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Analysis of Passenger Terminal Area Needs and Passenger Circulation in 2044 at the Toraja Airport

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ABSTRACT

Toraja Airport has a passenger terminal area of 1,484 m2 and has experienced an increase in the number of passengers per year. This study aims to estimate the number of passengers and the need for a passenger terminal area at Toraja Airport for the next 20 years in 2044. This study uses a quantitative method, which uses 5-year passenger support data from 2019–2023 and uses a linear regression method. Peak passenger data is used to distribute space capacity at the airport terminal, referring to SKEP/VI/77/2005. The analysis of passenger terminal area requirements in 2044 is calculated based on SKEP/VI/77/2005 using the number of peak passengers. With a total of 170.704 passengers in 2044, a terminal area of 186 m2 is required.

INTRODUCTION

The increased demand for air transportation will certainly affect the facilities and infrastructure needed for Air Transportation. The most important facility in air transportation activities is the airport. Transportation facilities and infrastructure in South Sulawesi Province in general have played a significant role in the development of the economic sector and provide convenience in mobility because if using the land route from Makassar to Toraja it must take 9 hours while using the air route it only takes 50 minutes.

The types of data collected include the number of passengers in 2019-2023, the area of the departure terminal, and the number of facilities at the departure terminal. The benefits for regional economic actors can accelerate the economy which will ultimately have a positive impact on the need for increased facilities and infrastructure and it is hoped that Toraja Airport can develop infrastructure to anticipate an increase.

Air transport significantly contributes to regional economic growth, as evidenced by studies showing a positive correlation between increased air passenger traffic and economic development, Nguyen, (2024). Enhanced air connectivity can stimulate local innovation, as regions with better air transport access tend to exhibit higher patent activity, indicating a boost in innovative capacity, (Inggrid & Resosudarmo, 2024). The current infrastructure at Toraja Airport must be upgraded to accommodate the anticipated increase in passenger numbers and improve service quality, Dhian et al., 2024). Recommendations include expanding terminal areas and enhancing facilities to ensure efficient operations and passenger satisfaction, Syahputra et al., (2024). Air travel drastically reduces travel time, facilitating better mobility for economic actors and tourists, which is crucial for local businesses and tourism, Nguyen, (2024). Improved airport facilities can enhance the overall travel experience, promoting regional tourism and economic activities, Genggona & Nieamah, (2024).

LITERATURE REVIEW

Linear regression

Simple linear regression is a statistical method for measuring the relationship between independent and dependent variables. Simple linear regression is a fundamental statistical method used to quantify the relationship between an independent variable and a dependent variable. This technique is particularly valued for its simplicity and interpretability, making it a popular choice in various fields, including healthcare and data science. The primary goal of simple linear regression is to fit a linear equation to observed data, allowing for predictions and insights into the relationship between variables(Roustaei, 2024)("Regression", 2024).

Key Features of Simple Linear Regression, Modeling Relationships: It identifies the underlying pattern connecting independent and dependent variables, enabling predictions based on the independent variable's values, Roustaei, (2024). Assumptions: The method relies on several assumptions, including linearity, independence, and homoscedasticity, which must be met for accurate results, Roustaei, (2024). Applications: Simple linear regression is widely used in various research areas, including healthcare, to model outcomes and inform decision-making, (Roustaei, 2024)(Al-Quraishi & Alhashimi, 2024). Despite its utility, simple linear regression has limitations, particularly in real-world scenarios where relationships may not be strictly linear. In such cases, more complex models or transformations may be necessary to capture the true nature of the data, Jovanović et al., (2024). Additionally, the presence of outliers can significantly affect the model's accuracy, necessitating robust regression techniques (Al-Quraishi & Alhashimi, 2024).

METHODOLOGY

This study uses manual and software quantitative analysis. Manual analysis, namely the analysis of the passenger terminal space requirements of Toraja Airport for the next 20 years using the linear regression method, and Software Analysis, namely the analysis of space requirements at the Toraja Airport passenger terminal in 2044 using SPSS software analysis using the Linear Regression method. The use of a simple linear regression method with SPSS software to determine whether or not there is an independent variable (x) on the dependent variable (y). The number of passengers is the dependent variable in this study, while the year range used for the projection is the independent variable. This study uses IBM SPSS Statistics and Autocad software. As the object material in this study, secondary data from Toraja Airport is used. Data on the number of passenger and aircraft movements are used in the implementation of the study. The data collection method technique used in this study is the first, namely the collection of secondary data in the form of information on the existing terminal area, passenger movement data for 2019-2023, and the existing layout of the Toraja Airport terminal. Second, field observations were carried out during On The Job Training so that the author could review directly in the field, namely at Toraja Airport. The third is a literature study through the library method, the data collection process is carried out based on literature studies and supporting data by the research, namely the SKEP 347/XII/1999 regulation, the journal of the previous research.

Information on terminal area, passenger movements from 2019-2023, and existing terminal layouts were gathered to establish a baseline for analysis. Relevant regulations, such as SKEP 347/XII/1999, and previous research journals provided a theoretical framework and context for the study. The integration of local wisdom and cultural elements, as seen in other airports, can enhance passenger experience but may also present challenges in maintaining service quality and capacity, Genggona & Nieamah, (2024). The impact of external factors, such as the COVID-19 pandemic, has necessitated adaptive strategies in airport operations, highlighting the importance of flexibility in data collection and analysis, nua & Masyi'ah, (2023).

RESEARCH RESULTS

Annual Passenger Movement Data

Table 1 Annual Passenger Data

No.	Year	Passenger		Total
		Arrival	Departure	
1	2019	347	346	693
2	2020	4.993	3.297	8.290
3	2021	7.616	8.636	16.252
4	2022	10.225	10.401	20.626
5	2023	9.793	9.563	19.356

Passenger Forecasting Calculation with SPSS

The purpose of the simple linear regression method using SPSS is to calculate the estimated average value and value of the dependent variable according to the value of the independent variable and to predict the average of the independent variable based on the value of the independent variable outside the sample range.

Dependent Variable, which uses passenger number data, and Independent Variable, which uses data from the range of years used for forecasting, the data is used in the SPSS data input process. The form of the regression equation can be written as follows:

$$Y = a + bX \quad \text{..... (1)}$$

$$Y = -13679644{,}800 + 6776{,}100\ X \quad \text{..... (2)}$$

Busy Time Passenger Calculation

It is estimated that the number of passengers at Labuan Bajo Airport will reach more than 1,000,000 passengers in the period 2024-2044. Therefore, it is determined that the coefficient to determine the number of busy time passengers above 1,000,000 passengers uses a coefficient of 0.05. Thus, the forecast calculation of the number of busy time passengers can be calculated using the following formula.

$$PWS = \frac{\text{Number of Passengers Per Year X TPHP Coefficient}}{100} \quad \text{..... (3)}$$

$$PWS = \frac{170.704 \text{ X } 0.20\%}{100} \text{..... (4)}$$

Space Requirements Analysis

The data needed to calculate the area of space and facilities available for the passenger terminal is the data on passengers arriving and departing during peak hours, as shown in Table 3. In 2044, there were 977 passengers arriving during peak hours and 977 passengers departing during peak hours. Furthermore, the data is used to calculate the number of transfer passengers. According to SKEP 77/VI/2005 concerning the Operation of Airport Technical Facilities, the number of transfer passengers must be 20% of the number of passengers during peak hours.

Effective management of passenger flows is essential for optimizing terminal operations. Simulation models can help assess crowd dynamics and enhance terminal efficiency, Oprea et al., (2024). Data-driven approaches, like those implemented at Phoenix Sky Harbor International Airport, allow for real-time insights into passenger activity, improving resource allocation and reducing congestion, Malik, (2023).

According to SKEP 77/VI/2005, transfer passengers should be calculated as 20% of peak-hour passengers. For 977 passengers, this results in 196 transfer passengers, which is critical for planning terminal space and services. Assessing terminal capacity involves understanding the equilibrium between service resources and passenger demand. This ensures that facilities can accommodate peak passenger loads effectively, ("A Methodology for Assessing Airport Terminal Capacity Based on Service Resource Equilibrium", 2023).

To find out the number of transfer passengers, you can use the calculation formula below:

Number of transfer passengers = Peak time passengers x 20%

Number of transfer passengers = 341 x 20% = 68.3

Table 2. Recapitulation of Passenger Predictions

Passenger Data	Total
Passengers during peak hours	**341**
Passengers departing during peak hours	**171**
Passengers arriving during peak hours	**171**
Passengers transferring during peak hours	**68**

After calculating the amount of space needed for the domestic terminal of Toraja Airport, it can be concluded that to provide better service to passengers, terminal expansion is needed. This will allow Toraja Airport to handle all passenger movements.

Table 3. Analysis of Space Requirements

No	Facilities	Existing Terminal (2023)	Terminal Requirements Analysis (2044)
1.	Passenger Capacity	19.356 pax	170.704 pax
2.	Departure Hall Area	180 m^2	445,3 m^2
3.	Departure Waiting Room	315 m^2	250,5 m^2
4.	Check-in Area	162 m^2	59,8 m^2

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No	Facilities	Existing Terminal (2023)	Terminal Requirements Analysis (2044)
5.	Seating	122 m^2	114 seat
6.	Check-in Counter	2 unit	6 unit
7.	Public Facilities (Departure Toilet)	108 m^2	68,5 m^2
8.	Arrival Hall	180 m^2	346 m^2
9.	Baggage Claim Area	297 m	154 m^2
10.	Public Facilities (Arrival Toilet)	150 m^2	68,5 m^2
TOTAL		1.484 m^2	1.670 m^2

DISCUSSION

The forecast of the number of passengers for the next 20 years starts in 2024-2044. The passenger forecast for 2044 is 170,704, the number of passengers during peak hours is 341, and the number of passengers arriving and departing is the same, 171. Analysis of the passenger terminal area requirements in 2044 is calculated based on SKEP/VI/77/2005 using the number of passengers during peak hours. With a total of 170.704 passengers in 2044, a terminal expansion of 186 m2 is required. With the direction of terminal development horizontally to the left side of the terminal.

The analysis of passenger terminal area requirements for 2044 indicates a significant need for expansion due to projected increases in passenger volume. The forecasted total of 170,704 passengers necessitates a terminal expansion of 186 m², with development directed horizontally to the left side of the terminal. This conclusion is supported by various forecasting methodologies and studies that highlight the importance of accurate predictions in airport planning.

These models have been effectively used to forecast passenger numbers, demonstrating their utility in predicting trends over time, (Febiola et al., 2024)(Gu et al., 2024). Graph Convolutional Networks: This advanced model captures spatio-temporal correlations, enhancing prediction accuracy for passenger flows, (Ma & Li, (2024). Peak Hour Analysis: The peak hour passenger count of 341 indicates the need for sufficient terminal space to accommodate fluctuations in passenger traffic, Febiola et al., (2024). Expansion Justification: The calculated expansion of 186 m² is based on the peak hour data, ensuring that the terminal can handle future demands efficiently, Febiola et al., (2024). While the forecast suggests a clear need for expansion, it is essential to consider potential fluctuations in passenger numbers due to unforeseen events, such as economic downturns or global crises, which could impact air travel demand, Gu et al., (2024).

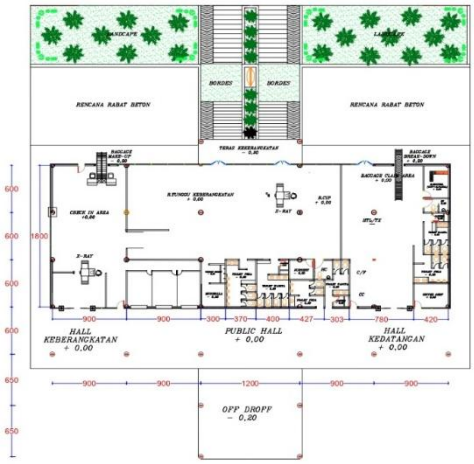

Figure 2. Existing Plan

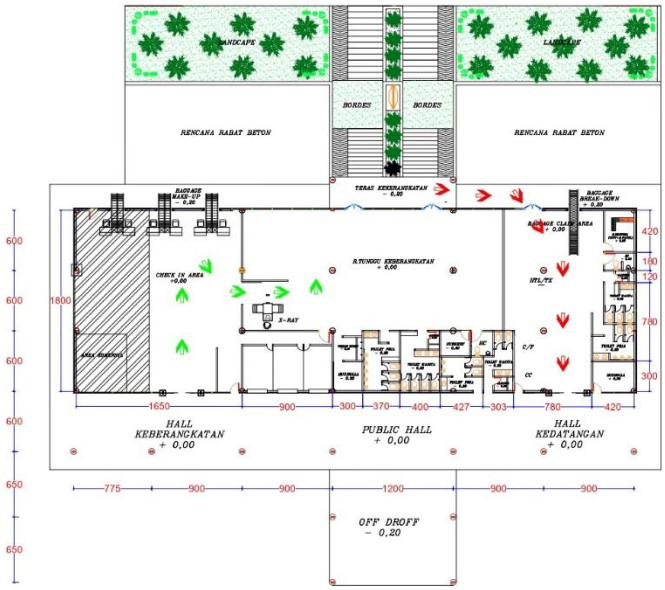

Figure 3. Development Plan Layout

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the passenger forecast analysis and space requirements for the Toraja Airport terminal, the following conclusions can be drawn.

1. Passenger forecasting in 2044: using the linear regression method, the total predicted number of passengers is 170,704 pax, with 341 passengers during peak hours.
2. Based on the analysis of the calculation of the passenger terminal space needed at Toraja Airport, namely the passenger terminal facility area of 1,484 m2 to 1,670 m2. The total space requirement for terminal facilities is 186 m² for 2044.
3. Passenger circulation planning at the departure passenger terminal in 2044, as explained in the attached image.

CONTINUED RESEARCH

Based on the analysis of the results of passenger forecasting and space requirements for the Toraja Airport terminal, the author's suggestions can be seen as follows:.

1. Toraja Airport can use the results of the analysis as a reference in expanding the terminal area for the next 20 years in 2044.
2. It is hoped that in the future the airport can car stainable development of the terminal area by calculating the growth of future passengers according to the location that is sufficient to carry out expansion of the air terminal.ry out su

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