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Runway Extension Plan Analysis of Adi Soemarmo Airport Solo

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Abstract: Transportation has a very big influence in the economic aspect. An economy that is increasingly developing towards globalization requires high mobility. One of the infrastructures that is the focus of development is Adi Soemarmo Solo Airport. Based on the Adi Soemarmo Solo Airport master plan as stated in the Regulation of the Director General of Civil Aviation No. KP 408 In 2017, the planned development of air side facilities in this case the runway with dimensions of 2600x45m will be extended to 3000x45m for the type of planned aircraft A330-300 with the aim of anticipating the need for increased air traffic transportation in the future considering the number of passengers will increase every year. This study aims to calculate the need for runways for aircraft operations according to the master plan that will be used to meet the increasing demand for air transportation services in the next 20 years using the classic method of the Director General of Civil Aviation, and forecasting demand for air transportation services using simple and multiple linear regression analysis methods. Based on the results of the analysis, the length of the runway needed to meet the demand for air transportation services in the next 20 years, namely in 2038 as many as 9,028,256 passengers and 44,917 aircraft movements is 3,200 meters long with a minimum width of 45m. The pavement thickness for critical aircraft is planned for the next 20 years, namely the A330-300 with a CBR subgrade of 6%, the total thickness of the pavement layer is 42.5 inches or 107.95 cm with a sub base course thickness of 24.5 inches or 62.23 cm, thick surface 4 inches or 10 cm and base course thickness 14 inches or 35.56cm. The PCN value obtained is 66 F/C/X/T.

Keywords: *Airport, Air Traffic Forecasting, Extension, Runway, Masterplan*

Introduction

Transportation develops from time to time in accordance with the needs and interests as well as the growth and development of the population running in an area. Transportation has the meaning of transporting or carrying (something) to the other side or from one place to another (Hutama, Aditya L. dkk, 2021)

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Transportation has a very big influence in the economic aspect. An economy that is growing towards globalization demands high mobility, so that people will be more frequent and intense in using and choosing the means of transportation to be used. Connectivity in globalization has many contexts, especially connectivity related to the development of infrastructure development as a result of economic globalization activities. There is an urgency for connectivity and infrastructure in the economic globalization scheme because these two things greatly determine the continuity of international trade, capital inflows, to the mobilization of labor which in aggregate affects a country's economic growth. In this context, the existence of infrastructure and domestic economic policies affect the dynamics of the effectiveness and efficiency of global production chains (Priyanto, Heri dkk, 2019)

One of the infrastructure that is the focus of development is Adi Soemarmo Solo Airport. According to UU no. 1 of 2009 about Aviation, an airport is an area on land and/or waters with certain boundaries that is used as a place for aircraft to land and take off, boarding passengers, loading and unloading goods, and places for intra and intermodal transportation, which are equipped with with aviation safety and security facilities, as well as basic facilities and other supporting facilities .Based on data on the number of passengers and aircraft movements obtained from data from PT. Angkasa Pura I, flight activity at Adi Soemarmo Airport Solo from 2013-2019 has increased and decreased. The following is a table of data on the number of passengers at Adi Soemarmo Airport in 2013-2019 according to data from PT. Angkasa Pura I.

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Figure 1. Adi Soemarmo Airport Passengers 2013 – 2019

Based on the data above, the number of passengers and aircraft movements at Adi Soemarmo Airport Solo shows a significant development from 2013-2018. However, it decreased in 2018-2019. This is due to the Covid-19 case that broke out in early 2019 and hit all sectors including the economy and mobilization. Before the Covid case, the number of passengers at Adi Soemarmo Airport in Solo had a level of stability and a tendency to increase every year. However, if you look at the changes to endemic conditions where the pandemic has started to end, it can be predicted that there will be an increase in air traffic, passengers and mobility in the country, especially at Adi Soemarmo Solo Airport.

Adi Soemarmo Solo Airport annually serves approximately 15 local and international traffic such as from Denpasar, Surabaya, Ujung Pandang, Yogyakarta etc. Based on a study of the Adi Soemarmo Solo Airport master plan as stated in the Regulation of the Director General of Civil Aviation No. KP 408 of 2017 it can be seen that the concept of the air side development plan that will be implemented is one of which is to anticipate the need for increasing air traffic transportation in the future and to facilitate direct Hajj

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flights (Direct Flights) with the Solo-Jeddah flight route. Based on the master plan, the existing runway 2600m long will be extended to 3000m to accommodate various types of aircraft with destinations to several other cities to international destinations. The implementation of the Adi Soemarmo Solo Airport development policy which has been accommodated in the legislation, is to extend the runway along 3000 m, which is expected to be able to meet the level of demand for air transportation services in accordance with the development of the number of passenger flows in the future.

From this background, it is very important to conduct an analysis regarding future demand for air transportation services and their effect on runway extension. In addition, it is also necessary to analyze the 3000 m runway extension plan to ensure that the runway extension according to the master plan is sufficient to meet the increasing demand for air transport services in the future in this case is the next 20 years.

This study contains about, "Runway Extension Plan Analysis of Adi Soemarmo Airport Solo" in order to determine the ability of the planned runway length to serve the increasing demand for air transportation services and maximum aircraft according to the master plan for the next 20 years.

Method

The research method used in this research is quantitative method research, which is the process of finding knowledge by using numerical data as a tool to analyze. Data collection for the preparation of the thesis was carried out during field work practices at Adi Soemarmo Airport Solo. The method used is to collect secondary data to support the process of analyzing the runway extension plan. Literature review is done by searching and collecting literature or research related to the topic of discussion in this case,

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namely the analysis of the runway extension plan. The literature collected is in the form of regulations, internet and books, documents and other print media related to the title and object of research. There are 3 stages in data processing, which are as follows:

1. Forecasting Air Traffic Growth

   At this stage, air traffic growth forecasts are carried out for the long term, namely the next 20 years. Forecasting Traffic Growth for the next 20 years using data on aircraft movements and the number of passengers from 2013 to the next 20 years.

2. Runway Calculation and Its Element

   This stage calculates the planned runway requirement using specification data for the masterplan aircraft, namely the Airbus A330-300, ARFL or the base of the planned runway with a length of 2490 m and the results of the correction calculations which become the factors that affect the calculation of the runway length, namely altitude correction, temperature correction, and the longitudinal slope of the airport. At this stage, it will be concluded whether the planned runway extension is sufficient to accommodate the ideal runway needs for aircraft operations for the next 20 years.

3. Calculation of Pavement Thickness and PCN

   At this stage, PCN calculations will be carried out to determine the strength of the corrected runway pavement and pavement thickness. At this stage, the corrected runway pavement strength figures will be obtained to accommodate flight operations for the next 20 years.

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At this stage, conclusions can be drawn from several stages that have been carried out above, namely obtaining the dimensions of the runway requirements, runway strips and other runway elements to accommodate the runway extension plan. Likewise with suggestions that can be written for future development.

Discussion and Result

1. Forecasting Air Traffic Growth

a. Forecasting the Number of Passengers for the Next 20 Years

Forecasting the growth of air traffic is a reference whether or not the development of airport facilities is necessary. Based on the results of this forecast, air transportation managers and providers can evaluate the existing facilities and infrastructure whether they can still serve flight activities in the next few years. If the evaluation results state that in the next 20 years, the facilities and infrastructure will no longer be able to serve flight activities optimally, then the best solution can be found to deal with the problem. The data that will be used for forecasting is data on the number of passengers and aircraft movements in 2013-2018. The following is the total number of passengers for the next 20 years:

Table 1. Total Number of Passengers for the Next 20 Years

Year	Total Passengers	Year	Total Passengers
2019	3.116.449	2029	6.227.927
2020	3.427.597	2030	6.539.074
2021	3.738.745	2031	6.850.222
2022	4.049.892	2032	7.161.370

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2023	4.361.040	2033	7.472.518
2024	4.672.188	2034	7.783.665
2025	4.983.336	2035	8.094.813
2026	5.294.483	2036	8.405.961
2027	5.605.631	2037	8.717.109
2028	5.916.779	2038	9.028.256

Based on the results of forecasting the number of passengers above, it is known that the possibility of passenger growth at Adi Soemarmo Airport each year is an average of 6% and the number of passengers in the next 20 years is 9,028,256 passengers in 2038.

b. Passenger Rush Hour Calculation For The Next 20 Years

The need for airport facilities is built based on a forecast to find the relationship between demand and the capacity of existing facilities so that the need for airport facilities can be determined. Therefore, the estimation of the number of passengers during peak hours is the basis for analyzing the estimated facilities needed at the airport, especially air side facilities. The calculation of the estimated number of passengers during peak hours is the multiplication of the number of annual passengers with the coefficient written in the Regulation of the Minister of Transportation No. PM 178 of 2015. The coefficient used is 0.050%, because the estimated number of passengers ranges from 1 to 9.999 million per year. The following is the calculation of peak hours for the next 20 years according to the Regulation of the Minister of Transportation No. PM 178 of 2015:

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Table 2. Passenger Peak Hours Forecast Results

Year	Peak Hour Passenger	Year	Peak Hour Passenger
2019	1.558	2029	3.114
2020	1.714	2030	3.270
2021	1.869	2031	3.425
2022	2.025	2032	3.581
2023	2.181	2033	3.736
2024	2.336	2034	3.892
2025	2.492	2035	4.047
2026	2.647	2036	4.203
2027	2.803	2037	4.359
2028	2.958	2038	4.514

Based on the results of the calculation of the number of peak hour passengers above, it is known that the possibility of peak hour passenger growth at Adi Soemarmo Airport each year is an average of 5.7% and the number of peak hour passengers in the next 20 years is 4,514 passengers in 2038.

c. Forecasting Aircraft Movements and Peak Hours for the Next 20 Years

The calculation of the number of movements and aircraft busy hours has an effect on the analysis of air side facility planning. In carrying out the initial calculations, several assumptions were made, including the type of critical aircraft Narrow Body operating in the existing year was B737-800 which has an aircraft capacity of 185 passengers and a load factor of 60% to determine the saturation point of aircraft movement. The following is a table

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of forecasts for the number of requests for air transportation services for the next 20 years, compiled with the assumption that the existing stage is 2018, Stage I is 2028, Stage II is 2038 as follows:

Tabel 3. Forecast of Air Transport Services for the Next 20 Years

No	Description	Exsisting 2018	Stage I	Stage II	Information
1.	Passengers				
	Yearly	2.735.819	5.916.779	9.028.256	Pax
	Peak Hour	1.368	2.958	4.514	Pax
	Daily	7.495	16.210	24.735	Pax
2.	Aircraft Movement				
	Yearly	24.268	29.437	44.917	Aircraft
	Peak Hour	11	12	15	Aircraft
	Daily	67	81	213	Aircraft
3.	Largest Type of Aircraft	A330-300	A330-300	A330-300	

2. Dimensions of the Runway and its Elements

a. Correction Factor Calculation

The elevation correction factor (Fe) needs to be calculated based on ICAO recommendations, ARFL increases by 7% for every 300 m increase calculated from sea level height. The height data of Adi Soemarmo Airport is 418 ft or 127,506 m. The calculation results obtained are Fe of 1.0297. The temperature correction factor (Ft) is recommended by ICAO to account for the length of the runway to temperature of 1% for every 1°C increase. The Ft result is 1.13828139. The gradient correction factor (Fs) is 10% for every 1% slope. An upward slope requires a longer base than a flat or descending base. The result of Fs is 1.07.

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b. Runway Dimension Calculation

The planned runway length is 3,200 m, with a minimum runway width of 45 m based on the A330-300 aircraft wing span and Airport code 4E. With the calculation of the runway length above, the aircraft that can also operate based on the calculated runway length other than the A330-300 is the 777-300ER with the assumption of operating load restrictions.

c. Stopway Dimension Calculation

The stopway must be 60 meters long and the same width as the runway to which it is connected. So, the dimensions of the planned stopway are 60 x 45 m.

d. Determination of RESA Dimensions

For airport code 4, because there is no anchoring system available at Adi Soemarmo Solo airport, according to the Regulation of the Director General of Civil Aviation No. KP 326 of 2019 RESA must extend from the end of the runway strip to a distance of at least 240 m and have a width that must be at least twice the width of the runway due to the lack of an Engineered Material Arresting System (EMAS) retaining system at the airport for reduce the fatality rate in the event of an overrun/overshoot aircraft. Therefore, the dimensions of the planned RESA are 240 x 90 m.

e. Runway Strip Dimensions Calculation

The width of the runway strip is determined by the use of the runway operation. The runway operation at Adi Soemarmo airport is Runway Precision Cat I using ILS navigation aids Category I. Based on the Regulation of the Director General of Civil Aviation No. KP 93 of 2015, the width of the runway strip is 300 meters. Thus, the dimensions of the runway to be planned are 3,320 x 300 m.

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3. PCN Calculation and Pavement Table

a. Critical Aircraft Determination

Critical Aircraft is a type of aircraft that has a dominant effect on the pavement. The effect given by the aircraft on the pavement varies depending on the type of aircraft, the type of landing gear and various variations in the load of aircraft operating at an airport. To determine critical aircraft at Adi Soemarmo airport, data on aircraft type, aircraft load (MTOW), aircraft annual departure data and type of landing gear are required for each type of aircraft. The following is data on aircraft type, aircraft load (MTOW), aircraft annual departure data and type of landing gear for each type of aircraft at Adi Soemarmo airport. (Andri et al., 2015)

Table 4. Aircraft Specifications and Annual Departure Year 2019

Aircraft	Landing Gear Configuration	MTOW	Annual Departure
ATR 72	Dual Wheel	22.800	625
737-800	Dual Wheel	79.243	1728
737-900	Dual Wheel	85.366	1307
A320-200	Dual Wheel	77.000	2463
A330-300	Dual Tandem	215.000	139

b. Annual Departure Conversion Based on Critical Aircraft Landing Wheel Type.

After obtaining the type of critical aircraft, namely A330-300 with a Dual Tandem Wheel landing gear type and a wheel load of 27,776 Kg, the

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Annual Departure data for non-critical aircraft will be converted based on the type of critical aircraft landing gear, namely from the dual wheel type to the dual tandem type. produces the value of Equivalent Dual Tandem Landing Gear.

c. Equivalent Annual Departure

After determining the critical aircraft and their loads, calculating the converted aircraft wheel loads and calculating the Annual Departure conversion to the critical aircraft landing gear types. The total number of Equivalent Annual Departures is 15.33 + 388.32 + 379.57 + 481.45 + 139 = 1403.66 rounded up to 1404 aircraft/year.

d. Calculation of Pavement Thickness Classical FAA Method

This calculation has determined that the planned aircraft is an Airbus A330-300 with the aircraft's main wheel configuration being dual tandem with an MTOW of 215,000 Kg (474,000 lbs). The flexible pavement curve graph that will be used is the graph for dual tandem. The subgrade CBR value used is 6%. The CBR value of the subbase used according to the FAA, the minimum requirement for the CBR for the sub base is 20%. The value for the thickness of the pavement surfaces with a critical aircraft dual tandem landing gear type is set at 4 inches/10.16 cm. The plotting of the pavement thickness graph for the dual wheel can be seen in the following image:

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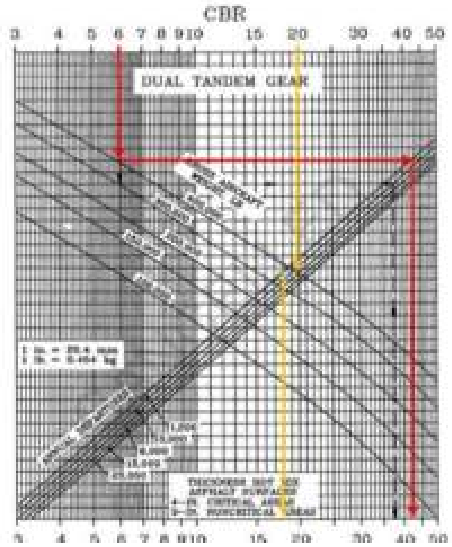

Figure 2. Plot Value of Flexible Pavement Thickness Dual Tandem Gear

The results of the pavement thickness based on the plotting of the graph above by pulling the CBR subgrade 6% plot obtained a total pavement thickness of 42.5 in/107.95cm. The thickness of other pavement layers is as follows:

1. For subbase pavement thickness with CBR 20, the pavement thickness plot is 18 in/45.72cm. So the thickness of the sub base course layer is 42.5 – 18 = 24.5 in/62.23cm.
2. The thickness of the surface pavement for critical aircraft is 4in/10.16cm.
3. For Base Course thickness is 18-4 = 14 in/35.56 cm. The minimum thickness of the base course layer needs to be controlled with a graph of the minimum thickness of the base course

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Conclusion

The conclusions from the analysis of the calculation of the runway extension plan above are as follows:

1. The plan to extend the runway according to the master plan of 3,000 meters can still serve A330-300 aircraft but only in conditions of Restricted Take-Off Weight or conditions of operating load restrictions. The optimal runway length required to serve planned aircraft according to the master plan, namely the A330-300, is 3,200 meters long with a minimum width of 45m for maximum aircraft load conditions or maximum take-off weight.
2. Thickness of pavement for planned aircraft, namely A330-300 with CBR subgrade6%, the total thickness of the pavement layer is 42.5 inches or 107.95 cm with sub base course thickness of 24.5 inches or 62.23 cm, thickness of surface 4 inches or 10 cm and the base course thickness is 14 inches or 35.56 cm.
3. The PCN value obtained from the classical method of PCN calculations obtained a value of 66 F/C/X/U with the conclusion that the PCN value is the same as the A330-300 critical aircraft ACN value, which is 66.

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