Planning the Expansion of Ground Support Equipment Parking Using Rigid Pavement for the Next 10 Years at Juanda International Airport

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ABSTRACT
Juanda International Airport is projected to experience a significant increase in aircraft and domestic passenger movements by 2035. This growth will impact the demand for Ground Support Equipment (GSE) parking, which is expected to exceed the current capacity of 13,596 m². This study aims to determine the required GSE parking area during peak hours in 2035 using linear regression for traffic projections, SKEP.47/III/2007 for equipment estimation, and the Ministry of Public Works Circular SE 02/SE/M/2018 for parking design standards. The analysis results indicate a required parking area of 16,250 m² and a rigid pavement thickness of 32.4 cm, calculated using FAARFIELD 2.0.18. The estimated construction cost is Rp22,394,502,687.

Keywords: *Ground Support Equipment, Parking expansion, Rigid pavement, FAARFIELD, Juanda International Airport.*

1. INTRODUCTION

Juanda International Airport has experienced a significant increase in domestic passenger movements over the past five years, leading to a higher frequency of aircraft operations and, consequently, an increased demand for Ground Support Equipment (GSE). The limited GSE parking area poses potential risks of operational disruption and delays. Therefore, the expansion of the GSE parking area is a crucial measure to maintain operational efficiency, comply with airport safety standards, and improve the punctuality of ground handling services.

This study aims to plan the GSE parking requirements at Juanda International Airport for the next 10-year projection, covering: (1) Passenger and aircraft movement projections during peak periods, (2) Estimation of the required number of GSE units, (3) Determination of the necessary GSE parking area, and (4) Cost Estimate (RAB) calculation for the expansion of the GSE parking area.

The benefits of this research are as follows: (1) For the researcher, it enhances knowledge and experience in planning the expansion of the GSE parking area at Juanda International Airport. (2) For the airport authority, it serves as a reference in planning the GSE parking area expansion for the next decade. (3) For educational institutions, it provides literature references related to future GSE parking planning.

2. METHODS

The object of this research is the existing Ground Support Equipment (GSE) parking area located on the east side of the domestic terminal apron at Juanda International Airport. This study employs a descriptive method with both manual and software-assisted approaches. Manual calculations were carried out based on SKEP.47/III/2007 to determine the required number of Ground Support Equipment (GSE) units and the necessary parking area. Passenger and aircraft movement projections during peak hours in 2035 were estimated using linear regression with Microsoft Excel, based on the past five years of data. The projection results were then used to estimate future GSE requirements. In addition, FAARFIELD 2.0.18 software was applied to design the rigid pavement thickness for the GSE parking area at Juanda International Airport's domestic terminal.

The data collection methods in this study include literature review, direct observation, and field data gathering. The literature review involved examining relevant references and regulations as the theoretical foundation. Direct observation was conducted during On-The-Job Training at Juanda International Airport to obtain an overview of actual field conditions. Data were obtained directly from the airport authority, including information on the existing GSE parking area, types and quantities of available GSE, as well as other supporting data used as the basis for planning the expansion of the GSE parking area for the next 10-year projection.

Figure 1 Ground Support Equipment Location at Juanda International Airport

The preparation of the Cost Estimate (RAB) in this final project aims to calculate the estimated expenses for the expansion of the Ground Support Equipment (GSE) parking area. The cost reference is based on the 2024 Standard Activity Unit Price (HSPK) issued by the Surabaya City Government, while the calculation coefficients refer to the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 78 of 2014 concerning Cost Standards within the Ministry of Transportation.

The objective of this study is to formulate a plan for the expansion of the Ground Support Equipment (GSE) parking area at the Domestic Terminal of Juanda International Airport for the next 10-year projection. This planning is expected to ensure that the GSE parking capacity can adequately accommodate all equipment needs in accordance with the projected operational demand during the period.

3. RESULT AND DISCUSSION

3.1. Existing Condition of Ground Support Equipment Parking

Juanda International Airport is the third busiest airport in Indonesia after Soekarno-Hatta and Ngurah Rai. Based on the trend of increasing domestic aircraft movements over the past five years, the number of aircraft movements during peak hours is projected to rise within the next 10 years. Along with this growth, the demand for Ground Support Equipment (GSE) is also expected to increase. With the existing GSE parking area covering 13,596 m², this capacity is projected to be insufficient to accommodate all GSE units in the future. An illustration of the current GSE parking condition at the Domestic Terminal is presented in Figure 2.

Figure 2 Existing Condition of GSE Parking

3.2. Passenger Forecast Calculation for 2035

The annual passenger forecast was carried out using the Simple Linear Regression method with the following equation: $Y = a + bX$ (1)

Where:

Y = Response Variable

X = Predictor Variable

a = Constant

b = Regression Coefficient

Table 1. Annual Passenger Forecast

Year	X	X^2	Y	XY	Y^2
2020	1	1	6370743	6370743	4,05864E+13
2021	2	4	5831529	11663058	3,40067E+13
2022	3	9	9847916	29543748	9,69814E+13
2023	4	16	9933285	39733140	9,86702E+13
2024	5	25	11713720	58568600	1,37211E+14
Total	15	55	43697193	145879289	4,07456E+14

After obtaining the forecasting results as presented in Table 1, the next step is to conduct forecasting using the linear regression method to project the number of passengers for the period 2025 to 2035. The purpose of this calculation is to estimate passenger growth within that timeframe, as shown in the following calculation:

$$Y = a + bX2 \quad (2)$$

$$b = \frac{n \sum xy - (\sum x)(\sum y)}{n \sum x^2 - (\sum x)^2} \quad (3)$$

$$a = \frac{\Sigma y}{n} - (b \times \frac{\Sigma x}{n}) \quad (4)$$

Calculated :

$$b = \frac{5\ x\ 145.879.289 - (15)(43.697.193)}{5\ x\ 55 - (15)^2}$$

$$b = \frac{729.396.445 - 655.457.895}{275 - 225}$$

$$b = \frac{73.938.550}{50}$$

b = 1.478.771

$$a = \frac{43.697.193}{5} - 1.478.771 \times \frac{15}{5}$$

a = 8.739.439 – 4.436.313

a = 4.303.126

After obtaining the values of *a* and *b*, the calculation can then be carried out as follows:

$$Y = a + bX \quad (5)$$

Y = 4.303.126 + (1.478.771 x 16)

Y = 27.963.462

After obtaining the projected number of passengers in 2035, which amounts to 27,963,462 people, the daily passenger volume can be determined using the following formula:

$$\text{Daily Passengers} = \frac{Annual\ Passengers}{365} \quad (6)$$

$$\text{Annual Passengers} = \frac{27.963.462}{365} = 76.612 \text{ Passengers}$$

3.3. Calculation of Peak Hour Passenger Volume

Based on the Regulation of the Minister of Transportation of the Republic of Indonesia Number 41 of 2023, the number of Peak Hour Passengers (PWS) can be determined using Table 2 below.

Table 2. Coefficient of Peak Hour Passengers (PWS)

Number of Passengers/ Year (Million)	Coefficient PWS (%)	PWS
> 30	0,035%	> 10,500
20-29,999	0,040%	8000 – 11999
10-19,999	0,045%	4500 – 8999
1-9,999	0,050%	500 – 4999
0,5-0,999	0,080%	400 – 799
0,1-0,4999	0,130%	130 – 649
< 0,1	0,2%	< 200

The number of passengers from 2020 to 2023 exceeded 1 million, and in 2024 increased to more than 10 million. Based on Table 3, coefficients of 0.045% and 0.040% were used to calculate the Peak Hour Passengers (PWS), using the following formula:

$$PWS = \frac{\text{Number of Passenger/Year}}{100} \text{ x Coefficient} \quad (7)$$

Table 3. Peak Hour Passenger Forecast

Year	Passenger/Year	Coefficient	PWS
2025	13.175.752	0,045	5.929
2026	14.654.523	0,045	6.595
2027	16.133.294	0,045	7.260
2028	17.612.065	0,045	7.925
2029	19.090.836	0,045	8.591
2030	20.569.607	0,040	8.228
2031	22.048.378	0,040	8.819
2032	23.527.149	0,040	9.411
2033	25.005.920	0,040	10.002
2034	26.484.691	0,040	10.594
2035	27.963.462	0,040	11.185

Based on the calculation of peak-hour passengers as stipulated in the Regulation of the Minister of Transportation of the Republic of Indonesia Number 41 of 2023 concerning Airport Services at Airports, the projected number of peak-hour passengers over the next 10 years (by 2035) is estimated to reach 11,185 passengers."

3.4. Calculation of Peak Hour Aircraft Movements and Fleet Requirements in 2035

The projection of aircraft movements during peak hours in 2035 is based on air traffic growth trends and annual growth assumptions. This increase in movements directly affects the additional requirements for ground support equipment (GSE), which are calculated by considering aircraft types, flight frequency, and average service time to ensure optimal operations during peak hours. The following equation and table present the projected number of aircraft movements during peak hours in 2035

Load Factor = Passenger Capacity x 65% (8)

Table 4. Passenger Capacity and Load Factor

Aircraft Type	Number of Passengers	
	Passenger Capacity	Load Factor (65%)
Airbus A320-200	180	117
Boeing 737-800	189	123
Boeing 737-900	215	140
Airbus A330 900 neo	440	286

Number of Peak Hour Aircraft = A x Load Factor (9)

A = Fleet Requirement Plan

Table 5. Daily Number of Aircraft

Year	Aircraft Fleet Requirements			
	Airbus A320-200	Boeing 737-800	Boeing 737-900	Airbus A330 900 neo
2035	169	178	148	50

Table 6. Number of Peak Hour Aircraft

Year	Aircraft Fleet Requirements			
	Airbus A320-200	Boeing 737-800	Boeing 737-900	Airbus A330 900 neo
2035	21	22	23	10

The number of required aircraft fleet during the 2035 peak hour is calculated using the following formula:

$$\text{Aircraft Fleet Requirements} = \frac{\text{Peak Hour Aircraft}}{2} \quad (10)$$

Because each aircraft carries out both arrival and departure movements.

Table 7. Peak Hour Aircraft Fleet Requirements in 2035

Year	Aircraft Fleet Requirements			
	Airbus A320-200	Boeing 737-800	Boeing 737-900	Airbus A330 900 neo
2035	11	11	12	5

3.5. Calculation of GSE Requirements During Peak Hour in 2035

The calculation of Ground Support Equipment (GSE) requirements during the peak hour in 2035 is carried out to ensure the availability of adequate ground handling facilities to support aircraft operations on the airport apron. GSE plays a vital role in ensuring the smooth execution of ground services, including boarding, unloading, refueling, and light maintenance. The following table presents the projected GSE requirements during the peak hour in 2035.

Table 8. Total Equipment Requirements

No	Equipment Name	Total Requirements	
		Narrow	Wide
1	ATT	1	1
2	BTT	3	4
3	PBS	2	3
4	WST	1	1
5	HCT	-	2
6	APB	2	4
7	GPU	1	1

The following formula and table present the Ground Support Equipment (GSE) requirements during peak hours in 2035:

Equipment Requirement = Number of Aircraft × Equipment Ratio (11)

Table 9. Total Equipment Requirements

No	Aircraft Type/ Equipment Name	Airbus A320-200	Boeing 737-800	Boeing 737-900	Airbus A330 900 neo	Total
1	ATT	10	10	13	5	38
2	BTT	30	30	39	20	119
3	PBS	20	20	26	15	80
4	WST	10	10	13	5	38
5	HCT	0	0	0	10	10
6	APB	20	20	26	20	86
7	GPU	10	10	13	5	38

3.6. Calculation of GSE Parking Area Referring to the Circular of the Minister of Public Works and Public Housing No. 02/SE/M/2018

The calculation of the GSE parking area on the apron refers to the Circular of the Minister of Public Works and Public Housing No. 02/SE/M/2018 to ensure compliance with national standards. The table presenting the total parking area is shown below:

Table 10. GSE Parking Area Calculation

No	Equipment Name	Dimension (m^2)	standard regulation (m^2)	Aircraft Type				Total (m^2)
				Narrow			Wide	
				A320-200	B737-800	B737-900	A330-900 neo	
1	ATT	8,28	12,5	10	10	13	5	625
2	BTT	4,96	12,5	30	30	39	20	1487,5
3	PBS	18	-	20	20	26	15	1012,5
4	WST	15,62	42,5	10	10	13	5	1615
5	HCT	43	42,5	0	0	0	10	425
6	APB	31,25	42,5	20	20	26	20	3655
7	GPU	8,16	12,5	10	10	13	5	475
Luasan Area Parkir								9145
Akses Jalan								7105
Total Area Perencanaan								16.250

The calculated land deficit is 16,250 m². Accordingly, the proposed expansion plan is designed to cover an area of 130 m × 125 m.

3.7. Layout Overview of Ground Support Equipment (GSE) Parking Area

The layout of Ground Support Equipment (GSE) refers to the designated arrangement of areas for storing aircraft ground operation equipment. This arrangement considers aspects of safety, efficiency, and the grouping of equipment based on function. The layout is designed to facilitate the visualization of the planned expansion area.

3.8. Pavement Design Planning Using FAARFIELD

The determination of vehicle loads and soil data serves as the basis for pavement design in the GSE parking area. The data include the heaviest load, represented by a High Lift Catering Truck weighing 17.5 tons (38,581 lbs), and a subgrade soil CBR value of 15% (unsoaked). Pavement thickness calculations were performed using FAARFIELD software, with the modeling results presented in the following figure.

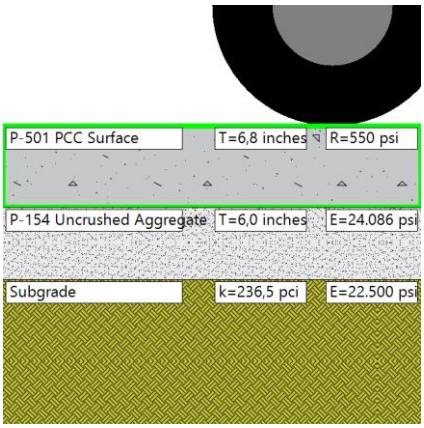

Figure 3. Pavement Thickness Calculation Results Using FAARFIELD

3.9. Cost Estimation

The estimated Cost Budget Plan (RAB) for the expansion of the parking area with rigid pavement, including VAT, is approximately IDR 22,394,502,687,-.

4. CONCLUSION AND RECOMMENDATION

4.1. Conclusion

In 2035, the number of domestic passengers during peak hours at Juanda International Airport is projected to reach 11,185, with an estimated 39 aircraft movements. The demand for Ground Support Equipment (GSE) is projected to comprise 408 units, necessitating an

additional parking area of 16,250 m². The pavement is planned to use rigid pavement with an estimated cost of IDR 22,394,502,687.

4.2. Recommendation

The results of this Ground Support Equipment (GSE) parking expansion plan can serve as a reference for Juanda International Airport management in future decision-making. The involvement of airport authorities and GSE operators from the early planning stage is crucial to ensure that the design aligns with operational requirements and remains cost-efficient. Future studies are recommended to examine drainage and pavement markings to further strengthen the comprehensiveness of GSE facility planning.

AUTHORS' CONTRIBUTIONS

A.A.S. conducted the research and drafted the manuscript.
F.R. supervised the research and provided critical review.
W.S. contributed to conceptualization and revised the manuscript.

ACKNOWLEDGMENTS

The author would like to express the deepest gratitude to Allah SWT for His blessings and guidance throughout this research. Special thanks are extended to the supervisors, Mr. Fahrur Rozi, S.T., M.Sc. and Mr. Dr. Wiwid Suryono, S.Pd., M.M. for their valuable guidance, continuous support, and constructive feedback. The author also sincerely thanks PT Angkasa Pura Indonesia – Juanda International Airport for granting permission and providing access to the necessary data. Heartfelt appreciation is conveyed to the author's parents and family for their endless prayers and encouragement, as well as to Reynata Habsari Wibisono for the unwavering support and motivation during the completion of this study.

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