Original Article

Study of the multi-airport system in "Greater Jakarta" with the potential of secondary airports of Pondok Cabe or Budiarto

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Abstract

Soekarno-Hatta International Airport is a major hub airport that serves as a transit point from 364 indirect domestic flight routes and serves more than 48 million air passengers annually. To cope with the enormous demand, in 2014 the Indonesian government opened Halim Perdana Kusuma Airport for commercial services, which was previously the headquarters of the Indonesian Air Force Operations Command. The current capacity is no longer able to serve the current demand. Taking the existence of the closest non-commercial airports into consideration, this study aims to determine how much potential passenger sharing would be if a multi-airport system was implemented. The approach is carried out using Jovanovic's theory and Ministerial Regulation No. 39 of 2019. The results indicated the Pondok Cabe and Budiarto predicted to be able to accommodate the generation of air passengers in the Greater Jakarta areas are 21-55% and 19-51% respectively.

Keywords: multi airport system, Soekarno-Hatta, passenger sharing

1. Introduction

Soekarno-Hatta International Airport is located in Tangerang City, Banten province, Indonesia. Although limited by the provincial administrative area, this airport is the backbone of air transportation which serves the country's capital *(*Jakarta*)* and surrounding areas. The service area of Soekarno-Hatta Airport covers the metropolitan area of Greater Jakarta, namely Jakarta, Bogor, Depok, Tangerang, and Bekasi. It is the largest hub airport serving as a transit point from 364 indirect domestic flight routes in Indonesia and serving domestic flights of more than 48 million passengers annually *(*Subdirectorate of Transportation Statistics, 2017*)*. To cope with such great demand, in 2014 the Indonesian government officially opened Halim Perdana Kusuma Airport in Jakarta City for commercial services. This airport was previously the headquarters of the Air Force Operations Command and was only used for military purposes.

Five years after the commercial operation of Halim Perdana Kusuma Airport, the demand for air passengers remains unstoppable. Therefore, Soekarno-Hatta Airport continues to develop capacity in terms of the land-side *(*passenger terminal*)* and the air-side *(*runway*)*. To date, Soekarno-Hatta Airport has three runways and three passenger terminals with a total area of 714,821 m^2 to serve both domestic and international flights; while Halim Perdana Kusuma Airport has a runway and two passenger terminals with a total area of 19,810 m^2 for both domestic and international flights *(*Ministry of Air Transportation, 2018*)*. Although it was aimed at breaking down the demand for air passengers in Soekarno-Hatta, the current demand for air passengers at Halim Perdana Kusuma is increasingly unstoppable. Annually, the demand for air passengers at this airport increases seven times faster than Soekarno-Hatta. Statistically, the existing capacity is no longer able to serve the increasing demand for air passengers. One of the concepts offered to break down the demand for air passengers at Soekarno-Hatta and Halim Perdana Kusuma is a multi-airport system.

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Suwardo, Haryanto, and Wiryanta *(*2013*)* examined the potential of the multiple-airport system in this area; with Majalengka and Karawang as the potential secondary airports, located at 270 km and 70 km respectively from the city centers of the Greater Jakarta. At the time, the two areas were predicted that new airports would be built as secondary airports for Soekarno-Hatta Airport. However, the results indicated a very small passenger sharing value in Majalengka by only 0.3-1%. Meanwhile, Karawang had a greater value of passenger sharing by 10-29%; however, the travel time from city centers of Greater Jakarta to Karawang is ±3 hours by four-wheeled vehicles. This is making it less effective as a secondary airport.

Currently, there are two non-commercial airports in the Greater Jakarta, namely Pondok Cabe Airport and Budiarto Airport, each of which is only 30 km and 36 km from the city centers of the Greater Jakarta. Pondok Cabe Airport is a military base owned by PT Pertamina, while Budiarto Airport is a training ground for students of the Indonesian Civil Aviation Institute *(*STPI*)*. Given that a multi-airport system is needed for the Greater Jakarta, it is necessary to calculate passenger sharing not only at Pondok Cabe Airport but also at Budiarto Airport which has the closest access to Soekarno–Hatta Airport. It is expected that the results of this study will be considered in making policies related to the development of the multi-airport system at Soekarno-Hatta Airport. Basically, Soekarno-Hatta Airport is not only the center of flights in the Greater Jakarta area, but also the main of national flights in Indonesia.

2. Approach and Analysis

The approach and analysis were performed by referring to the following points:

1. In accordance with the Regulation of Minister of Transportation No. 39 of 2019 concerning National Airport System, airport services on Java island are within a radius of 50 km (the straight distance of two airports is 100 km (Ministry of Transportation, 2019); therefore, secondary airports should be within a maximum distance of 100. In this case, the Budiarto Airport and Pondok Cabe Airport are located at a distance of 30 km and 36 km from Soekarno-Hatta, respectively. The coverage area of each airport is shown in Figure 1.

2. Accessibility is the average travel distance from city centers of the Greater Jakarta (Jakarta, Bogor, Depok, Tangerang, Bekasi) to the departure airport using four-wheeled vehicles, and the frequency of direct flights offered by secondary airports.

3. In the calculation of the multi-airport system, airports are categorized into two types, namely closer airport and distant airport. A closer airport is a departure airport which is closer to the city centers, while a distant airport is another departure airport, whose distance is farther away. A distant airport has the potential to become a secondary airport in a multi-airport system if it is able to accommodate 10-50% of air passenger generation at primary airports (Neufville & Odoni, 2013).

4. To calculate the value of passenger sharing in this study, the authors refer to Jovanovic's theory. This theory is based on an exponential formula in calculating the effects of choice variables on the attractiveness of every single airport in the system. Since a study of passenger sharing in Indonesia's airport produces a significant model with the current conditions in the field (Suwardo *et al.*, 2013), this study implements a similar method in exploring the air passenger sharing on the multi-airport system in Greater Jakarta. The calculation stages are based on Jovanovic (2004), including:

a) Determining the primary airport and airports that have the potential to become secondary airports, by examining the straight distance between the airport and the airport service area.

b) Calculating the difference in access time difference (ATD)

c) Calculating the frequency ratio:

$$FR = 1,1025e^{0,7392.ATD} \qquad (1)$$

d) Determining FF_c and FF_D. FF_c is the frequency of direct flights offered by airports closer to the destination airport, and FF_D is the frequency of direct flights offered by the distant airport to the destination airport. It is assumed that the frequency of direct flights at distant airports (secondary potential) is lower than that of direct flights at closer airports (primary airports).
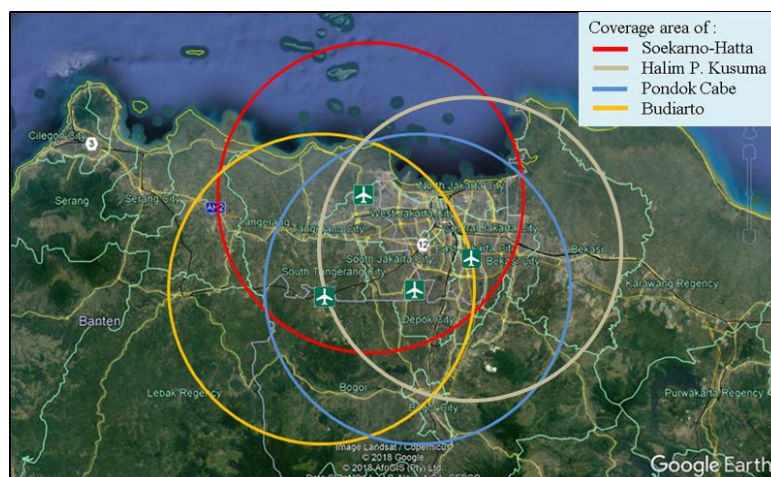

Figure 1. Coverage area of Soekarno-Hatta, Halim Perdana Kusuma, Budiarto, and Pondok Cabe Airport

e) Calculating direct flights connected from distant airports FF_K

$$FF_K = FR \times FF_c \qquad (2)$$

f) Calculating the relative frequency of local secondary airports (LRF_D)

$$LRF_D = FF_D / FF_K \qquad (3)$$

g) Calculating the relative frequency of distant airport and closer airport (RF_D)

$$RF_D = LRF_D / (LRF_D + LRF_C) \qquad (4)$$

$$RF_C = 1 - RF_D \qquad (5)$$

With $LRF_C = 1$

h) Calculating passenger sharing (PS) of a secondary airport (PS_D) and primary airport (PS_C)

$$PS_D = RF_D / [RF_D{}^\alpha + (1-RF_D)^\alpha] \qquad (6)$$

$$PS_C = 1 - PS_D \qquad (7)$$

With α value of between 1 and 2

5. The prediction of air passenger demand in Soekarno-Hatta and Halim Perdana Kusuma was calculated using the trend method, and the data of air passengers were obtained from the air transportation statistics from 2012 to 2019 (the last eight years).

3. Results

Using air passenger data obtained from the Air Transportation Statistics from 2010 to 2019 and calculated using the trend method approach, the prediction results of air passengers in 2024 and 2029 are shown in Table 1. It can be seen that the number of domestic air passengers in the Greater Jakarta area in 2024 is predicted to reach 78,588,012 passengers with a total generation of 38,345,851 passengers and a total attraction of 40,242,162 passengers. In 2029, the demand for air passengers is predicted to reach 106.447.444 passengers with a total generation of 53,696,630 passengers and a total attraction of 52,750,814 passengers.

The calculation results of ATD (access time difference) for Soekarno Hatta-Pondok Cabe and Soekarno-Budiarto are shown in Table 2. From this table, the average distance between the city centers of the Greater Jakarta to Soekarno-Hatta Airport is 26 km, to Pondok Cabe Airport is 30 km, and to Budiarto airport is 36 km. The access time difference between Soekarno-Hatta and Pondok Cabe Airport is 5.33 minutes, and the access time difference between Soekarno Hatta and Budiarto Airport at 13.33 minutes.

Furthermore, the value of passenger sharing between Soekarno Hatta – Pondok Cabe and Soekarno Hatta–Budiarto was obtained using Equation (1) to (7). In this calculation, the total demand considered was the total generation of air passengers in the Greater Jakarta area. Because flights in the Greater Jakarta area were currently served by Soekarno-Hatta Airport and Halim Perdana Kusuma Airport, the total generation was calculated from the total generation at Soekarno-Hatta Airport and Halim Perdana Kusuma Airport. Besides, due to the status of Pondok Cabe and Budiarto airport as a secondary airport, it is assumed that the frequency of direct flights from this airport was lower than that of direct flights from Soekarno-Hatta Airport. This value is shown in the columns FF_C and FF_D in Table 3 and Table 4. From this table, it can be seen that the value of passenger sharing at Pondok Cabe Airport is 21-55%; and passengers sharing air at Budiarto Airport by 19-51%.

Based on the prediction of the number of air passengers in the plan year and the number of passenger sharing obtained, the value of air passenger sharing both at the closest airport (Soekarno-Hatta) and the secondary airport (Pondok Cabe and Budiarto) in 2024 and 2029 can be predicted. The results of this prediction are shown in Table 5 and Table 6.

As a potential secondary airport, it is known that Pondok Cabe Airport has the same land area as the existing secondary airport, namely Halim Perdana Kusuma. Pondok Cabe Airport has a land area of 170 hectares (ha) and a runway length of 2,200 meters x 45 meters. Meanwhile, Budiarto airport has a land area of 360 hectares (ha) and two runways along 1,602 meters and 1,821 meters. Apart from the high number of passenger sharing, this airport has the potential to be developed because it has a land area that is twice as large as Halim Perdana Kusuma and Pondok Cabe airports.

Table 1.   Prediction of domestic air passenger demand

Year	Soekarno-Hatta			Halim Perdana Kusuma			Total
	Generation	Attraction	Number	Generation	Attraction	Number	
2024	29,231,370	30,194,474	59,425,845	9,114,480	10,047,687	19,162,168	78,588,012
2029	34,771,297	34,726,369	69,497,665	18,925,333	18,024,445	36,949,778	106,447,444

Table 2.   Access time difference Soekarno Hatta–Pondok Cabe and Soekarno Hatta–Budiarto

Characteristics	Jabodetabek - CGK	Jabodetabek - PCB	Jabodetabek - BTO	ATD (minute) CGK - PCB	ATD (minute) CGK - BTO
Distance (km)	26	30	36		
Speed* (km/h)	45	45	45	5,33	13,33
Travel time (min)	34,67	40,00	48,00		

*Speed here means the expected minimum speed of road vehicle on an arterial road with good structural condition

Table 3.　Passenger sharing between Soekarno-Hatta and Pondok Cabe

ATD	FR	FF_C	FF_K	FF_D	LRF_D (%)	RF_D (%)	RF_C (%)	PS_D (%)						PS_C (%)
								$\alpha = 1$	$\alpha = 1.25$	$\alpha = 1.5$	$\alpha = 1.75$	$\alpha = 2$	average	
5.33	1.18	2	2.35	1	42.47	29.81	70.19	29.81	34.55	39.70	45.27	51.26	40.12	59.88
		3	3.53	1	28.31	22.06	77.94	22.06	24.97	27.87	30.75	33.63	27.86	72.14
				2	56.62	36.15	63.85	36.15	42.48	49.69	57.88	67.15	50.67	49.33
		4	4.71	1	21.23	17.51	82.49	17.51	19.47	21.30	23.00	24.63	21.18	78.82
				2	42.47	29.81	70.19	29.81	34.55	39.70	45.27	51.26	40.12	59.88
				3	63.70	38.91	61.09	38.91	45.92	54.03	63.40	74.18	55.29	44.71

Table 4.　Passenger sharing between Soekarno-Hatta and Budiarto

ATD	FR	FF_C	FF_K	FF_D	LRF_D (%)	RF_D (%)	RF_C (%)	PS_D (%)						PS_C (%)
								$\alpha = 1$	$\alpha = 1.25$	$\alpha = 1.5$	$\alpha = 1.75$	$\alpha = 2$	average	
13.33	1.30	2	2.60	1	38.48	7.79	72.21	27.79	32.04	36.56	41.35	46.42	36.83	63.17
		3	3.89	1	25.65	20.42	79.58	20.42	22.97	25.45	27.87	30.25	25.39	74.61
				2	51.31	33.91	66.09	33.91	39.68	46.15	53.39	61.46	46.92	53.08
		4	5.19	1	19.24	16.14	83.86	16.14	17.83	19.38	20.79	22.12	19.25	80.75
				2	38.48	27.79	72.21	27.79	32.02	36.56	41.35	46.42	36.83	63.17
				3	57.72	36.60	63.40	36.60	43.03	50.39	58.77	68.29	51.42	48.58

Table 5.　Prediction of passenger sharing between Soekarno-Hatta and Pondok Cabe

FF_C	FF_D	PS_D (%)	PS_C (%)	Prediction of passenger sharing at 2022			Prediction of passenger sharing at 2027		
				Total	Soekarno-Hatta	Pondok Cabe	Total	Soekarno-Hatta	Pondok Cabe
2	1	40.12	59.88	38,345,851	22,962,624	15,383,226	53,696,630	32,155,123	21,541,507
3	1	27.86	72.14		27,663,102	10,682,748		38,737,317	14,959,313
	2	50.67	49.33		18,915,353	19,430,498		26,487,630	27,209,000
4	1	21.18	78.82		30,222,599	8,123,251		42,321,443	11,375,187
	2	40.12	59.88		22,962,624	15,383,226		32,155,123	21,541,507
	3	55.29	44.71		17,145,177	21,200,674		24,008,809	29,687,821

Table 6.　Prediction of passenger sharing between Soekarno-Hatta and Budiarto

FF_C	FF_D	PS_D (%)	PS_C (%)	Prediction of passenger sharing at 2022			Prediction of passenger sharing at 2027		
				Total	Soekarno-Hatta	Budiarto	Total	Soekarno-Hatta	Budiarto
2	1	36.83	63.17	38,345,851	24,223,319	14,122,532	53,696,630	19,968,597	33,728,033
3	1	25,39	74,61		28,609,858	9,735,992		33,920,504	19,776,126
	2	46,92	53,08		20,355,165	17,990,686		40,063,083	13,633,547
4	1	19,25	80,75		30,963,393	7,382,458		28,503,834	25,192,796
	2	36,83	63,17		24,223,319	14,122,532		43,358,794	10,337,836
	3	51,42	48,58		18,629,540	19,716,311		33,920,504	19,776,126

4. Discussion

This section discusses the prediction of air passenger demand in 2024 and 2029 related to the current capacity of Soekarno Hatta Airport and Halim Perdana Kusuma Airport. Furthermore, this research discusses the results of the calculation of passenger sharing between Soekarno-Hatta Airport (representing Soekarno-Hatta and Halim Perdana Kusuma demands) and Pondok Cabe Airport, as well as between Soekarno-Hatta Airport (representing Soekarno-Hatta and Halim Perdana Kusuma demands) and Budiarto Airport. This is to examine its potential to become a secondary airport for Soekarno-Hatta and Halim Perdana Kusuma Airport in the metropolitan area of Greater Jakarta.

The prediction results indicated that the number of domestic air passengers in the Greater Jakarta area is 78.588.012 passengers in 2024 and 106.447.444 passengers in 2027. The terminal areas of Soekarno-Hatta Airport and Halim Perdana Kusuma Airport currently cover an area of 714,821 m^2 and 19,810 m^2 (Ministry of Air Transportation, 2018). Based on ideal capacity, each can accommodate a maximum of 75 million and 2.4 million passengers; and if summed, they can accommodate a total of ± 77.4 million passengers. The capacity of 77.4 million will not be able to

accommodate the air passenger demand in 2029 with a total passenger of 104.45 million people. This area is an airport expansion for several times. It is recorded that at least Halim Perdana Kusuma was expanded once and Soekarno-Hatta was three times in the last ten years. This expansion has been performed to the maximum. If it continues, it will be obstructed by land limitations. As Butler (2008) argues that the expansion of airport capacity often encounters land limitations.

The limited air passenger capacity in Soekarno-Hatta has attracted the attention of several researchers. Defiani (2012) once recommended adding areas and changing layouts at Soekarno-Hatta Airport, because Soekarno-Hatta Airport will reach saturation in 2020. The Japan International Cooperation Agency (JICA) also reviewed the development of Soekarno-Hatta Airport in 2010-2012. According to JICA (2012), Soekarno-Hatta does not have enough capacity to accommodate demand and is not possible to be expanded due to environmental factors. JICA also recommended the construction of a new airport in 2019, which is in the potential area of Karawang. However, in 2014 the Indonesian government opened Halim Perdana Kusuma Airport for commercial services and it operates until now.

Although Soekarno-Hatta Airport has been very actively expanded and can accommodate the air passenger demand in 2024, it is different from Halim Perdana Kusuma Airport. Halim Perdana Kusuma Airport is currently unable to accommodate the air passenger demand in 2024 and beyond. The airport capacity and air passenger demand in Soekarno-Hatta and Halim Perdana Kusuma are illustrated in Figure 2. The dotted circle represents the airport capacity, while the circle without lines is the prediction of demand in 2024. A gap is visible from this picture. Therefore, airport development should be carried out as early as possible.

The calculation results of passenger sharing in Table 3 shows very high values, which are 21-55%. This is the values of passenger sharing between Soekarno Hatta Airport and Pondok Cabe Airport. The variation in passenger sharing values ranges from 21% to 55% was greatly affected by the ratio of the frequency of direct flights. This can be seen from the value of passenger sharing that tends to increase with the increasing frequency of direct flights at the departure airport. Not much different from the value of passenger sharing at Soekarno Hatta-Pondok Cabe Airport, the values of passenger sharing at Soekarno Hatta-Budiarto Airport in Table 6 are 19-51%. The values are slightly lower than those of Pondok

Cabe, but they are quite high. Jovanovic (2004) argues that a distant airport has the potential to become secondary if it has a passenger sharing value between 20% and 50%. From the values obtained, both Pondok Cabe Airport and Budiarto Airport have the potential to become secondary to Soekarno-Hatta Airport.

The values of passenger sharing at Pondok Cabe Airport and Budiarto Airport are much higher than those of passenger sharing at Majalengka Airport and in potential areas of Karawang which were previously studied by Suwardo *et al.* in 2013. At that time, the passenger sharing value for Majalengka was 0.3-1% and the potential area of Karawang was 10-29% (Suwardo *et al.*, 2013). This supports the view of Persadanta and Dewanti (2017) that Pondok Cabe has the potential to become a secondary airport accompanying Soekarno-Hatta Airport in a multi-airport system in the Greater Jakarta. The comparison of passenger sharing values from these four airports is shown in Figure 3.

There is a linear correlation between the distance from the airport and the city centers with the value of passenger sharing. The longer the distance from the city centers to the departure airport is, the lower the value of passenger sharing will be. Similarly, there is a linear correlation between the frequency of direct flights offered and the value of passengers sharing. The higher the frequency of direct flights offered is, the higher the value of passengers sharing will be. The correlation between the value of passenger sharing and the frequency of direct flights is inversely proportional to the correlation between the value of passengers sharing and the travel distance from the city centers to the airport. This is shown in Figure 4.
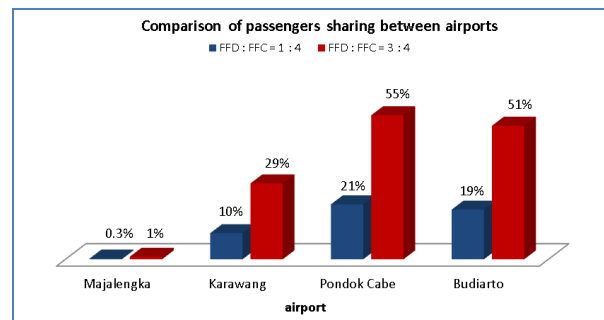

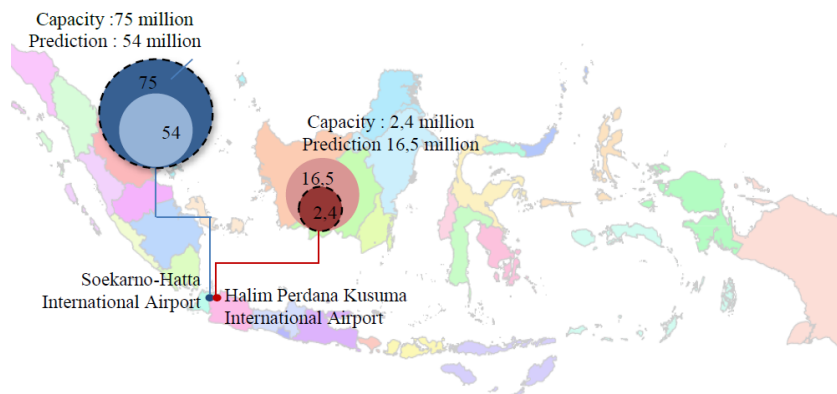Figure 3.   Comparison of the value of passenger sharing between airports

Figure 2.   Capacity versus prediction of domestic air passengers at Soekarno-Hatta and Halim Perdana Kusuma in 2024

Comparison between distance and passengers sharing
■ FFD : FFC= 1 : 4   ■ FFD : FFC= 3 : 4

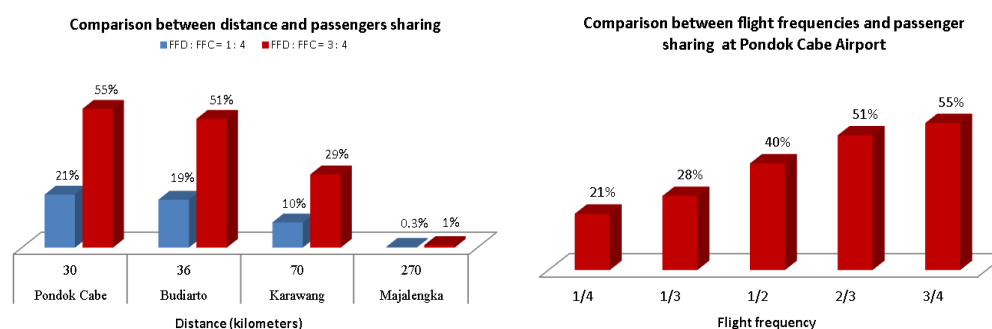**Comparison between flight frequencies and passenger sharing at Pondok Cabe Airport**

Figure 4.   Comparison of distance (km) and flight frequencies with passenger sharing

Figure 4 above indirectly supports the views expressed by Pels, Nijkamp, and Rietveld (2003); Phillips, Wheatherford, Mason, and Kunce (2005); Zhang and Xie (2005); Hess and Polak (2005); Suzuki (2007); Fuellhart (2007); Loo (2008); Lian and Ronnevik (2011); Marcucci and Gatta (2011); Lieshout (2012); and Paliska, Drobne, Borruso, Gardina, and Fabjan (2016) that the accessibility of travel to the airport and the frequency of flights significantly affect the preference of departure airport by air passengers and the airport catchment area will decrease as the access time to the airport increases (Paliska *et al.*, 2016).

4. Conclusions

By taking Budiarto Airport and Pondok Cabe Airport which are much closer to the city centers of Greater Jakarta into consideration, this study aims to reveal the potential of these airports to accommodate air passengers in the Greater Jakarta area if the multi-airport system is implemented. Results show that both Budiarto Airport and Pondok Cabe Airport has the potential to become secondary airports for Soekarno-Hatta Airport with passenger sharing values of 19-51% and 21-55%, respectively. The passenger sharing values even surpasses the passenger sharing value in the potential area of Karawang airport (10-29%) which was predicted as a potential secondary airport for Soekarno-Hatta Airport.

Although Pondok Cabe Airport and Budiarto Airport have a very high value of passengers sharing, this is not the only consideration. Policies on the development of airports in the metropolitan area of Greater Jakarta require a comprehensive study. In addition to predicting the value of passenger sharing at each airport, central and regional governments should be wise to other multifactor. These factors include secondary airport capacity, ownership, management, services of the secondary airport; stakeholder readiness; and regulation. If Budiarto Airport or Pondok Cabe Airport starts to serve as secondary airports to Soekarno Hatta Airport, it means that there will be services shift, changes in spatial planning, and short-term development plans which should be adjusted based on the needs. However, whatever policy will be implemented for the development of the airport in the Greater Jakarta, it should be the best one. This is due to the vital function of Soekarno-Hatta Airport both for flights in the Greater Jakarta and for national flights in Indonesia.

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