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Optimization international airport capacity I Gusti Ngurah Rai Bali

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ABSTRACT

This study discuss about optimization capacity on land new to I Gusti Airport International Ngurah Rai, Bali with review evaluation capacity moment this. Development Airport Ngurah Rai consists of of 2 (two) stages. Stage One consists of from development international terminal capacity 189,000 meters square. For Step second, development in the form of international terminal expansion to 265,891 meters. Development process stage I requires reclamation land area of 47 (four twenty seven) hectares, and when it's 35 (three twenty five) hectares has reclaimed. Whereas the rest still in the licensing process and targeted done mid December 2018. Development process Phase II will need reclamation land area of 71 (seven twenty one) hectare. Based on plan development Stages I and II are the addition of an apron covering an area of 47.9 hectares so need conducted calculation optimization capacity airport Ngurah Rai with consider adequate condition of the apron and runway given by PT Angkasa Pura I considering that condition expansion more carry on will difficult because cost development consequence crisis global pandemic and vulnerable damage surroundings waters airport that can damage area. Study this aim for knowing amount movement the plane that will wearing a new apron To use serve movement aircraft in 2022. Analysis started with needs runway length in Maximum Take - off Weight (MTOW) for type aircraft largest operating in 2019 (Boeing 747 – 400), next analyze amount runway capacity and prediction year 2022 in operation mix (Take – off/Landing), and do analysis linear regression for estimate amount movement aircraft optimally for 2022. Continued with determine score rmonth, Rday, and the later Rhour multiplied with score results regression for get score Nmonth, Nday, and Nhour. Nhour value in year planning. Analysis result show evaluation condition existing runway 3000 m to runway needs with aircraft Boeing 747 – 400ER plan, then results correct to influence height from sea level (Fe) is 3323.4 m, while correct to influence temperature air (Ft) obtained 3620.4 m. amount movement aircraft in 2022 results analysis operating runway capacity arrival just is 18 operations per hour, for operation departure just is 44 operations per hour, whereas for operation mixture is 58 operations per hour. The result of parking stand requirements is obtained in class of aircraft 3 C as many as 34 parking stands and 4C as many as 45 parking stands. From result determination new apron capacity in 2022 with total dimensions 122130.4 $m^{2.}$ Next recommended for conducted analysis more carry on in the form of arrangement of parking stands on land reclamation stages I and II. for 2022.

Keywords: Airport, Apron, Capacity, Optimization, Runway.

1 Introduction

Bali's I Gusti Ngurah Rai International Airport is the busiest airport and is an airport for transit assistance for flights on the eastern route. The current condition of Bali's I Gusti Ngurah Rai International Airport has an apron of 381,862 m2, consisting of 53 aircraft stands on the north apron and 11 aircraft stands on the south apron which are intended for narrow body aircraft. Flight activity at I Gusti Ngurah Rai Airport from take-off and landing during peak hours reached 146,554 movements in 2019 serving domestic, international and cargo flights. In anticipation of the management developing a new apron project which was in the reclamation stage in early 2018, until now in 2020 it is still ongoing. However, aircraft, passenger and cargo traffic in January 2020 to April 2020 decreased by 70%, resulting in the closure of airport access in June 2020 compared to the same period last year.

The airport manager in Indonesia, PT Angkasa Pura II Gusti Ngurah Rai Bali hopes that along with large-scale social restrictions, it will restore passenger and goods transport traffic, at least approaching the target capacity for passenger and cargo flows that have been set, of course, will optimize the budget stage by stage of development. a new apron with the aim that at any time if the flight traffic performance increases. Company PT. Angkasa Pura I (Persero) is motivated by the main problem faced in airport management, namely the lack of airport capacity both in terms of check-in facilities, parking stands, and other facilities that are no longer in accordance with the number of passengers/consumers. The development of Ngurah Rai Airport consists of 2 (two) stages. Phase One consists of developing an international terminal capacity of 189,000 square meters. For the second phase, the development consists of expanding the international terminal to 265,891 meters. Phase I development process requires land reclamation of 47 (forty seven) hectares, and currently 35 (thirty five) hectares have been reclaimed. While the rest are still in the licensing process and are targeted for completion in mid-December 2018. The Phase II development process will require land reclamation of 71 (seventy one) hectares. Based on the development plans for stages I and II, namely the addition of a 47.9 hectare apron and a 400 meter runway extension, it is necessary to calculate the optimization of the capacity of the Ngurah Rai airport by taking into account the condition of the apron and runway that PT Angkasa Pura I is able to provide considering that further expansion conditions will be difficult to carry out. because of the cost of development due to the global pandemic crisis and prone to environmental damage around the airport's waters which will be able to damage the area.

2 Data and Method

Location study carried out at I Gusti Ngurah Rai International Airport, which is located in the south of Bali, Indonesia, precisely in the Tuban area, Kuta District, Badung Regency, about 13 km from Denpasar which reaches moment this managed by PT. Angkasa Pura I (Persero) Bali Branch. Next conducted secondary data collection obtained from notes, reports, and references related. For more complete is in the table as following.

Table 1. Flowchart Study

Stage Processing	Data	Work Details	Results
Background Behind	References and literature	1. Identification Study 2. Studies Literature	Formulas Study
Airport Classification	• Annual Departure Data for the Period of 2017 to 2019 • Schedule data time use of parking stands • Airport layout data • Airport AIP Data • Result data large reclamation Phase I & II Airport	3. Airport Classification 4. Secondary Data Collection	Existence addition airport area capacity
Traffic in Bali Region	Data collection in the form of Annual Departure s period year 2019 with timetable flight and type take- off / landing aircraft at the airport Ngurah Rai	5. Recap Type Aircraft from Largest to Type Aircraft 6. Air Traffic Data 2019 _ 7. Peak Month, Day, Hour Analisis Analysis 8. Analysis Runway Capacity	Results of forecasting data processing until year 2022 and results recap data types plane. Analysis Apron Capacity
Analysis To Airport Capability	9. Analysis Capacity Airport Air Side.		Optimization results in the form of score dimensions, quantities, and time movement aircraft to airport expansion
Research Results		Conclusion	Suggestion

3 Results and Discussion

3.1 Characteristics and Type Data Aircraft

Here in the table classify Maximum Take Off Weight, Speed Approach, Runway Occupancy Time, and Frequency movement, so that the data will used for analysis capacity runways and aprons.

Table 2. Table Characteristics and Type Aircraft

Type Aircraft	Speed Approch (Knots)	Occupancy Time		Frequency (1 Week)	MTOW (Kg)
		Run way	Apon		
A332	140	65	30	34	230000
A333	130	65	30	47	230000
B788	140	65	30	36	228000
B744ER	**160**	**70**	**40**	**20**	**396890**
A343	150	70	40	25	275000
A342	150	70	40	42	275000
B773	149	70	40	30	299370
B772ER	136	70	40	38	247200
B739ER	**145**	**50**	**30**	**85**	**79015**

3.2 Analysis Calculation Runway Capacity Based on Runway Length Requirement

Runway requirements are determined use correct elevation, temperature, horizontal slope takeoff pacemaker, and ARFL (Aeroplan Reference Field Length), from aircraft critical operating for operate take-off, landing, and maneuver with burden maximum. Following is the discussion:

Data AIP (Airport Information Publicer) Airport Ngurah Rai.

1) Elevation above sea level (h) = 14 ft (4.2 m)
2) Temperature (T) = 33.8° C
3) The horizontal slope of the runway pace (S) = 1.5%
4) ARFL B747 – 400 ER = 3300 m

3.3 Runway Length Correction

Based on the existing airside facility data, the runway length correction can be made as follows.

1. Effect of altitude from sea level (Fe)

   Fe = (ARFL x 0.07 xh/3) + L
   Fe = (3300 x 0.07 x 4.2/3) + 3000
   Fe = 3323.4 m
   Information:
   L = Existing runway length
   ARFL = Aeroplan Reference Field Length

2. Effect of air temperature

   Ft = [ARFL x (t – 15) x 0.01] + L
   Ft = [3300 x (33.8 – 15) x 0.01] + 3000
   Ft = 3620.4 m
   Information:
   t = Temperature

From the results of the above calculations, to evaluate the existing condition of the existing 3000 m runway, the results of the correction to the effect of altitude from sea level (Fe) are 3323.4 m, while the correction to the effect of air temperature (Ft) is 3620.4 m.

3.4 Capacity Runway System for Arrival Just

Runway has a FAP length (γ) of 5 nm and an interarrival separation of 5 nm. Furthermore, the aircraft are grouped based on the approach speed and the [Mij] matrix as follows:

a. State Docking / Closing (Vi < Vj)

Is state where speed plane in front (leading, Vi) slower than the plane behind (trailing, Vj). Equation used is like seen in Eq following this.

$$\Delta T_{ij} = T_j - T_i = \frac{\delta_{ij}}{v_j}$$

Vi = 130 Knots and Vj = 130 Knots

$$\Delta T_{ij} = \frac{\delta_{ij}}{v_j} = \frac{5}{130} = 0.039 \text{ jam} = 140{,}4 \text{ detik}$$

So, separation time between arrival sequentially with (leading, Vi = 130 knots) and (trailing, Vj = 130 knots) is 140.40 seconds.

b. State Stretching /Opening (Vi > Vj)

Is a condition where the speed of the aircraft in front (leading, Vi) is faster than the speed of the aircraft behind (trailing, Vj). The equation used is as shown in the following equation.

$$\Delta T_{ij} = T_j - T_i = \frac{\delta_{ij}}{v_j} + \gamma\left(\frac{1}{V_j} - \frac{1}{V_i}\right)$$

a. Vi = 140 Knots and Vj = 130 Knots

$$\Delta T_{ij} = T_j - T_i = \frac{\delta_{ij}}{v_j} + \gamma\left(\frac{1}{V_j} + \frac{1}{V_i}\right)$$
$$= \frac{5}{130} + 5\left(\frac{1}{130} - \frac{1}{140}\right)$$
$$= 0.042 \text{ jam } (151.2 \text{ dtk})$$

So, the separation time between consecutive arrivals with (leading, Vi = 140 knots) and (trailing, Vj = 130 knots) is 151.20 seconds.
Then all the above results are entered into the [Mij] Matrix:

Table 3. Matrix [Mij]

		Leading (Vi)			
		130 Knots	140 Knots	150 Knots	160 Knots
Trailing (Vj)	130 Knots	140.40 sec	151.20 sec	158.40 sec	165.60 sec
	140 Knots	118.80 sec	129.60 sec	140.40 sec	144 sec
	150 Knots	104.40 sec	111.60 sec	122.40 sec	129.60 sec
	160 Knots	90.00 sec	97.20 sec	108 sec	111.60 sec

Whereas probability happening order the plane that came for all the combination of Vi and Vj obtained from frequency movement (Table 3), namely like in [Pij] matrix in (Table 4) below this:

Table 4. Matrix [Pij] For Arrival

		Leading			
		130 Knots	140 Knots	150 Knots	160 Knots
Trailing	130 Knots	0	0.02184179	0.07817228	0.01819851
	140 Knots	0.03913512	0.04994516	0.07817228	0.06935354
	150 Knots	0.05855379	0.20880723	0.08877119	0.28586839
	160 Knots	0.01950984	0.05965411	0.21528587	0.05965471

Approximate value time between arrival (interval time) is product of probability happening order aircraft i followed with with plane j called Pij with separation time between arrival aircraft i followed plane j that has arranged in Matrix [Mij] (Table 3) that can be declared in equality following this :

$$E(\Delta T_{ij}) = \sum P_{ij}\ m_{ij} = \sum [P_{ij}]\ [m_{ij}]$$

= 0(140.40) + 0.03913512(118.80) +
0.05855379(104.40) + 0.01950984(90) +
0.02184179(151.20) + 0.04994516(129.60) +
0.20880723(111.60) + 0.05965411(97.20) +
0.07817228(158.40) + 0.07817228(140.40) +
0.08877119(122.40) + 0.21528587(108) +
0.01819851(165.60) + 0.06935354(144) +
0.28586839(129.60) + 0.05965471(111.60) =
154.40 detik

If score estimation time between arrival called (ΔTij) is declared in unit second so capacity runways per hour for operation arrival got from equality following this:

$$C_\alpha = \frac{3600}{E(\Delta T_{ij})} = \frac{3600}{154.40 \text{ detik}}$$

= 23.32 (23 operasi kedatangan per jam)

So capacity runway for arrival just is 23 operations hourly arrivals.

3.5 Capacity Runway System for Departure Just

Interdeparture time matrix is prepared based on the existing minimum separation rules between departures. ICAO in DOC.444 Air Traffic Management classifies aircraft into 3 based on Maximum Take Off Weight (MOTW) (Table 4.6). Then the matrix [t d] is made.

Table 5. Interdepature Time

		Leading	
		Large	Medium
Trailing	Large	60	60
	Medium	120	60

Probability happening order departing plane for all combination aircraft Medium and Large obtained from frequency movement (Table 5), can seen in (Table 6) below.

Table 6. Matrix [Pij] For Departure

		Leading	
		Large	Medium
Trailing	Large	0.81372549	0.09803922
	Medium	0.08823529	0

Based on equation, can calculated big time service between departure on the verge runway is as following:

$$E(T_{td}) = \Sigma[P_{ij}][td]$$

= 0.81372549(60) + 0.08823529(120)
+0.09803922(60) + 0(60) = 65.30 detik

So, capacity runways per hour for serve departure just obtained from formula in equation namely:

$$C_\alpha = \frac{3600}{E(T_d)} = \frac{3600}{65.30 \text{ detik}}$$

= 55.14 (55 operasi keberangkatan per jam)

3.6 Capacity Runway System for Operation Mixture

Because of rule separation between arrival that is not interspersed with something departure different with interspersed arrival something departure, then conducted calculation return time interarrival runway in operation arrival with separation between arrival ($\boldsymbol{\delta}$) 8 nm and FAP Length ($\boldsymbol{\gamma}$) 5 nm. Previously searching for matrix [Mij] with use equations 2 and 3. Next all above results entered to in Matrix [Mij]:

Table 7. Matrix [Mij] For 8 nm separation

		Leading (V i)			
		130 Knots	140 Knots	150 Knots	160 Knots
Trailing (Vj)	130 Knots	223.2	234	241.2	248.4
	140 Knots	198	205.2	216	223.2
	150 Knots	176.4	183.6	194.4	201.6
	160 Knots	154.8	165.6	172.8	180

Approximate value time between arrival (interval time) is product of probability happening order aircraft i followed with with plane j called Pij with separation time between arrival aircraft i followed plane j that has arranged in Matrix [Mij] (Table 6). Who can declare in equality following this:

$$E(\Delta T_{ij}) = \sum P_{ij}\ m_{ij} = \sum [P_{ij}]\ [m_{ij}]$$

= 0(223.2) + 0.03913512(198)
+ 0.05855379(176.4)
+ 0.01950984(154.8)
+ 0.02184179(234)
+ 0.04994516(205.2)
+ 0.20880723(183.6)
+ 0.05965411(165.6)
+ 0.07817228(241.2)
+ 0.07817228(216)
+ 0.08877119(194.4)
+ 0.21528587(172.8)
+ 0.01819851(248.4)
+ 0.06935354(223.2)
+ 0.28586839(201.6)
+ 0.05965471(180)
= 333.79 detik

If score estimation time between arrival called (ΔTij) is declared in unit second so capacity runways per hour for operation arrival got from equality following this:

$$C_\alpha = \frac{3600}{E(\Delta T_{ij})} = \frac{3600}{333.79 \text{ detik}}$$

$= 10.79$ (11 operasi kedatangan per jam)

So, capacity runways per hour for arrival only on operation mixture is 11 operations hourly arrivals.

3.7 Delivery Time Arrival for Could Interspersed by A Departure

Next calculated time between arrival for could punctuated by a departure with separation between followed departure arrival (**δ**d) 5 nm, namely:

a. Every type aircraft grouped based on Runway Occupancy Time with probability operate based on frequency movement.

Table 8. Grouping Runway Occupancy

Type Aircraft	Runway Occupancy Time	Probability
Boeing B747 400ER, Airbus A340 – 300, Airbus A340 – 200, Boeing B777 – 300, Boeing B777 - 200ER	70	0.209712
Airbus A330 200, Airbus A330 300, Boeing B787 – 8	65	0.194734
Boeing B737 - 900ER	50	0.149795

Movement airplane on the runway must prioritize the plane that will be landed (arrivals) because if there is a delay of 30 minutes, then the plane that will land the will diverted to airport closest. Usage time runway mean E[Ri], is amount multiplication from probability mixture airplane during rush hour with average time usage runway each category plane. Next calculated the value of E(Ri) is as following:

$E(R_i)$ = probability mix x time usage runway

$= 0.209712(70) + 0.194734(65) + 0.149795(50)$

$= 34.83$ seconds

So, time usage the average runway E[Ri] is 34.83 seconds.

b. Every group type aircraft grouped based on Approach Speed with probability operate based on frequency movement.

Table 9. Table Approach Speed

Type Aircraft	Approach Speed	Probability
Boeing B747 400ER	160	0.124712
Airbus A340 – 300, Boeing B777 – 300, Boeing B737 - 900ER	150	0.026667
Airbus A340 – 200, Airbus A330 200, Boeing B787 – 8, Boeing B777 - 200ER	140	0.028576
Airbus A330 300	130	0.007713

Expected time the plane that came for go through last 2 miles distance to threshold runway is amount multiplication from probability mixture planes during rush hour. Like equality following searching for value of E(δd/ Vj):

$$E\left(\frac{\delta_d}{V_j}\right) = \left[\text{probabilitas campuran } \frac{\text{jarak tempuh}}{(\text{approach speed})}\right]$$

$$= 0.124712\left(\frac{5}{160}\right) + 0.026667\left(\frac{5}{150}\right) + 0.028576\left(\frac{5}{140}\right) + 0.007713\left(\frac{5}{130}\right)$$

$$= 0.011419 + 0.001999 + 0.002931 + 0.001319 = 0.017668 \text{ jam (63.60 detik)}$$

So expected time the plane that came for go through last 2 miles distance to threshold runway is 63.60 seconds. Because that, time between arrival required for To do one departure between two arrival is as following :

$$E(\Delta T_{ij}) \geq E(R_i) + E\left(\frac{\delta_d}{V_j}\right) + (n_d - 1)E[t_d]$$

$$\geq 34.83 + 63.60 + 65.30\,(n_d - 1)$$

$$\geq 98.43 + 65.30\,(n_d - 1)$$

$$C_m = \frac{3600}{E(\Delta T_{ij})}\,(1 + \Sigma n_d\, P_{nd})$$

$$C_m = \frac{3600}{98.43}\,(1 + 1(1))$$

$= 73.15$ (73 operasi per jam)

3.8 Analysis Calculation Runway Capacity

Capacity saturated I Gusti International Airport runway Ngurah Rai Bali for operation mix (50% arrivals and 50% departures) is 73 operations per hour. Capacity runway saturation is estimation amount movement aircraft that can accommodated by a runway in something period certain, with ignore the delay that occurs, when in reality the delay is not could fully avoided. In base theory has explained about capacity practical runway about 80% of capacity saturate the runway for anticipate possible delay during During operation if a number of factor external like weather, operation delay from company aviation, etc., interfere normal operation. So capacity practical runway I Gusti International Airport Ngurah Rai Bali is as following:

- Operation arrival only = 80% x 23 = 18.4 (18 operations per hour)
- Operation departure only = 80% x 55 = 44 operations per hour

- Operation mix = 80% x 73 = 58.4 (58 operations per hour)

3.9 Apron Capacity

Apron capacity starts with more formerly knowing existing and continued apron capacity with calculation ratio capacity aprons. Determination of the existing apron conducted with three approaches use three different parking times. Approach this meant for knowing how capacity apron existing based on parking time the for then one of the parking times is used as reference design.

a. Analysis Movement Aircraft 2019

Analysis movement aircraft calculated based on movement from 2017 to 2019, so will get results movement aircraft until 2022. Method used is method linear regression, the following is the calculation:

Table 10. Movement Results Aircraft

Year	X	X^2	Movement Aircraft (Y)	XY	Y2 -
2017	1	1	126,345	126,345	15,963,059,025
2018	2	4	139,092	278,184	19,346,584,464
2019	3	9	146,554	439,662	21.475.143.936
Total	6	14	411,991	844,191	56,784,787,425

$b = \frac{n\sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2}$ $a = \bar{y} - b\bar{x}$

$b = \frac{3(884191) - (6 \times 411991)}{3(14) - (6)^2}$ $\bar{y} = \frac{\sum y}{n}$ $\bar{x} = \frac{\sum x}{n}$

$b = \frac{180627}{6} = 30104.5$ ⍰ $= \frac{411991}{3} = 137330.4$

x = 6/3 = 2

a = 1 37330.4 – (30104.5 x 2)

a = 137330.4 – 60209

a = 77121.4

b. Forecasting Parameters

Calculation starting with peak month ratio with movement data aircraft air (table 4.14) in 2017 to 2019, then could calculated the value of peak mountain ratio per year as following:

$$\text{R Month} = \frac{\text{N month}}{\text{N year}}$$

Table 11. Table of Peak Month Rotio. Results

Calculation of peak month ratio

Year

2020	2021	2022
0.0842	0.0834	0.0830
0.0769	0.0789	0.0726
0.0788	0.0805	0.0766
0.0822	0.0801	0.0789
0.0852	0.0843	0.0830
0.0822	0.0783	0.0812
0.0846	0.0887	0.0918
0.0886	0.0872	0.0911
0.0841	0.0828	0.0892
0.0878	0.0858	0.0844
0.0746	0.0823	0.0820
0.0908	0.0876	0.0870

Based on table 11 can seen score biggest from calculation peak month ratio that is on the moon July year 2019 with score of 0.0918. Next count peak day ratio on 21 July 2019 and movement data aircraft air daily the busiest (table 4.13).

$$\text{R Day} = \frac{\text{N day}}{\text{N month}} = \frac{462}{13.520} = 0{,}0342$$

After peak day ratio, next count peak hour ratio and movement data aircraft busiest hour (table 4.13).

$$\text{R Hour} = \frac{\text{N hour}}{\text{N day}} = \frac{32}{462} = 0{,}0896$$

c. Calculation Until Period 2022 _

From result calculation movement aircraft air, got the value of the regression parameter a = 77121.4, and b = 30104.5 then there is equality as following.

Table 12. Predictions Movement Aircraft

Year	a	b	X	Prediction Movement Aircraft (Y = a + bx)
2020	77121.4	30104.5	4	197539.4
2021	77121.4	30104.5	5	227643.9
2022	77121.4	30104.5	6	257748.4

3.10 Needs Number of Parking Stands

Before count needs number of parking stands, gate occupancy time data is required which is average time of parking stand usage every type plane.

Table 13. Gate Occupancy Time Aircraft

Class of Aircraft	Gates Occupancy Time (Minutes)
3C	30
4C/4E	40

Ti $= \frac{30+40}{2} = 50$

S $= \left(\frac{50}{60} \times 58\right) + 1$

$= 49$

Based on Result of 49 parking stands, next conducted checking capacity aprons.

3.11 Checking Apron Capacity

Checking aim for knowing the existing apron capacity at Ngurah Rai Airport is based on Class of Aircraft with amount movement aircraft in 2022 of 58 movements / hour (results correct needs runway capacity), total plan 49 parking stand needs. Determination of the existing apron take 2 approaches based on table 13 then one of the gate occupancy times is used as reference design.

Table 14. Capacity Apron Based on Gates Occupancy Time

Class of Aircraft	Gates Occupancy Time (Minutes)	Capacity Apron	Ratio Capacity Apron
3C	30	98	1.7
4C/4E	40	73	1.3

3.12 Determination New Apron Capacity

Table 15. Needs Parking Stand Based on Checking Results Capacity Apron

Class of Aircraft	Ratio Capacity Apron	Capacity Apron New
3C	1.7	34
4C/4E	1.3	45

Based on review availability land new in the area of I Gusti International Airport Ngurah Rai Bali then results dominate Class of Aircraft 4C/4E totals 45 with Gates Occupancy Time 40 minutes.

3.13 Calculation Apron Dimension

After determination apron capacity, next taken into account apron dimensions for know amount dimensions obtained and so on adjustment with land reclamation new 47.9 hectares at I Gusti. International Airport Ngurah Rai Bali get calculated needs for apron dimensions as following:
For aircraft Category 4 C:
Range wing / Wing span (W)= 35.7 m = 36 m
Clearence Wing span with object taxi line = 26 m
Distance Room Between Wings Aircraft = 4.5m
Clearence Wing span aircraft with limit apron edge = 10 m
For aircraft Category 4 E:
Range wing / Wing span (W)= 64.92m = 65 m
Clearence Wing span with object taxi line = 47.5 m
Distance Room Between Wings Aircraft = 7.5m
Clearence Wing span aircraft with limit apron edge = 10 m
So could is known results the calculation are:
l = width apron existing + (7.5 x (wing span B.737 900- ER)) + (0.5 x (wingspan B 747 400) + (Result of capacity apron new x Distance Room Between Wings Airplane) + Distance room between end wing aircraft with apron edge + Distance Room Between Wings Aircraft class 4E)
l = 180.8 + (7.5 x (36)) + (0.5 x 65) + (79 x 4.5) + 10 + 7.5
= 180.8 + 270 + 32.5 + 355.5 + 17.5
= 856.3 m
Planning widening aprons:
Calculation result – width apron existing:
= 856.3 – 180.8
= 675.5 m
Planning Expansion aprons:
L = 675.5 x 180.8
= 122130.4 m ^{2}
Based on calculation on obtained expansion planning apron of 122130.4 m $^{2.}$ From the results obtained so comparison with 47.9 Hectares (479000 m $^{2)}$ with results expansion planning apron 122130.4 m ^{2} still could adapt to existing land, so that part land could used for facility parallel taxiway, terminal and side virgin t.

4 Conclusion

Based on the results of data analysis and processing, it can be concluded as follows.

1. To evaluate the existing condition of the existing 3000 m runway against the runway requirement with the Boeing 747 – 400ER plan aircraft, the correction results for the effect of altitude from sea level (Fe) is 3323.4 m, while the correction for the effect of air temperature (Ft) is 3620.4 m.
2. From result no. 1 that the 3400 runway planning is compared to the results of the air temperature correction analysis (Ft) which is 3620.4 m, therefore to increase the runway capacity in the future, it is necessary to plan an additional 300 m of runway length in order to maximize it according to the MTOW of the Boeing 747 – 400ER planned aircraft.
3. Runway capacity analysis, arrival operations alone are 18 operations per hour, for departure operations only are 44 operations per hour, while for mixed operations it is 58 operations per hour.
4. Based on the calculation no. 3 obtained in mixed operations amounting to 58 operations per hour, then this is not comparable to the 2022 data for capacity at peak hours, which is 29 operations per hour. To overcome this, airport operations must create parallel taxiways from the north and south sides at the location of the new apron expansion.
5. Apron capacity for reclaimed land, there is a need for the number of parking stands in Class of Aircraft 4C totaling 45 with Gates Occupancy Time of 40 minutes and Class of Aircraft 3C amounting to 34 with Gates Occupancy Time of 30 minutes.
6. Apron expansion plan is 122130.4 m2 with dimensions of 675.5 x 180.8 m for 79 parking stands.

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