Study of Runway 3 Performance and the Effect of Crossing Taxiway on Runway 2 Capacity at Soekarno-Hatta International Airport

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ABSTRACT

Soekarno-Hatta International Airport is the busiest airport in Indonesia, and the number of passengers keeps increasing. Therefore, a larger runway capacity is required due to increased aircraft movements. Soekarno-Hatta International Airport has a new 3000 x 60 meter runway 3 to increase runway capacity by 114 to 120 movements per hour. Runway 3 and Runway 2 are parallel runways where Runway 3 is connected by a crossing taxiway if the aircraft on Runway 3 will head to the terminal. This study analyzed the suitability of parallel runways and the effect of crossing taxiways on the capacity of runway 2. The FAAA method is used in analyzing the length of runway 3, whereas the suitability of the separation distance between runways used the rules of ICAO. The calculation of runway capacity used the time-space analysis method and mathematical simulation modeling with the principle of Air Traffic Separation. The results of the calculation analysis found that the required runway length evaluation of 3200 meters, so the addition needs to be done. A distance of 500 meters is obtained for the runway separation distance analysis. For the non-instrument approach, it has been fulfilled, whereas for the instrument approach, it was not fulfilled. The simulation analysis found that the capacity of runway 2 decreased from 42 to 30 movements, while on runway 3, 29 movements were found. The total movement reached 59 movements. Therefore, the addition of runway 3 only increased flight operations by 17 movements compared to operations using only runway 2.

Keywords

Crossing Taxiway, Runway Capacity, Parallel Runway, Simulation.

INTRODUCTION

A. Background

Aircraft is one of the vital means of transport in a country where the number of passengers both domestic and international keep increasing. As a result of the increasing demand for transport, the airport also needs to be considered both from the air side and land side facilities. Airside facilities include runway, taxiway, and apron.

One of the busiest flight operations in Indonesia is Soekarno-Hatta Airport in Tangerang, Banten. This can be seen from the number of passenger movements at Soekarno-Hatta International Airport in the first semester (January-June 2018) reached 32,424,261 passengers or grew by 9% compared to the same period in 2017 which was 29,837,845 passengers (SINDONEWS.com, 2018). Currently, the arrival and departure operations of Soekarno-Hatta aircrafts are carried out on three parallel runways, namely runway one with the name 07R/25L, runway two with the name 07L/25R, and the latest third runway which was just inaugurated on 15 August 2019. *Runway one has dimensions of 3660 x 60 meters, runway two is shorter than 3600 x 60 meters, whereas runway three has dimensions of 2500 x 60 meters.* The runway three construction efforts by PT Angkasa Pura II is to increase the capacity of aircraft movements by 114 to 120 movements every hour. The East Cross Taxiway was also built on the east side of the airport to increase the runway capacity to more than 86 movements every hour.

The existence of additional runway in addition to increasing the capacity of aircraft movements, the capacity of an airport is also related to flight safety. If the number of aircraft operating exceeds its capacity at an airport, it will certainly cause overload on the Air Traffic Management (ATM) system. For example, Air Traffic Controllers encounter work overload and fatigue. Therefore, the chance of violations will increase, which can endanger the safety of flight operations. As the first step to prevent violations, analyzing the suitability of the additional runway with existing regulations is necessary. The regulations referred to are the provisions of technical requirements for the operation of airport technical facilities as stated in SKEP Number 77 of 2005 and flight operational safety criteria as stated in SNI 03-7112-2005. [1].

However, the construction of the third runway, which is planned to increase the runway capacity to 114 to 120 movements, needs to be reviewed after the third runway is

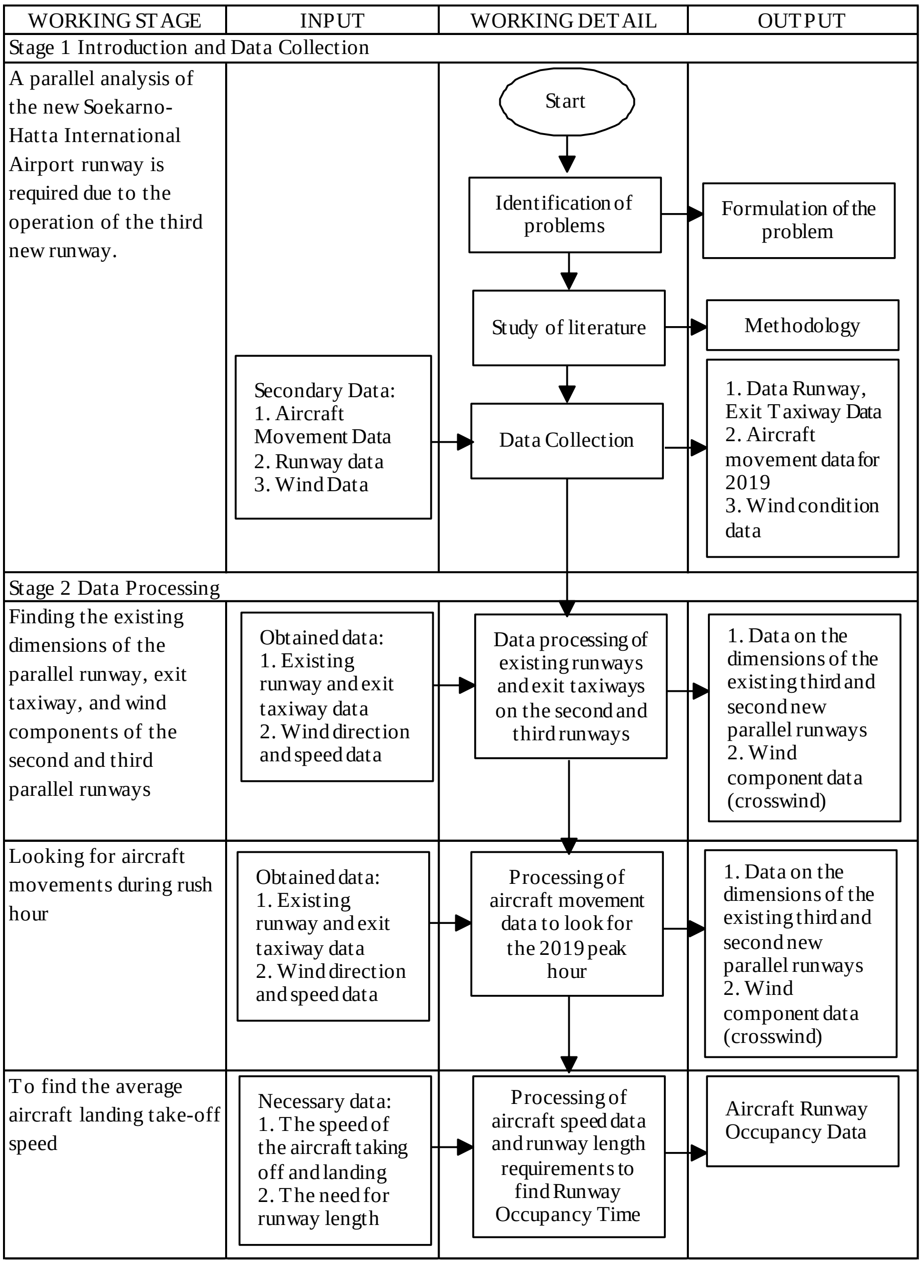


Figure 1. Methodology Flowchart.

operating. The existence of a crossing taxiway between runway three and two also needs to be reviewed whether it causes the capacity of runway two to decrease and the movement of aircraft on runway three to be not maximized. It is stated that the capacity of runway two can decrease when an aircraft on runway two have to queue when an aircraft crosses the crossing taxiway.

Therefore, it is necessary to analyze the runway objects currently operating at Soekarno-Hatta airport by identifying the traffic density on the runway, analyzing the maximum capacity that each runway can accommodate, and identifying the magnitude of the growth rate of aircraft movements, then the planned runway capacity can be evaluated in accordance with the runway capacity after the third runway is operated.

B. *Problem Formulation*

Based on the background that has been conveyed, a case study needs to be conducted to find out, as follows :

1. How is the suitability of parallel runways on the second and third runway of Soekarno-Hatta International Airport based on the provisions of the technical requirements for the operation of airport technical facilities and flight operational safety criteria?
2. How big is the existing capacity of the second and third runways of Soekarno-Hatta International Airport?
3. How does crossing taxiways affect the capacity of the second and third runways of Soekarno-Hatta International Airport?

C. *Scope of Discussion*

The Research Limitations used in this study were:

1. The airport airside facilities reviewed were Runway, Parallel Taxiway, and Exit Taxiway.
2. The location reviewed in the writing of this study was Soekarno-Hatta International Airport.
3. The data taken was secondary data and did not conduct a direct survey in the field.

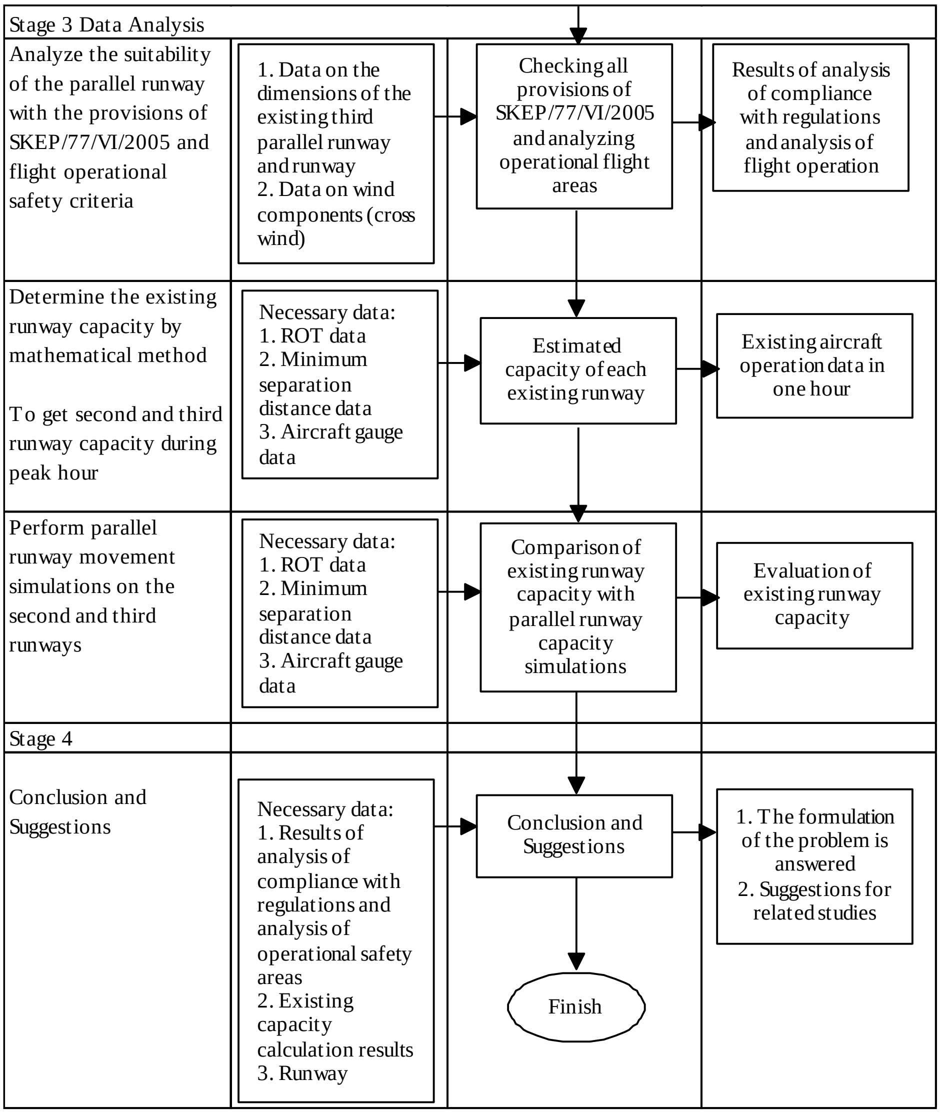


Figure 2. Methodology Flowchart (continued).

4. The method used for runway capacity calculation was the time-space analysis method.

D. Aims of Study

The objectives of this study were as follows:

1. To find out the suitability of parallel runways on the second and third runways of Soekarno-Hatta International Airport with the provisions of the technical requirements for the operation of airport engineering facilities and fulfilling flight operational safety criteria.
2. To determine the capacity of the second and third runways of Soekarno-Hatta International Airport.
3. To identify the effect of crossing taxiways on the capacity of the second and third runways of Soekarno-Hatta International Airport.

E. Significant of Study

Benefits that can be obtained from this study were as follows:

1. As additional knowledge on how to calculate the runway capacity of an airport.
2. As one of the references related to efforts that can be made to increase runway capacity.
3. Can be used as a reference in the construction of parallel runways at an airport.

METHODOLOGY

Figure 1, Figure 2 explains the study completion flow chart to facilitate the study work.

RESULT OF RUNWAY SUITABILITY ANALYSIS

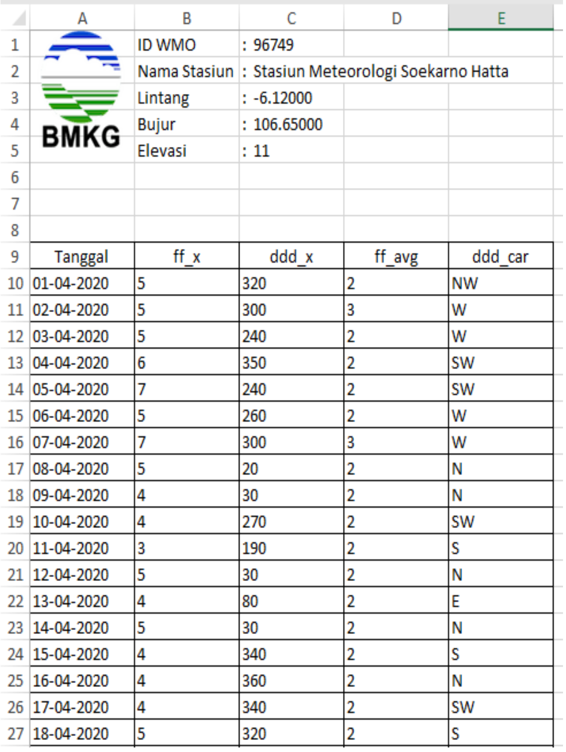
A. Runway Length Analysis

Currently, Soekarno-Hatta Airport has 3 parallel runways. Runway one is known as 07R/25L, with 3660 x 60 meters dimensions. Runway 2 is known as 07L/25R has dimensions of 3600 x 60 meters, while the latest runway 3 known as 06/24, has dimensions of 2500 x 60 meters. The length of runway 3 increased by 500 meters to a total length of 3000 meters by December 2019. Based on movement data from Tengku Annisa's Final Project [2], The largest aircraft in operation is the Boeing 747-400 aircraft. The corrected runway length analysis was carried out by calculating the corrected ARFL of the largest aircraft against the runway's elevation, temperature, and slope.

1) Elevation Correction (Fe)

The ARFL-based elevation correction calculation is increased by 7% for every 300 meters (1000 ft) increase,

Figure 3. Measurement Results of Runway 2 and Runway 3 Separation Distance.



	A	B	C	D	E
1	BMKG	ID WMO	: 96749		
2		Nama Stasiun	: Stasiun Meteorologi Soekarno Hatta		
3		Lintang	: -6.12000		
4		Bujur	: 106.65000		
5		Elevasi	: 11		
6					
7					
8					
9	Tanggal	ff_x	ddd_x	ff_avg	ddd_car
10	01-04-2020	5	320	2	NW
11	02-04-2020	5	300	3	W
12	03-04-2020	5	240	2	W
13	04-04-2020	6	350	2	SW
14	05-04-2020	7	240	2	SW
15	06-04-2020	5	260	2	W
16	07-04-2020	7	300	3	W
17	08-04-2020	5	20	2	N
18	09-04-2020	4	30	2	N
19	10-04-2020	4	270	2	SW
20	11-04-2020	3	190	2	S
21	12-04-2020	5	30	2	N
22	13-04-2020	4	80	2	E
23	14-04-2020	5	30	2	N
24	15-04-2020	4	340	2	S
25	16-04-2020	4	360	2	N
26	17-04-2020	4	340	2	SW
27	18-04-2020	5	320	2	S

Figure 4. Wind data from the BMKG website.

Table 1. *Maksimum Crosswind.*

Reference field length	Max *cross wind*		
m	knot	km/hour	mil/hour
>1500	20	37	23
1200-1499	13	24	15
<1200	10	19	11,5

calculated from sea level. The runway elevation at Soekarno-Hatta International Airport is 9,754 m.

$$Fe = 1 + 0{,}07\ (h/300)$$

Fe = 1 + 0,07 (9,754/300)

2) *Temperature Correction (Ft)*

Runway length must be corrected for temperature by 1% for every 1°C increase according to ICAO. Whereas, for every 1000 metres rise in mean sea level, the air temperature is decreased by 6.5°C. At Mean Sea Level, the standard temperature is 15°C. The highest temperature data at Soekarno-Hatta International Airport is 34°C.

$$Ft = 1 + 0{,}01\ (T - (15 - 0{,}0065xh))$$

Ft = 1 + 0,01 (34 – (15 – 0,0065x9,754))
Ft = 1,189

3) *Slope Correction (Fs)*

In airport planning, the FAA introduces "Gradient Effective," which is the height difference between the lowest point and the highest point of the runway's longitudinal section divided by the length of the runway. The slope correction factor is 10% for every 1% slope.

$$Fs = 1 + 0{,}1\ S$$

Fs = 1 + 0,1 (0,1667%)
Fs = 1,000167

For ARFL obtained by 2675 using the take off length chart for Boeing 747-400 aircraft The results of the calculation of runway length requirements are:
= ARFL x Fe X Ft x Fs
= 2675 x 1,0023 x 1,0002
= 3189,326 m = 3200 m.

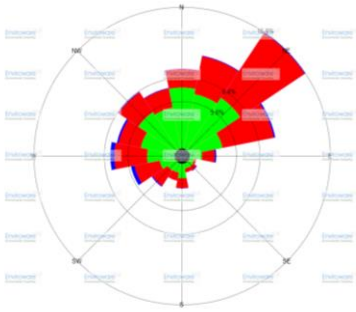


Figure 5. Windrose Analysis Results.

Table 2. *Wind Coverage Results.*

Runway Orientation (degree)	Wind Coverage
0	98,91989199
10	99,00990099
20	98,91989199
30	99,05490549
40	99,05490549
50	99,05490549
60	99,00990099
70	98,96489649
80	98,96489649
90	98,91989199
100	98,91989199
110	98,87488749
120	98,87488749
130	98,96489649
140	98,96489649
150	98,87488749
160	98,96489649
170	98,87488749
180	98,91989199
190	99,00990099
200	98,91989199
210	99,05490549
220	99,05490549
230	99,05490549
240	99,00990099
250	98,96489649
260	98,96489649
270	98,91989199
280	98,91989199
290	98,87488749
300	98,87488749
310	98,96489649
320	98,96489649
330	98,87488749
340	98,96489649
350	98,87488749

B. *Parallel Runway 2 and Runway 3 Suitability Analysis*

The provision of centreline separation between two runways needs to be considered in parallel runway configuration. According to ICAO in Annex 14 Aerodrome Volume I (2004), the distance between parallel non-instrument runways is divided into three,

Table 3. Historical Aircraft Movement Data.

No.	Day	Date	Total Movement	Percentage of Movement
1	Sunday	12 July 2015	1256	14.427%
2	Monday	13 July 2015	1230	14.128%
3	Tuesday	14 July 2015	1225	14.071%
4	Wednesday	15 July 2015	1267	14.553%
5	Thursday	16 July 2015	1254	14.404%
6	Friday	17 July 2015	1241	14.255%
7	Saturday	18 July 2015	1233	14.163%
TOTAL			8706	100%

Table 4. Departure and Arrival Recapitulation during peak day.

		15-Jul-15			Percentage
No.	Time	Depature	Arrival	Total	Percentage
1	00:45 - 01:44	7	2	9	0,710%
2	01:45 - 02:44	6	1	7	0,552%
3	02:45 - 03:44	0	1	1	0,079%
4	03:45 - 04:44	5	3	8	0,631%
5	04:45 - 05:44	40	0	40	3,157%
6	05:45 - 06:44	46	2	48	3,788%
7	06:45 - 07:44	27	30	57	4,499%
8	07:45 - 08:44	38	32	70	5,525%
9	08:45 - 09:45	39	34	73	5,762%
10	09:45 - 10:44	29	41	70	5,525%
11	10:45 - 11:44	46	35	81	6,393%
12	11:45 -12:44	26	31	57	4,499%
13	12:45 - 13:44	43	51	94	7,419%
14	13:45 - 14:44	33	39	72	5,683%
15	14:45 - 15:44	36	47	83	6,551%
16	15:45 - 16:44	39	41	80	6,314%
17	16:45 - 17:44	37	40	77	6,077%
18	17:45 - 18:44	39	34	73	5,762%
19	18:45 - 19:44	28	41	69	5,446%
20	19:45 - 20:44	21	38	59	4,657%
21	20:45 - 21:44	13	49	62	4,893%
22	21:45 - 22:44	12	25	37	2,920%
23	22:45 - 23:44	5	18	23	1,815%
24	23:45 - 00:44	11	6	17	1,342%
Total		626	641	1267	100,0%

namely Close (Adjacent) with a distance between the axis to the runway axis of 120 m (394 ft). Intermediate with a minimum distance between the axis and runway axis of 150 m (492 ft). Kemudian *Far* (Berjauhan) memiliki jarak antar sumbu sejauh 210 m (689 ft). Sedangkan jarak antara *parallel instrument runway* dapat dibedakan menjadi empat, yaitu sejauh 1.035 m (3.396 ft) untuk *independent parallel approaches*, 915 m (3.002 ft) untuk *dependent parallel approaches*, 760 m (2.493 ft) untuk *independent parallel departure*, dan sejauh 760 m (2.493 ft) untuk *segregated parallel operations.* The analysis referred to here is by comparing existing conditions with existing provisions. For the results of measuring the separation distance of Runway 2 and Runway 3 can be seen in Figure 3.

From the measurements using the Autocad assistant program, the distance of the center line separating Runway 2 and Runway 3 is 500 m. After the distance is obtained, it is then categorized according to the ICAO provisions above.

a. For non-instrument runway parallel, it is categorized as Far (Far apart) due to distance >210 with code number 4.
b. For the instrument parallel runways, the distance between runways does not meet the minimum distance of the four categories due to the minimum distance is 760 m, whereas the distance between runways is found at 500 m.

From the above results, the runway separation distance for instrument approaches is not met. Therefore, if the flight is in bad weather that requires the aircraft to use an instrument approach with IFR (Instrument Flight Rules) conditions cannot be done. From these conditions related to flight safety, both runways cannot be used simultaneously for aircraft take-off and landing because the distance is too close.

C. *Wind Analysis*

The analysis is carried out to determine the runway direction on the new runway 3 and whether it is in accordance with the conditions around the runway. Wind data is taken from the Meteorology, Climatology and Geophysics Agency (BMKG) website as presented in Figure 4.

Determination of runway direction by looking at wind direction using the usability factor, which is the percentage of wind data (wind coverage) showing wind conditions around the runway meets the requirements based on the crosswind value that can occur. The minimum usability limit of the runway direction that can be selected is 95% according to ICAO Annex 14: Aerodrome Volume I Chapter 3 Section 3.1 and FAA AC 150/5300 - 13 Appendix 1. Analysis using the WindrosePro utility by entering wind data (wind direction and speed) and the maximum allowable crosswind based on FAA by examining the aircraft with the shortest wingspan can be seen in Table 1.

The most critical aircraft, or the one with the shortest wingspan, is the BAE System 146 aircraft with a wingspan of 26.21 meters and an ARFL of 1210 meters. Therefore, a maximum crosswind of 13 knots is obtained. Windrose

Table 5. Total Air Transport Data in 2019.

No.	Month	Aircraft		
		Arr.	Dep.	Tot.
1	January	16.850	16.426	33.276
2	February	14.737	14.333	29.070

Table 6. Division of Aircraft Categories.

Aircraft Type	Landing Speed (knots)	Take Off Speed (knots)
C	134	141
D	150	162

Table 7. Landing and Take-off Length Requirements.

Aircraft Type	Category	Take Off Speed (knots)	Landing Speed (knots)	Take Off Length Required (m)	Landing Length Requirements
Airbus A319	C	135	130	1750	1350
Airbus A320	C	145	137	2190	1440
Airbus A321	C	145	134	2210	1600
Airbus A330-200	C	145	140	2300	1800
Airbus A330-300	C	145	140	2300	1700
Airbus A350-900	D	150	155	888	888
BAE System 146	C	125	125	1600	1200
Boeing 737-300	C	140	132	1600	1400
Boeing 737-400	C	150	139	2000	1500
Boeing 737-500	C	139	128	1500	1400
Boeing 737-800	D	145	147	2300	1600
Boeing 737-900	D	149	150	2300	1700
Boeing 747-400	D	185	152	3300	2130
Boeing 777-300	D	168	149	3000	1800
Boeing 787-800	C	165	140	2820	1520
Embarer 195	C	138	131	2056	1323

and Wind Coverage values were obtained as presented in Figure 5.

It is known that the existing runway has a direction of 60 ° - 240 °, the results of the calculation of the usability factor obtained more than 95%, which is 98%-99%, can be seen in the wind coverage Table 2, therefore it meets the requirements of the usability factor which is ≥ 95%. Because the usability factor against crosswind meets the requirements, the direction of the existing runway 3 with the calculation of the analysis is in accordance with the direction of 60 ° - 240 °. The results of the wind coverage are shown in Figure 5.

RUNWAY CAPACITY SIMULATION

A. Aircraft Movement Data and Peak Hour Determination.

The aircraft movement data was taken from Tengku Anisa's Final Project [2], namely, aircraft movement data dated on 12 July 2015 to 18 July 2015. Can be found in Table 2.

Based on the data in Table 3, it can be concluded that the largest number of aircraft movements occurred on Wednesday, 15 July 2015, with a total of 1267 aircraft movements.

The percentage of movement is obtained by dividing each movement by the total movement per day and per hour for the recapitulation of departures and arrivals during peak hours can be found in Table 4.

B. Aircraft Movement Conversion in 2019

To obtain the number of peak hour movements in 2019, it is necessary to convert the existing data, which is the data on 15 July 2015.

From the data in Table 5, the most movements occurred in January at 33,276 movements. The conversion calculation is by assuming that there are four weeks in one month. It can be concluded that aircraft movements per week in January 2019 as follows:

= Number of departure movements/4 weeks
= 16.426/4
= 4.107 movement/week
= Number of Arrival movements/4 weeks
= 16.850/4
= 4.213 movements/week
= 4.107 + 4.213
=8.320 movements

After obtaining the total movements per week in 2019, multiply the percent of movements per day from 12 July 2015 to 18 July 2015 by the number of movements per week in 2019. Because the peak day occurred on Wednesday 2015, then the calculation of peak day on Wednesday 2019 is as follows :

= Movement percentage/ total days in 2015 x the number of movements /total weeks in 2019
= 14,553% x 8.320
= 1.211 movements

For peak hour, by multiplying the hourly movement percentage on 15 July 2015 by the total peak day movement in 2019.

= Movement percentage/total hour in 2015 x the number of movements/total days in 2019
= 7,419% x 1.211
= 90 movements

C. Aircraft Movement Categories and Characteristics.

Aircraft are categorized based on FAA regulations based on aircraft landing speed. Aircraft type characteristics were obtained for peak hour flights on 15 July 2015 at 12:45 - 1:44 PM. The characteristics of aircraft types during peak hour are described in Table 6.

Landing and take-off length requirement data is required for ROT calculation. Table 7 shows the landing and take off length requirements of each aircraft.

Table 8. Division of Runway Movement.

Arr/Dep	Total		Percentage	
	Arrival	Depature	Arrival	Depature
Runway 1	18	26	41%	59%
Runway 2	33	17	66%	34%
Runway 3	60	40	60%	40%

Table 9. The Percentage Variation of Aircraft Category.

Aircraft Type	Total of Movements	Percentage
C	42	45%
D	52	55%
Total	94	100%

Table 10. Minimum separation distance.

Leading	Trailing			
	C (Arrival) nm	D (Arrival) nm	C (Depature) second	D (Depature) second
C (Arrival)	3	3	60	90
D (Arrival)	5	3	120	120
C (Depature)	2	2	60	90
D (Depature)	5	2	120	120

Table 11. The speed and deceleration of the aircraft.

Aircraft Type	Ve exit taxiway (m/s)			Deceleration on the runway
	Sudut 30°	Sudut 45°	Sudut 90°	a (m/s2)
A	30,87	20,58	7,72	1,52
B	30,87	20,58	7,72	1,52
C	30,87	20,58	7,72	1,52

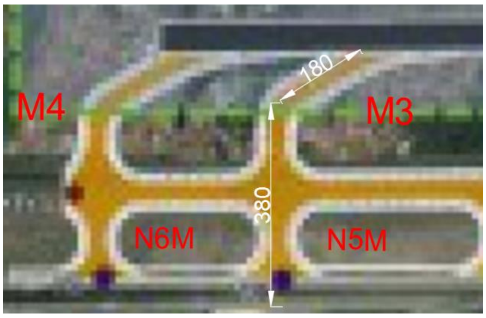


Figure 6. Aircraft Travelling Distance on the Runway to the end of the runway/crossing taxiway is 560m.

D. Simulation of Runway 1 and Runway 2 Capacity Time Space Analysis Method.

Before calculating the capacity simulation, it is necessary to divide the use of the runway by aircraft for arrival and departure movements as presented in Table 8.

The percentage variation of aircraft category is obtained from the number of aircraft movements of category C or D divided by the total aircraft of category C and D. The percentage variation of aircraft category is presented in Table 11.

The steps for calculating runway capacity are as follows:

1. Determine each aircraft category's arrival, departure, and mix schedules using random numbers in Microsoft Excel. The percentage is shown in Table 9 with the assumption that if the random number value that appears is less than 0.45, then it is included in Category C and if it is more than 0.45, it is included in Category D. While the division for arrival departure, if the random number is less than 0.41 then it is classified as arrival, and if it is more than 0.41 then it is classified as departure.
2. Determine the Minimum Separation. The determination of the minimum separation distance uses the concept of leading (aircraft at the front) and trailing (aircraft at the back). For the determination of the minimum separation distance can be seen from Table 10.
3. Determine the interarrival time. The interarrival time is obtained from the minimum separation distance with the approach speed of each aircraft type. Example :

If the aircraft at the front is classified as a category D aircraft and is departing at an approach speed of 145 knots, while the aircraft at the back is classified as category D and is arriving, the calculation is as follows :

$$\textit{Interarrival Time} = \frac{2}{145} \times 60$$
$$= 0{,}83 \text{ minutes}$$

4. Time of *Arrival. Time of arrival is the sum of the accumulated interarrival times. Calculation example*:

Time of arrival = 0,83 minutes + 2 minutes
= 2,83 minutes

5. *Runway Occupancy Time. Runway occupancy time is obtained by dividing the runway length and each aircraft's speed ROT calculation*:
If the landing speed is 147 knots and the runway length requirement is 1825 m, we obtained :

1 knots = 0,51444 m/sec

$$\text{ROT} = \left(\frac{1825}{147 \, x \, 0{,}5144}\right) / 60$$

ROT= 0,40 minutes

6. Obtain Time Service. Time Service is the sum of the time of arrival and ROT that has been done before. Example of calculation:

Time service = Time of Arrival + ROT

Time service = 2,83 minutes + 0,40 minutes
= 3,23 minutes

To get the total runway capacity, it is necessary to calculate using random numbers until the total service time ≤ 60.

E. Simulation of Runway 3 Capacity Time Space Analysis Method.

The simulation calculation on the runway is slightly different because runway 3 must pass through the exit taxiway, parallel taxiway, and runway 2 and finally enter the apron. Therefore, additional calculations are required to obtain aircraft service time. The calculation of taxiway usage time is as follows :

a. The Calculation of Travel Time at Exit Taxiway.
The calculation is done by dividing the travel distance by the speed of the aircraft at the exit taxiway. The speed of the aircraft at the exit taxiway was obtained from a previous study by Zadly (2006). The following is the speed and deceleration of the aircraft at the exit taxiway. The speed at the exit taxiway is 30.87 m / s2 because it is known that the landing length for runway 3 is located at exit taxiway M1 and M2 with an angle of 30 °.

b. Aircraft Travel Distance on Taxiway to the End of Runway
The calculation of travel distance using Autocad is presented.

c. Travel Time Calculation:
Given :

Vexit taxiway 30° = 30,87 m/s
Vt apron = 7,716 m/s
S = total long of the distance = 560 m

Calculation :

Time calculation formula :

$T = \frac{Vo-Vt}{a}$

Note :

T : time at *exit taxiway* (s)
Vo : speed at *exit taxiway* 30° (m/s)
Vt : speed at apron (m/s)
a : deceleration at *exit taxiway* (m/s2)

The calculation of deceleration at the exit taxiway is done first. The calculation formula is as follows:

$$a = \frac{Vo^2 - Vt^2}{2s}$$

$$a = \frac{30{,}87^2 - 7{,}716^2}{2x560}$$

a = 0,798 m/s2

The value of T is obtained as follows:

$$T = \frac{30{,}87\ m/s - 7{,}716\ m/s}{0{,}798\ m/s2}$$

T = 29,026 seconds
T = 0,484 minutes

This travel time is summed with the ROT and interarrival time to get the service time.

F. Runway Usage Analysis Using the ATS (Air Traffic Separation) Principles.

The analysis aims to determine the actual conditions in the simulation of movements that occur in airport airside facilities. The analysis uses the principle of runway usage based on the principle of Air Traffic Separation where there is a separation distance for runway usage time to determine time requirements. Based on a study from Dwangga's Final Project [3], the principle of analysis is as follows:

1. Two or more aircraft are not allowed to operate at the same time on the runway. Therefore, it needs to be rearranged for arriving aircraft to take precedence over departing aircraft.
2. Departing aircraft is allowed to depart when the runway conditions are clear and the next arriving aircraft is within a certain distance of the runway threshold.

For the distance between flight times on the runway are as follows :

a. *Departure-departure* = 2 minutes
b. *Departure-Arrival* = 1 minute
c. *Arrival-Departure* = 1 minute
d. *Arrival-Arrival* = 1 minute

a) Time Separation Analysis of Runway 2 and 3 Operate Independently.

The analysis assumes that runway 2 and 3 operate independently or are not connected to each other. Therefore, the aircraft movements on runway 2 and 3 are not affected by each other. An example of analysing is as follows.

Given :

For the Departure-Departure condition.

The aircraft movement on *runway* 2

a. The 23rd aircraft movement is as follows :
Category C Departure, with time 13:1

b. The 24th aircraft movement is as follows:
Category C Departure, with time 13:19

Based on the previous analysis, principal:

1. Two or more aircraft are not allowed to operate at the same time on the runway. Therefore, it needs to be rearranged for arriving aircraft to take precedence over departing aircraft..

Assuming that runway 2 is independent, the first condition is fully met. (OK)

2. Departing aircraft is allowed to depart when the runway conditions are clear and the next arriving aircraft is within a certain distance of the runway threshold.

Regarding the second condition, the difference in movement time within 13:19 and 13:18 = 1 minute. According to the provisions for departure-departure conditions is 2 minutes. As the result, the second condition is not met. (NOT OK). Therefore, it is necessary to revise the time.

b) Time Separation Analysis of Runway 2 and 3 Operate Simultaneously

In the existing condition, runway 2 and runway 3 of both runways are interconnected (parallel runway) where aircraft movements on runway 3 must pass through the active runway 2. Based on the previous parallel runway suitability analysis, it is concluded that the aircraft movements on both runways cannot be performed out simultaneously for take-off and landing. Thus, it is required to simulate the movement for both runways based on the Air Traffic Rules Separation. The simulation is conducted with a total time within one hour by sorting the aircraft movements according to the time-in time done previously. The sorting of the movement schedule prioritises the aircraft movements on runway 2 because runway 2 is the closest runway to the Soekarno Hatta International Airport passenger terminal. The principle of schedule sorting analysis is as follows :

1. Schedule sorting is conducted by looking at the arrival and departure schedule data that has been done beforec.
2. Prioritising the aircraft movements on runway 2 over the movements on runway 3..
3. The aircraft movements for the arrivals are prioritised over the departures.
4. If there is the same schedule between the arrival and departure times on both runways, the time for arrival is entered first.
5. If there is the same scheduled arrival time on both runways, precedence is given to the arrival time on runway 2. Then the arrival time on runway 3 can be included with the revised time that caused the aircraft is delayed.
6. If the scheduled arrival times on runway 2 and 3 do not exist at a certain minute, then the scheduled departure times can be submitted. The departure time schedule submitted is the earliest departure time schedule and then the time revision is made.

CONCLUSIONS

A. *Conclusions*

From the analysis that has been conducted, the following conclusions are obtained :

1. The results of the analysis of the suitability of runway 2 and runway 3 of Soekarno-Hatta International Airport were as follows:

a) The length of the existing runway is 3000 metres, after the evaluation obtained a length requirement of 3200 metres using the largest aircraft Boeing 747-400. Whereas, the width of the runway is 45 metres, so that the existing runway width of 60 metres has been fulfilled.

b) The width of the taxiway after analysis was 25 metres, while the width of the existing taxiway was 30 metres wide, therefore it meets the standard regulations of the ICAO and FAA.

c) Based on the provisions of the runway separation distance, the separation distance between the two runways was 500 metres. From the analysis, it was found that the non-instrument approach has been fulfilled, whereas the instrument approach is not fulfilled, so if the flight is in bad weather that requires the aircraft to use an instrument approach with IFR (Instrument Flight Rules) conditions, it cannot be done. Both runways cannot be used simultaneously for aircraft take off and landing due to the close proximity which is related to the safety of the airport operations.

d) The usability factor value of 98%-99% is obtained with the dominant wind direction of 60 ° - 240 °. Therefore, the runway direction analysis results with the existing conditions were equal and appropriate.

2. The Results of the capacity calculation using the aircraft movement simulation:

a) For runway 1, the movement capacity was 45 movements with a time of 59.04 minutes used the time space analysis method simulation.

b) or runway 2, the movement capacity on the runway was 42 movements for 59.83 minutes.

c) For runway 3, the movement capacity on the runway was 43 movements for 59.29 minutes.

The total movement from the simulation calculation of three parallel runways is 130 aircraft movements per hour by considering runway 2 and runway 3 as independent runways.

Based on the analysis of the effect of crossing taxiways with the principle of Air Traffic Separation (ATS) on the capacity of runway 2, the aircraft movement capacity was 59 movements. Runway 2 capacity from simulation calculations obtained 42 movements reduced to 30 movements and runway 3 capacity reduced to 29 movements only. Thus, the crossing taxiway reduced the capacity on runway 2 by 12 movements and the addition of runway 3 only increased flight operations by 17 movements compared to aircraft movement operations used runway 2.

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