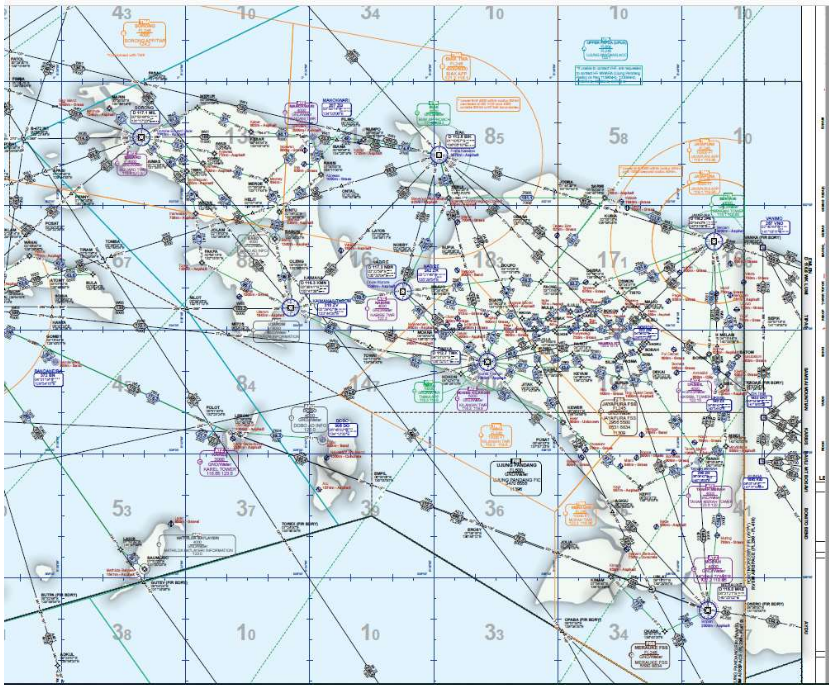

Figure 1. Map of IFR Route Of Papua Area

The IFR Route of the Papua area becomes the basis for the analysis to determine which airport will have the most optimal location if it will be used as the location of the logistics distribution center in Papua Province. So, the problems formulated in this study are: 1) Which airports are the research objects? 2) How to determine the airport's optimal location? and 3) Which airport has the most optimal location to serve areas throughout Papua?

LITERATURE REVIEW

Airport

According to the Law of the Republic Indonesia Number 1 of 2009 concerning Aviation, airport is an area on land or waters with certain boundaries that are used as a place for airplanes to land and take off, boarding and dropping passengers, loading and unloading goods, and a place for intra and intermodal transportation, which is equipped with aviation safety and security facilities, as well as basic facilities and other supporting facilities. An airport can act as a transportation node where people change their transportation mode. It can also function as a logistics node, where goods change ownership. In the context of the logistics network, the airport is a vital node for collecting, consolidating, and distributing goods. Based on that, the idea of the research is to make the airport as a logistics distribution center point. Previous research from Drljaca et al. (2020) said that an airport city (AC) represents a part of the supply chain with the facilities of ground handling, logistics, office space, shops, hotels, etc. The AC can contribute to optimal supply chain flows.

Logistics and Supply Chain

Bahagia, S.N. (2021) said there are three points of view when talking about logistics and supply chain: microscopic, mesoscopic, and macroscopic. The microscopic level is about the company, focused on physical supply, procurements, and physical distributions. Mesoscopic level deals with the corporation network, when some companies work together as a business network in logistics project and formed a supply chain networking. The macroscopic level is a platform of competitiveness and prosperity of the nation. So, logistics and supply chains are the way to achieve greater performance in delivering goods, whether it is for a company, corporation, or country. This research sees if the logistics business of goods distribution in Papua Province should be optimized by taking advantage of the position of the airport and its aviation transportation network. Logistics technology is procedures in the economic environment about the interaction of logistics using optimization methods. As said by Ferencova and Hurna (2017), the aviation industry uses these technologies to enhance development among other sectors.

A. Goods Distribution

Distribution of goods is the activity of moving goods from suppliers to final consumers through distribution channels to produce added value when consumers need it, with the right type, amount, time, cost level, and risk (Martono, 2015). The distribution network is a complex matter with various basic functions in the form of added value, facilitation of consolidation and delivery, determination of transportation modes, inventory storage, and the existence of reverse logistics (Martono, 2015). Service coverage to consumers is an important factor in the development of distribution by considering the location of the distribution facilities, reducing transportation costs, and shortening the time to fulfill consumer demands. It is important to determine the number of distribution facilities that can offset the level of service to consumers with other costs that will arise, such as transportation costs and warehousing costs (Martono, 2015). It refers to the consideration of determining the location, which includes (Martono, 2015): 1) The distance of the consumer's location; 2) Labor costs; 3) Business situation and conditions; 4) The balance of transportation costs and inventory storage costs. According to Lin et al. (2015), an airport distribution center would effectively integrate storekeeping, transporting, processing, manufacturing, and other industry-related functions into a highly efficient and concentrated logistics environment.

Shortest Path

The shortest path includes a network model for determining the shortest and various routes. This model analyzes the answer to questions such as which will be the shortest, fastest, or cheapest route to go to a location (FAA, 2012). In the shortest path route model, there are notations of X_{ij}, which is a route from i node to j node and R_{ij}, which is the distance, time, or cost from i node to j node. This model seeks to minimize the distance, cost, or journey time with a mathematic equation expressed as $\text{Min} \sum_{i=1}^{m} \sum_{j=1}^{n} R_{ij} . X_{ij}$ (Siswanto, 2007). To simplify the calculation process, we can use a Microsoft office excel add-on called solver (Siswanto, 2007).

Facility Location Problem

Determination of locations for logistics facilities, such as distribution centers and warehouses, aims to help minimize transportation and distribution costs (SCI, 2017). The key factors in determining the location of logistics facilities are geographical location factors, namely labor, transportation infrastructure, proximity to markets and consumers, completeness of facilities for quality of life, industrial areas, suppliers, land, water, energy, and telecommunications costs infrastructure (SCI, 2017). Site location considerations include transportation access (truck, air, train, and sea transportation), metropolitan area, availability of labor according to the required skills, land costs and taxes, water, energy, and telecommunications facilities (SCI, 2017).

The method of determining the location includes 1) The load-distance method $d_i = \sqrt{(x_i - x^*)^2 + (y_i - y^*)^2}$ with d_i = customer distance i and suggested locations, x_i = x coordinate of customer i, x^* = x coordinate of suggested facility, y^* = y coordinate of the suggested facility; 2)

Break-even analysis, with stages including a) Determine fixed and variable cost of each suggested site alternatives; b) Plotting of total cost line, includes the total of fixed and variable cost for each site; c) Identification of fixed and variable cost range estimation for each lower cost site; d) Calculation of *break-even point* between a closed site with an algebra equation (SCI, 2017). The analysis of the facility location problem in this research was helped by the solver adds-on in Microsoft excel.

Open Solver

Sometimes the solver function in MS Excel cannot calculate the data because of their size. The function has a limitation, so we have to find another solution, then we can use OpenSolver. OpenSolver is an Excel VBA add-in with a more powerful function, developed by Andrew Mason and students at the Engineering Science department, University of Auckland, New Zealand (www.opensolver.org). The excellent features of OpenSolver are no artificial limits on the problem size and it is free as open-source software. OpenSolver has been developed for Excel 2007/2010/2013/2016, running on Windows.

RESEARCH METHOD

To determine which airports in the Papua area are used as research objects, the stages of work are carried out, namely: 1) Inventory of airports in Papua through the information contained on the website http://server-application.dephub.go.id and the website https://aimindonesia.dephub.go.id; 2) Grouping airports into administrative areas per Regency/City; 3) Selecting an airport in one Regency/City to be the object of research, taking into account the distance between airports in one region and another; and 4) Make a map of the location of the airport.

In the second problem formulation, which is to determine the optimal distance between the airports, the following analysis is carried out: 1) Using the IFR Route map to determine the shortest route between airports; 2) Analysis of the shortest route with the shortest path problem using the help of the MS excel solver; 3) Create a distance matrix between airports. The third problem formulation to find out which airports have optimal flight distances to serve areas throughout Papua is carried out in the following stages: 1) The distance matrix between airports is analyzed using the facility location problem with the help of the MS excel solver; 2) Results of the analysis is to find the most optimal airport to serve other regions, this result is important to know to be one of the ingredients in determining the distribution of goods in the Papua area, which is indicated by the minimum value for the total flight distance; and 3) Analyzing the optimal number of airports as the origin of the service. As a simplification of the research method described above, the research flow chart can be seen in Figure 2.

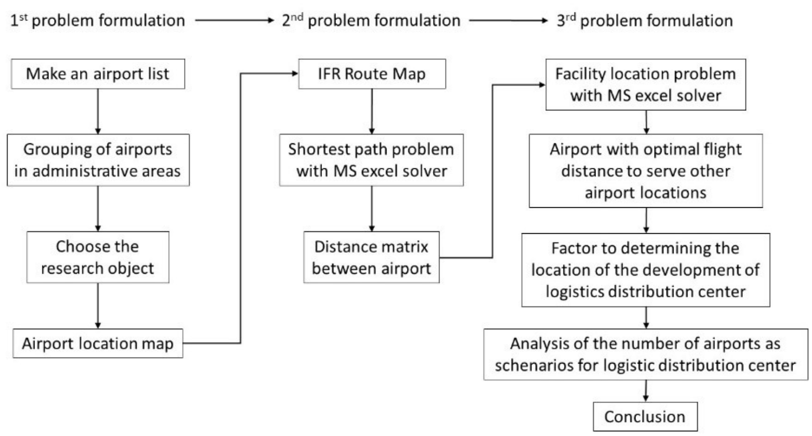

Figure 2. Research Flowchart

FINDINGS AND DISCUSSION

Research Object

This research took basic data from the website http://server-application.dephub.go.id, which is 83 airports, then grouped by administrative area. Based on these data, on average there are three airports per region, with the highest number of airports located in the Bintang Mountains Regency and two areas without an airport, namely Jayapura City and Supiori Regency. The next stage was the selection based on airport class, which was only class I, II and III, as well as consideration of the proximity of the distance between airports so that the object of research is obtained as Table 1.

Table 1. Researched Airport

NO	AIRPORT	AIRPORT CODE		AREA
		IATA	ICAO	
1	Frans Kaisiepo	BIK	WABB	Biak Numfor District
2	Bilogai	UGU	WABY	Intan Jaya District
3	Dabra	DRH	WAJC	Mamberamo Raya District
4	Dekai	DEX	WAVD	Yahukimo District
5	Elelim	ELR	WAVE	Yalimo District
6	Ewer	EWE	WAKG	Asmat District
7	Ilaga	ILA	WAYL	Puncak District
8	Karubaga	KBF	WABK	Tolikara District
9	Kepi	KEI	WAKP	Mappi District
10	Moanamani	ONI	WABD	Dogiyai District
11	Mopah	MKQ	WAKK	Merauke District
12	Mulia	LII	WAVA	Puncak Jaya District
13	Douw Aturure	NBC	WABI	Nabire District
14	Oksibil	OKL	WAJO	Pegunungan Bintang District
15	Mararena	ZRM	WAJI	Sarmi District
16	Senggeh	SHE	WAJS	Keerom District
17	Dortheys Hiyo Eluay	DJJ	WAJJ	Jayapura District
18	Stevanus Rumbewas	ZRI	WABO	Serui District
19	Tanah Merah	TMH	WAKT	Boven Digoel District
20	Mozes Kilangin	TIM	WAYY	Mimika District

NO	AIRPORT	AIRPORT CODE		AREA
		IATA	ICAO	
21	Tiom	TMY	WABH	Lanny Jaya District
22	Waghete	WET	WABA	Paniai District
23	Wamena	WMX	WAVV	Jayawijaya District

Next, a map of the distribution of researched airports was made and can be seen in Figure 3.

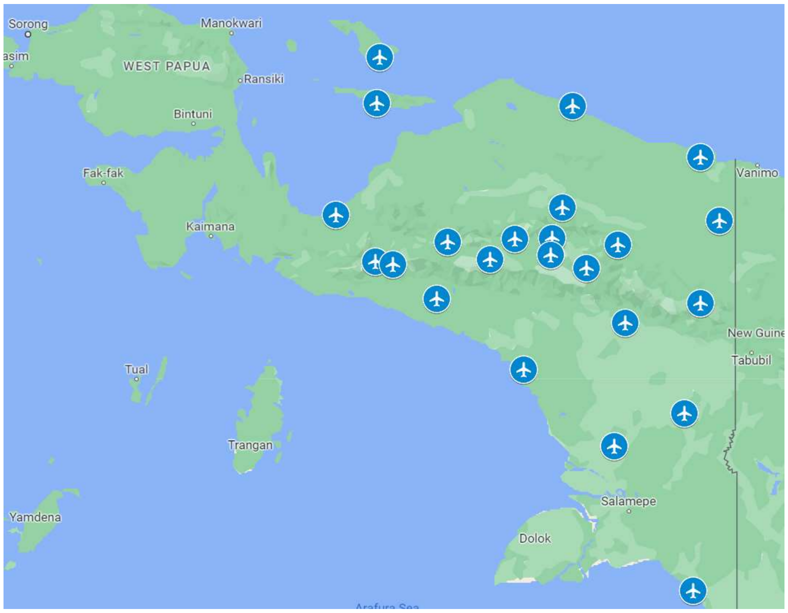

Figure 3. Researched airport location distribution map

Optimal Distance Between Airports

Analysis of the optimal distance between airports was carried out based on the length of the airways link in the IFR Route, as shown in Figure 1. It was known that there are 166 links on the map, complete with link length information in units of nautical miles (nm), 1 nm = 1.852 kilometers (km). The distance between airports was determined by calculating the shortest route using the shortest path problem method and the ms excel solver. The ms excel solver model analyzed the shortest route for trips from origin to destination between airports and calculated the optimal distance. Then a distance matrix was made, as seen in Table 2 and Table 3. Based on the table, it was known that the average flight route distance between airports is 215.2 nm or 398.5 km and the longest flight route is from Mopah Airport in Merauke to Serui Airport in Serui, which is 527.2 nm or 976.4 km.

Table 2. Distance Matrix Between Airports in Nautical Miles

	Biak	Bilogai/Suapa	Dabra	Dekai	Elelim	Ewer	Ilaga	Karubaga	Kepi	Moanami	Mopah	Mulia	Nabire	Oksibil	Sarmi/Mararena	Senggeh	Sentani	Serui	Tanah Merah	Timika	Tiom	Waghete	Wamena
Biak		229,1	322,6	302	276,8	302,9	268,3	286,8	400,3	184,2	523,1	288	134,9	420,2	193,4	335,7	278,9	42,3	390,8	204,5	276,9	198,8	245
Bilogai/Suapa	229,1		118,1	178,9	153,7	136,3	39,2	90,2	233,7	106,6	367	58,9	94,2	353,5	166,6	286,2	229,4	194,6	267,7	47,4	90	92	121,9
Dabra	322,6	118,1		297	271,8	254,4	157,3	208,3	351,8	224,7	479,1	177	187,7	262,9	154,9	178,4	121,6	288,1	348,7	165,5	208,1	210,1	240
Dekai	302	178,9	297		88,8	170,8	139,7	98,8	152,5	218	275,2	130,1	266	174,6	301,3	244,2	187,4	344,3	88,8	158,8	88,9	203,4	57
Elelim	276,8	153,7	271,8	88,8		211,6	114,5	73,6	241,3	218,7	309,9	104,9	247,9	263,4	276,1	219	162,2	319,1	177,6	159,5	63,7	204,1	31,8
Ewer	302,9	136,3	254,4	170,8	211,6		97,1	154,5	97,4	157,6	347,5	123,2	205,6	246,9	302,9	335,2	293,7	306	161,1	98,4	147,9	143	179,8
Ilaga	268,3	39,2	157,3	139,7	114,5	97,1		57,4	194,5	124,1	360,8	26,1	133,4	314,3	205,8	253,4	196,6	233,8	228,5	64,9	50,8	109,5	82,7
Karubaga	286,8	90,2	208,3	98,8	73,6	154,5	57,4		251,9	181,5	356,8	31,3	184,4	280,5	253,1	196,0	139,2	284,8	224,5	122,3	46,8	166,9	78,7
Kepi	400,3	233,7	351,8	152,5	241,3	97,4	194,5	251,9		255	250,1	220,6	303	149,5	400,3	237,8	290,8	403,4	63,7	195,8	241,4	240,4	209,5
Moanami	184,2	106,6	224,7	218	218,7	157,6	124,1	181,5	255		378,8	150,2	49,3	392,6	273,2	374,1	317,3	149,7	306,8	59,2	174,9	14,6	186,9
Mopah	523,1	367	479,1	275,2	309,9	347,5	360,8	356,8	250,1	378,8		351,2	426,8	217	471,4	305,3	357,5	527,2	186,4	319,6	310	364,2	278,1
Mulia	288	58,9	177	130,1	104,9	123,2	26,1	31,3	220,6	150,2	351,2		153,1	308	225,5	227,3	170,5	253,5	222,2	91	44,5	135,6	76,4
Nabire	134,9	94,2	187,7	266	247,9	205,6	133,4	184,4	303	49,3	426,8	153,1		440,6	236,2	366,1	309,3	100,4	354,8	107,2	184,2	63,9	216,1
Oksibil	420,2	353,5	262,9	174,6	263,4	246,9	314,3	280,5	149,5	392,6	217	308	440,6		255,2	88,3	141,3	406,3	85,8	333,4	263,5	378	231,6
Sarmi/Mararena	193,4	166,6	154,9	301,3	276,1	302,9	205,8	253,1	400,3	273,2	471,4	225,5	236,2	255,2		170,7	113,9	151,1	341	214	256,6	258,6	244,3
Senggeh	335,7	286,2	178,4	244,2	219	335,2	253,4	196,0	237,8	374,1	305,3	227,3	366,1	88,3	170,7		56,8	321,8	174,1	314,9	219,1	359,5	187,2
Sentani	278,9	229,4	121,6	187,4	162,2	293,7	196,6	139,2	290,8	317,3	357,5	170,5	309,3	141,3	113,9	56,8		265	227,1	258,1	162,3	302,7	130,4
Serui	42,3	194,6	288,1	344,3	319,1	306	233,8	284,8	403,4	149,7	527,2	253,5	100,4	406,3	151,1	321,8	265		433,1	207,6	284,6	164,3	287,3
Tanah Merah	390,8	267,7	348,7	88,8	177,6	161,1	228,5	224,5	63,7	306,8	186,4	222,2	354,8	85,8	341	174,1	227,1	433,1		247,6	177,7	292,2	145,8
Timika	204,5	47,4	165,5	158,8	159,5	98,4	64,9	122,3	195,8	59,2	319,6	91	107,2	333,4	214	314,9	258,1	207,6	247,6		115,7	44,6	127,7
Tiom	276,9	90	208,1	88,9	63,7	147,9	50,8	46,8	241,4	174,9	310	44,5	184,2	263,5	256,6	219,1	162,3	284,6	177,7	115,7		160,3	31,9
Waghete	198,8	92	210,1	203,4	204,1	143	109,5	166,9	240,4	14,6	364,2	135,6	63,9	378	258,6	359,5	302,7	164,3	292,2	44,6	160,3		172,3
Wamena	245	121,9	240	57	31,8	179,8	82,7	78,7	209,5	186,9	278,1	76,4	216,1	231,6	244,3	187,2	130,4	287,3	145,8	127,7	31,9	172,3	

Table 3. Distance Matrix Between Airports in Kilometers

	Biak	Bilogai/Suapa	Dabra	Dekai	Elelim	Ewer	Ilaga	Karubaga	Kepi	Moanami	Mopah	Mulia	Nabire	Oksibil	Sarmi/Mararena	Senggeh	Sentani	Serui	Tanah Merah	Timika	Tiom	Waghete	Wamena
Biak		424,3	597,5	559,3	512,6	561	496,9	531,2	741,4	341,1	968,8	533,4	249,8	778,2	358,2	621,7	516,5	78,34	723,8	378,7	512,8	368,2	453,7
Bilogai/Suapa	424,3		218,7	331,3	284,7	252,4	72,6	167,1	432,8	197,4	679,7	109,1	174,5	654,7	308,5	530	424,8	360,4	495,8	87,78	166,7	170,4	225,8
Dabra	597,5	218,7		550	503,4	471,1	291,3	385,8	651,5	416,1	887,3	327,8	347,6	486,9	286,9	330,4	225,2	533,6	645,8	306,5	385,4	389,1	444,5
Dekai	559,3	331,3	550		164,5	316,3	258,7	183	282,4	403,7	509,7	240,9	492,6	323,4	558	452,3	347,1	637,6	164,5	294,1	164,6	376,7	105,6
Elelim	512,6	284,7	503,4	164,5		391,9	212,1	136,3	446,9	405	573,9	194,3	459,1	487,8	511,3	405,6	300,4	591	328,9	295,4	118	378	58,89
Ewer	561	252,4	471,1	316,3	391,9		179,8	286,1	180,4	291,9	643,6	228,2	380,8	457,3	561	620,8	543,9	566,7	298,4	182,2	273,9	264,8	333
Ilaga	496,9	72,6	291,3	258,7	212,1	179,8		106,3	360,2	229,8	668,2	48,34	247,1	582,1	381,1	469,3	364,1	433	423,2	120,2	94,08	202,8	153,2
Karubaga	531,2	167,1	385,8	183	136,3	286,1	106,3		466,5	336,1	660,8	57,97	341,5	519,5	468,7	363	257,8	527,4	415,8	226,5	86,67	309,1	145,8
Kepi	741,4	432,8	651,5	282,4	446,9	180,4	360,2	466,5		472,3	463,2	408,6	561,2	276,9	741,4	440,4	538,6	747,1	118	362,6	447,1	445,2	388
Moanami	341,1	197,4	416,1	403,7	405	291,9	229,8	336,1	472,3		701,5	278,2	91,3	727,1	506	692,8	587,6	277,2	568,2	109,6	323,9	27,04	346,1
Mopah	968,8	679,7	887,3	509,7	573,9	643,6	668,2	660,8	463,2	701,5		650,4	790,4	401,9	873	565,4	662,1	976,4	345,2	591,9	574,1	674,5	515
Mulia	533,4	109,1	327,8	240,9	194,3	228,2	48,34	57,97	408,6	278,2	650,4		283,5	570,4	417,6	421	315,8	469,5	411,5	168,5	82,41	251,1	141,5
Nabire	249,8	174,5	347,6	492,6	459,1	380,8	247,1	341,5	561,2	91,3	790,4	283,5		816	437,4	678	572,8	185,9	657,1	198,5	341,1	118,3	400,2
Oksibil	778,2	654,7	486,9	323,4	487,8	457,3	582,1	519,5	276,9	727,1	401,9	570,4	816		472,6	163,5	261,7	752,5	158,9	617,5	488	700,1	428,9
Sarmi/Mararena	358,2	308,5	286,9	558	511,3	561	381,1	468,7	741,4	506	873	417,6	437,4	472,6		316,1	210,9	279,8	631,5	396,3	475,2	478,9	452,4
Senggeh	621,7	530	330,4	452,3	405,6	620,8	469,3	363	440,4	692,8	565,4	421	678	163,5	316,1		105,2	596	322,4	583,2	405,8	665,8	346,7
Sentani	516,5	424,8	225,2	347,1	300,4	543,9	364,1	257,8	538,6	587,6	662,1	315,8	572,8	261,7	210,9	105,2		490,8	420,6	478	300,6	560,6	241,5
Serui	78,34	360,4	533,6	637,6	591	566,7	433	527,4	747,1	277,2	976,4	469,5	185,9	752,5	279,8	596	490,8		802,1	384,5	527,1	304,3	532,1
Tanah Merah	723,8	495,8	645,8	164,5	328,9	298,4	423,2	415,8	118	568,2	345,2	411,5	657,1	158,9	631,5	322,4	420,6	802,1		458,6	329,1	541,2	270
Timika	378,7	87,78	306,5	294,1	295,4	182,2	120,2	226,5	362,6	109,6	591,9	168,5	198,5	617,5	396,3	583,2	478	384,5	458,6		214,3	82,6	236,5
Tiom	512,8	166,7	385,4	164,6	118	273,9	94,08	86,67	447,1	323,9	574,1	82,41	341,1	488	475,2	405,8	300,6	527,1	329,1	214,3		296,9	59,08
Waghete	368,2	170,4	389,1	376,7	378	264,8	202,8	309,1	445,2	27,04	674,5	251,1	118,3	700,1	478,9	665,8	560,6	304,3	541,2	82,6	296,9		319,1
Wamena	453,7	225,8	444,5	105,6	58,89	333	153,2	145,8	388	346,1	515	141,5	400,2	428,9	452,4	346,7	241,5	532,1	270	236,5	59,08	319,1	

The Most Optimal Airport Location

The matrix above became the material for the third analysis, to analyze which airports have optimal flight distances to serve areas throughout Papua. Facility location problem analysis using the MS-EXCEL solver was made with the scenario of the number of airports, namely one to four. The results of the analysis can be seen in Table 4.

Table 4. The Most Optimal Airports in Four Scenarios

NO	SCENARIOS	AIRPORT	FLIGHT DISTANCES	
			nm	km
1	One airport	Ilaga, Puncak District	3,452.7	6,394.4
2	Two airports	Ilaga, Puncak District	1,961.5	3,632.7
		Tanah Merah, Boven Digoel District	598.8	1,109.0
		Total distance	2,560.3	4,741.7
3	Three airports	Ilaga, Puncak District	1,120.2	2,074.6
		Tanah Merah, Boven Digoel District	598.8	1,109.0
		Serui, Yapen District	544.1	293.8
		Total distance	2,012.8	3,727.7
4	Four airports	Ilaga, Puncak District	532.7	986.6
		Tanah Merah, Boven Digoel District	424.7	786.5
		Dortheys Hiyo Eluay, Jayapura District	292.3	541.3
		Douw Aturure, Nabire District	348.5	645.4
		Total distance	1,598.2	2,959.9

In Scenario 1, if set only one airport was the most optimal location to serve all airports in Papua Province, then the Ilaga Airport has chosen. Scenario 2 explained if two airports were set, then Ilaga Airport and Tanah Merah Airport were chosen. In Scenario 3, if set three airports, then Ilaga Airport, Tanah Merah Airport, and Serui Airport were chosen. In Scenario 4, if set four airports, Ilaga Airport, Tanah Merah Airport, Dortheys Hiyo Eluay Airport, and Douw Aturure Airport, were chosen. The comparison graph of all flight distances between scenarios can be seen in Figure 4.

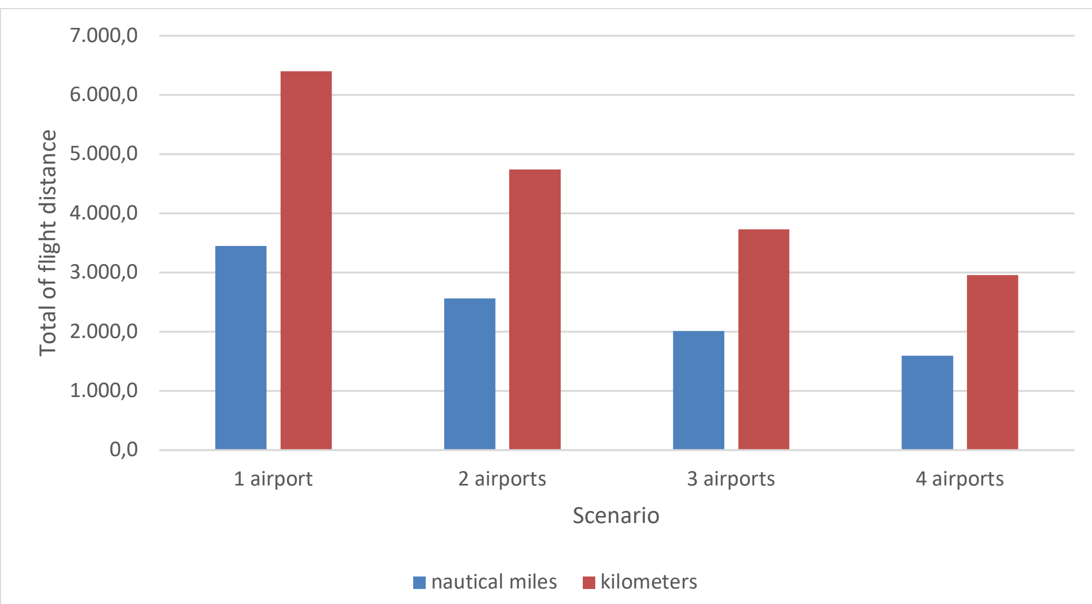

Figure 4. The bar chart of the total flight distance of all scenarios

Served area in Scenario 2 as seen in Table 5.

Table 5. Served area in Scenario 2

No	Airport		Total Flight Distances	
	Origin	**Destination**	**nms**	**kms**
1	Ilaga, Puncak District	Biak Bilogai Dabra Elelim Ewer Karubaga Moanamani Mulia Nabire Sarmi Sentani Serui Timika Tiom Waghete Wamena	1,961.5	3,632.7
2	Tanah Merah, Doven Bigoel District	Dekai Kepi Mopah Oksibil Senggeh	598,8	1,109

Served area in Scenario 3 as seen in Table 6.

Table 6. Served area in Scenario 3

No	Airport		Total Flight Distances	
	Origin	**Destination**	**nms**	**kms**
1	Ilaga, Puncak District	Bilogai Dabra Elelim Ewer Karubaga Moanamani Mulia Sentani Timika Tiom Waghete Wamena	1,120.2	2,074.6
2	Tanah Merah, Boven Digoel District	Dekai Kepi Mopah Oksibil Senggeh	598.8	1,109

No	**Airport**		**Total Flight Distances**	
	Origin	**Destination**	**nms**	**kms**
3	Serui, Yapen District	Biak Nabire Sarmi	293.8	544.1

Served area in Scenario 4 as seen in Table 7.

Table 7. Served area in Scenario 4

No	**Airport**		**Total Flight Distances**	
	Origin	**Destination**	**nms**	**kms**
1	Ilaga, Puncak District	Bilogai Elelim Ewer Karubaga Mulia Timika Tiom Wamena	532.7	986.6
2	Tanah Merah, Boven Digoel District	Dekai Kepi Mopah Oksibil	424.7	786.5
3	Douw Aturure, Nabire District	Biak Moanamani Serui Waghete	348.5	645.4
4	Dortheys Hiyo Eluay, Jayapura District	Dabra Sarmi Senggeh	292.3	541.3

CONCLUSION

The conclusions of this study is answering the formulated problem of this research, those are as follows: 1) Object of this research is the airport listed on the website http://server-application.dephub.go.id, then selected by the following considerations: a) at least a class III airport, b) represent the region and c) pay attention to the distance between airports in one region and in another, so the total of 23 airports are then selected; 2) Analysis of the shortest route between airports in the IFR Route Papua area network uses the optimal selection route procedures, produces a distance matrix between airports, which becomes the basic information for the analysis of the most optimal airport location; 3) Analysis of the facility location problem with the OpenSolver software, resulted in four scenarios of the number of airports – one, two, three and four airport – and their respective service areas, these results will be useful as one of the considerations in determining the logistics distribution strategy in Papua Province with an air transportation backbone. In Scenario One, the airport whose location is the most optimal is Ilaga Airport, with a total flight distance of 6,394.4 kms. In Scenario Two are Ilaga Airport and Tanah Merah Airport with a total flight distance of 4,741.7 kms. In Scenario Three are Ilaga Airport, Tanah Merah Airport, and Serui Airport with total flight distance of 3,727.7 kms. In Scenario Four, there are Ilaga Airport, Tanah Merah Airport, Dortheys Hiyo Eluay Airport, and Douw Aturure Airport, with a total flight distance of 2,959.9 kms.

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