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Forecasting Passengers Arriving and Departing at Sentani International Airport Terminal Using the ARIMA Method

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Abstract: The airport terminal is one of the impacts of Covid-19 which can still be felt with a decrease in the number of arriving passengers and the number of departing passengers. The sentani international airport terminal adjusts airport activities along with normalization after covid-19. The purpose of this study was to determine the number of arriving passengers and the number of departing passengers at the Sentani International Airport terminal by forecasting using the ARIMA forecasting method. This research method uses the ARIMA method. The results show that the best model for forecasting the number of incoming passengers is the ARIMA (1.1.1) model with an RMSE value of 31433.34, MAE of 23993.72, and MAPE of 5207.000, and the number of departing passengers with the ARIMA (1.1.1) model with RMSE of 25220.27, MAE of 18720.95, and MAPE of 11690.43. The ARIMA model can provide accurate forecasts if conducted over a short or brief time frame.

Keyword: airplane passenger forecast, ARIMA model, sentani airport

INTRODUCTION

The development of an area can be seen by the existence of tools that support society, such as adequate technology. One tool to support people in moving to an area is air transportation. Air transportation is a transportation system using air routes where people can move systematically and do not need a long time to travel long distances to a certain area. Air transportation is a modern means of transportation where this means of aviation creates an industry that can develop quickly and dynamically with technological assistance, and is very important for national development in a region. This aviation infrastructure is very important to enable the movement of both passengers (people) and goods to continue high levels of economic turnover. According to Republic of Indonesia Law number 1 of 2009 concerning aviation, aviation is a system consisting of the use of airspace, aircraft, airports, air transportation, flight navigation, safety and security aspects, and the environment. This system

also includes various supporting facilities and other public facilities (Republic of Indonesia Law No. 1 of 2009 concerning Aviation, 2009). An airport is an important facility that is part of a land and/or water area with certain boundaries. This airport functions as a landing and take-off place for aircraft, as well as a place for boarding and disembarking passengers, transporting goods, and transferring between modes of transportation. This facility is equipped with guaranteed safety and security standards, as well as other basic and supporting facilities.

Considering the problems that hit the world caused by Corona Virus Disease 2019 (Covid-19), the economic sector was paralyzed in 2020 and this downturn also had an impact on Indonesia. For example, the aviation and tourism sectors have a very strong impact. One of the parties or authorities at Sentani international airport issued a policy at that time where airport activities, especially for airplane passengers, were officially closed temporarily from 26 March 2020 to 9 April 2020. This is based on Law no. 1 of 2009 concerning aviation, Decree of the Director General of Civil Aviation Number: KP.239 /2014 concerning Airport Operating Hours, and Letter of Joint Agreement with the Papua Provincial Government Number 440/3612/SET, dated 24 March 2020 concerning Prevention, Control and Countermeasures Corona Virus Disease 2019 (Covid-19). This major impact on the world of aviation caused a decrease in passengers of 149% from the previous year. PT Angkasa Pura I, represented by Faik Fahmi as Main Director, revealed data before the pandemic hit, in 2019 there were 81 million passengers recorded, where this data was from 14 airports managed by PT Angkasa Pura I. At the beginning of 2020, the number of passengers served was 32 million, for 2020 Sentani Airport will become the 15th airport managed by PT Angkasa Pura 1.

Indonesia has a fairly large area, moving someone for business or tourism purposes requires adequate and affordable means of transportation to the area they want to visit. Indonesia is also included in the category of regions with economic activity that continues to grow and is most efficient when reached by air. Even remote areas of Indonesia can also be visited. Therefore, it is important for transportation and tourism-related parties in Indonesia to analyze and project passenger data and transportation traffic flows in order to develop appropriate strategies (Azaro et al., 2020). Papua Province is part of one of the provinces in Indonesia where it is located in the Papua Islands. The Papua Islands consist of Southwest Papua, West Papua, Central Papua, Mountainous Papua and South Papua (Gischa, 2022). Initially, the island was divided into two regions, namely Papua Province and West Papua Province. However, on June 30 2022, the People's Representative Council of the Republic of Indonesia (DPR RI) approved the formation of three new regions resulting from the expansion of Papua Province, namely Mountain Papua Province, South Papua Province and Central Papua Province. According to a statement by Indonesian President Joko Widodo, there is an imbalance in development between the eastern and western regions of Indonesia. He stated that the imbalance in development was reflected in the lack of infrastructure in eastern Indonesia, such as inadequate roads, bridges, ports and airports. In his discourse, infrastructure development will be carried out in 2022 in areas in eastern Indonesia so that they can be more advanced. One of the areas in the eastern region of Indonesia is the province of Papua. On the ministry's official website

Republic of Indonesia Transportation stated that according to a statement by Bambang Tjahjono, Director of the Air Transportation Directorate of the Ministry of Transportation, several airports in Papua would be revitalized by the Ministry of Transportation, including Sentani Jayapura Airport. The length of the Sentani Jayapura Airport runway will be extended to 3,000 meters. The Ministry of Transportation will also develop several other airports in Papua and West Papua, including Kaimana Airport, Wamena Airport which is planned to start in 2013, construction of Manokwari Airport in the capital of West Papua Province, and extending the runway as well as increasing the runway surface (overlay) at the airport Mopah Merauke.

Predicting the number of incoming and departing passengers on domestic flight routes is a management guideline for airport managers. This is very relevant to increasing profits and also being able to adjust the services and facilities that airplane passengers can receive. According to (Dheviani et al., 2018), the results of his research show that the forecasting method is able to predict the number of passengers. Forecasting is the analysis of past data in order to systematically identify relationships, trends and data patterns (SC & McGee, 1999). The aim of this research is to determine the increase or decrease in the number of arriving passengers and the number of departing passengers at the Sentani International Airport terminal by forecasting using the ARIMA forecasting method. In this research, the Autoregressive Integrated Moving Average (ARIMA) model method is used, known as ARIMA Box-Jenkins, which was popularized by George Box and Gwilym Jenkins. This research uses time series data from 2019-2021. The results that have been achieved show that the ARIMA model is able to show that the best model for predicting the number of arriving passengers is the ARIMA model (1.1.1) and the number of departing passengers is the ARIMA model (1.1.1).

METHOD

In this research, the Autoregressive Integrated Moving Average (ARIMA) method is used. The ARIMA method is also known as the Box-Jenkins time series method because the model was developed by George E. P. Box, (1976). ARIMA is very appropriate to use as a forecast result to predict short term in the long term will be constant. The ARIMA method involves a series of stages, starting from adjusting data stationarity, model identification, estimating model parameters, model testing, to applying the model for forecasting purposes. This research uses time series data with monthly data from the period January 2019 – December 2021. Modeling in the initial stage ensures that the data is stationary, which means that there are no drastic changes in the data. According to Jannah et al., (2017), the ARIMA model assumes that the data must be stationary.

Generally, time series data is said to be stationary if there are different fluctuations in the data around the mean value and constant variance. Stationarity can be seen by testing the ADF-test or seen in the ACF plot where the autocorrelation value of stationary data will decrease to zero after the second time lag. In the second stage, modeling can be done by identifying a model. In the third stage, a model estimation will be carried out where the model will be estimated to determine the best criteria model for the ARIMA model. In the fourth stage of testing a model where the modeling will provide a determination of the best forecast in the Autoregressive (AR) model, the Moving Average (MA) model and the Autoregressive Moving Average (ARMA) model and if the data is stationary at the first difference level then the Autoregressive Integrated Moving Average (ARIMA). The final stage is where the best model will make predictions from a predetermined forecast period. This research aims to predict the number of passengers arriving and departing in the next two years, namely from 2022 to 2023.

In this research, time series data is used. Time series is a collection of variable observations recorded sequentially based on fixed time intervals Wei, (2006) and Iqbalullah & Winahju, (2014) samples taken from the Papua Province Central Statistics Agency website which is a collection of administrative product data from various activities in the sector transportation by taking all air transportation production data at Sentani Airport in the period January 2019 – December 2021 (Distribution Statistics Field, 2020), (Distribution Statistics Field, 2021), (Distribution Statistics Field, 2022).

RESULTS AND DISCUSSION

This research focuses on time series data for a 3 year period to produce short term forecasts for the next 2 years. This research predicts two different data where the first data is the number of arriving passengers, while the second data aims to predict the number of

departing passengers. This data is carried out by forecasting where data calculations are carried out separately with two calculations using the ARIMA forecasting method.

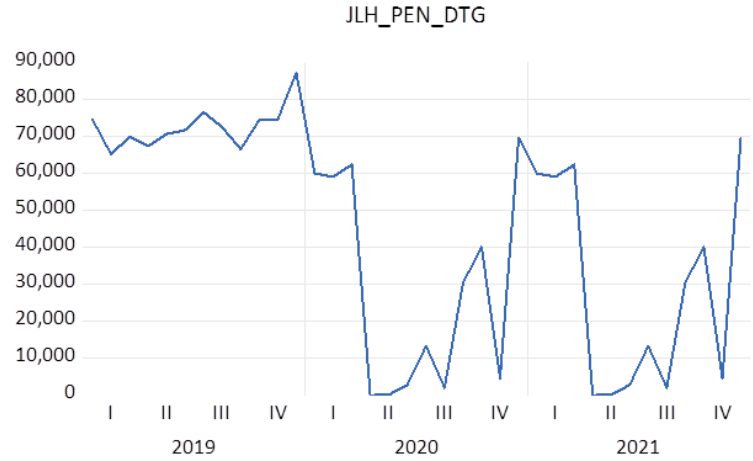

Figure 1. Graph of the Number of Passengers Arriving from the 2019-2021

Figure 1 displays a graph of the number of passengers arriving from 2019-2021 where there are fluctuations in the resulting graphic data. It can be seen that there is a decrease in the number of arriving passengers, where it is clear that there was a change in the number of arriving passengers at the beginning of 2020 due to the threat of the Covid-19 virus. This is not much different from the situation in the number of departing passengers, where at the beginning of 2020 there was a drastic decline as seen in Figure 2.

This caused the airport to close temporarily reducing the number of passengers arriving at the Sentani International Airport terminal. Again, with the increase in the number of Covid-19 circulating at the beginning of 2021, the number of arriving passengers and the number of departing passengers fell again, whereas in mid-June 2020 there was already a significant increase in the number of arriving passengers. At the end of 2021 the number of arriving passengers increased again in line with the decline in the rate of spread of the Covid-19 virus in Indonesia. Due to significant fluctuations in the number of arriving and departing passengers, researchers are interested in predicting these two variables at Sentani International Airport. This can provide good predictions for the future so that the management can consider the policies that will be made to be implemented in the future. will come so that the number of arriving passengers and the number of departing passengers can be increased properly.

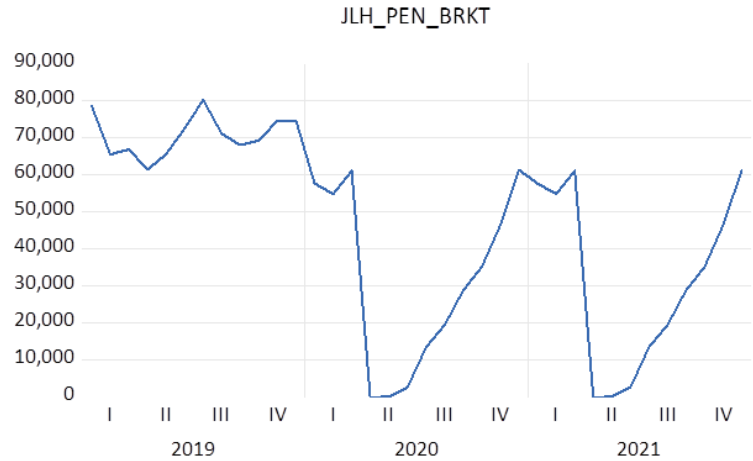

Figure 2. Graph of the Number of Departing Passengers from 2019-2021

As explained in the research method, the first stage was to test stationarity on the times series data. According to Dheviani et al., (2018), time series data is considered stationary when

it has fixed average and variance values, does not show trends in the data, and does not show seasonal patterns. The following are the results of stationarity calculation estimates at the first difference level.

Table 1. Unit Root Test

Variable Name	t-Statistic	Prob.*	Information
Number of Passengers Arriving	-3.458003	0.0182	first difference
Number of Departing Passengers	-5.583375	0.0001	first difference

The data in Table 1 displays the unit root test data or what is usually called the Unit Root Test with the Augmented Dickey-Fuller test model. In this test, stationarity testing has been carried out at a level where the results show that the probability data is greater than 0.05, thus the times series data has been tested again by lowering the level to the first difference level. As shown in Table 1, the results show that the probability value of the data produced is smaller than the alpha value (0.05<0.0182), so the data is declared to have passed the stationarity test and can be continued at the next stage.

In the second stage, model identification is carried out with the aim of checking the stationarity of the data and finding a suitable temporary model. Different from before, in this stage the assessment is carried out based on actual data plots, through observation of ACF (Autocorrelation Function) and PAC (Partial Autocorrelation Function) plots. To determine whether the data has achieved stationarity, researchers can look at a plot of the actual data and check whether the mean or variance is constant over the time span. If so, the data can be considered stationary data. Stationarity assessment based on ACF and PAC plots can be done by examining each lag. If the ACF and PAC graphs decrease sharply, then the data can be considered stationary.

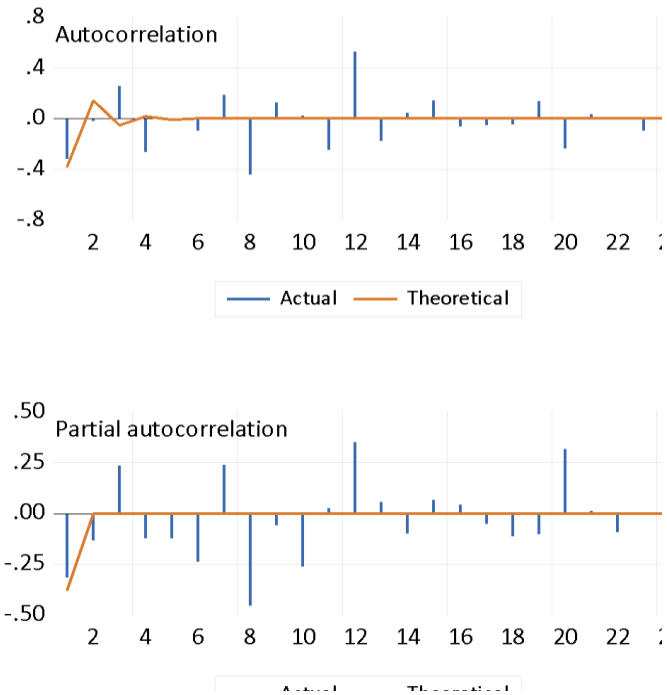

Figure 3. ACP plot of data on the number of passengers arriving

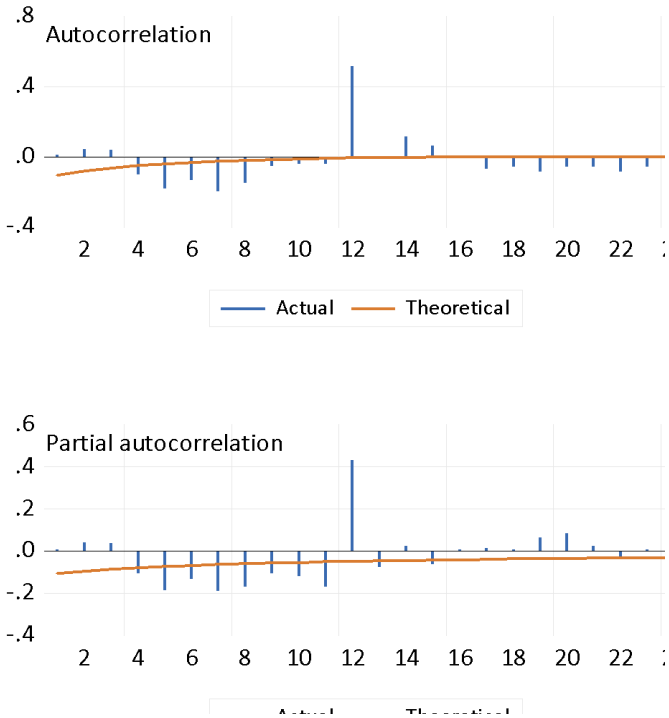

Figure 4. ACP plot of data on the number of passengers arriving

Estimation of model parameters is part of the next stage. This step will estimate the parameters in the model to obtain temporary values in order to make comparisons between the Autoregressive (AR) model, the Moving Average (MA) model and the Autoregressive Moving Average (ARMA) model. The following are the results of the Autoregressive (AR) model parameters

Table 2. Selection of model criteria

Parameter	Model	Significance of the Model	Residual Test	R-Square	AIC	SC
Number of arriving passengers	AR (1)	Significance	Free	**0.123767**	**23.15380**	**23.28712**
	MA (1)	Significance	Free	0.122171	23.15523	23.28854
	ARIMA (1.1.1)	Significance	Free	0.130314	23.20368	23.38143
Number of departing passengers	AR (1)	Significance	Free	0.000065	22.43437	22.56769
	MA (1)	Significance	Free	0.000060	22.43438	22.56769
	ARIMA (1.1.1)	Significance	Free	**0.103954**	**22.42835**	**22.60611**

Table 2 displays the model criteria data from the interim estimation results. If all the estimated parameters are significant and the residuals using the ARCH test have a threshold above the significance value of 0.05 then the model can be said to be good and conversely if it is below the threshold of a significance value of 0.05 then the model is indicated as homoscedasticity or cannot be said to be good. A significant model has criteria that display data with a large R-Square value, and a small Akaike info criterion (AIC), Schwarz criterion (SC) value.

The final stage displays the forecasting results from the best model that was determined in the previous stage. The best model that has been previously determined is that for the number of arriving passengers the best model for determining the model is the AR model (1.0.1) and for the number of departing passengers the ARIMA model (1.1.1) is determined. In Figure 5 and Figure 6, this section shows that the forecast for the number of arriving passengers and the

number of departing passengers at the Sentani international airport terminal shows a significant decline in the 2019-2023 period. According to Mujtaba et al., (2021) good forecasting can be determined from smaller MAPE (Mean Absolute Percentage Error) results. This statement is also strengthened by research conducted by Farida et al., (2021), which explains that there are four methods for considering forecasting results, one of which is using MAPE as a comparison of forecast results. The following is a comparison between the forecast results of each model.

Table 3. Result of Regression Model

Model	RMSE		MAE		MAPE	
	Number of Arriving Passenger	Numbe of Departing Passenger	Number of Arriving Passenger	Numbe of Departing Passenger	Number of Arriving Passenger	Numbe of Departing Passenger
AR (1)	31796.18	27937.46	24221.02	20402.62	5263.098	12802.61
MA (1)	34016.38	35376.55	24721.50	26311.62	5579.304	15262.24
ARIMA (1.1.1)	31433.34	25220.27	23993.72	18720.95	5207.000	11690.43

From the results of the forecast modeling, it can be seen that the value of the number of arriving passengers in the AR (1.0.1) modeling has an RMSE (Root Mean Sqaure Error) value of 31796.18 when seen from the MAE (Mean Absolute Error) results which has a value of 24221.02 and MAPE (Mean Absolute Percentage). Error) of 5263,098. MA modeling (0.1.1) shows RMSE results with a value of 34016.38 for MAE which has a value of 24721.50 while MAPE is 5579.304. In ARIMA modeling (1.1.1) it has an RMSE value of 31433.34, for MAE it has 23993.72 and for MAPE it has a value of 5207,000. From the results of forecasting modeling the number of arriving passengers which is the best model among the three models is in the form of the ARIMA (1.1.1) model where there are RMSE, MAE and MAPE values which get smaller values than the AR model (1.0.1) and MA (0.1.1). The following are the results of forecasting the number of arriving passengers using the ARIMA (1.1.1) model forecasting with the dynamic method.

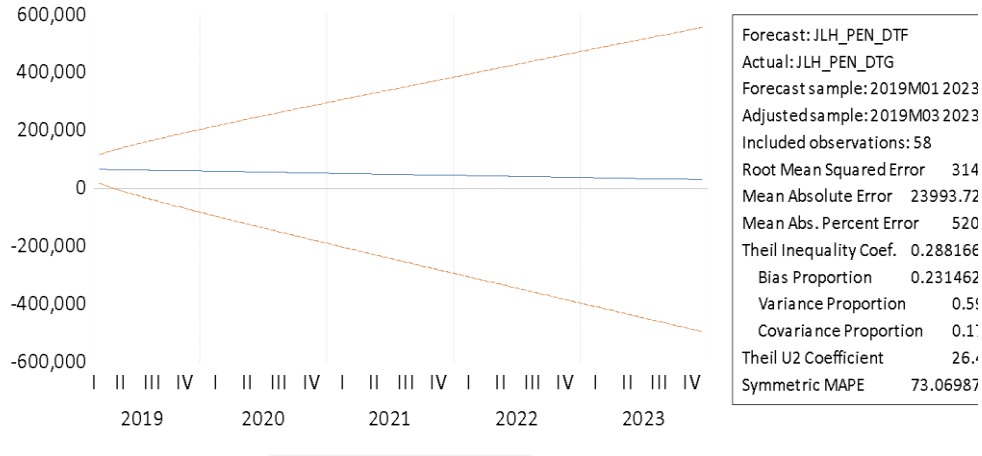

Figure 5. Forecasting the Number of Passengers Arriving with the Dynamic Method

Table 3 displays the estimated data for each forecast in the AR (1.0.1), MA (0.1.1) and ARIMA (1.1.1) models, where the results of the number of departing passengers obtained show that the RMSE value in the AR(1.0.1) model) of 27937.46 for the MAE value which has a value of 20402.62 and MAPE of 12802.61. The MA(0.1.1) model has an RMSE value of 35376.55 for an MAE value of 26311.62 and a MAPE value of 15262.24, while the ARIMA (1.1.1) model displays an RMSE value of 25220.27 for an MAE value of 18720.95 and a MAPE

of 11690.43. The results that show the smallest value in the comparison of values in the forecast results for the number of departing passengers have the best model among the three models, namely the ARIMA forecasting model (1.1.1). Forecasting results using the ARIMA (1,1,1) model include the following:

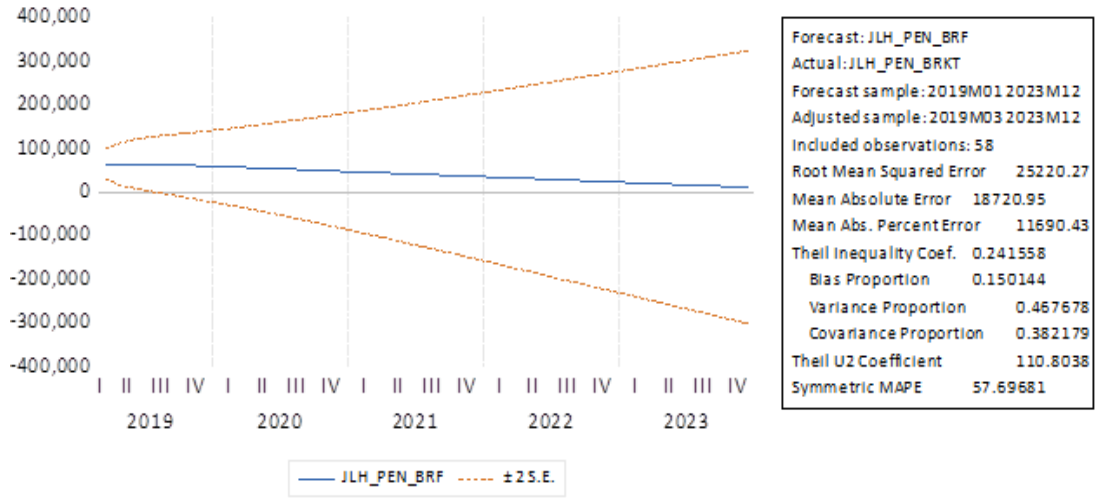

Figure 6. Forecasting the Number of Departing Passengers Using the Dynamic Method

According to Durrah et al., (2018), by obtaining information about the number of incoming passengers, companies can anticipate the expected increase in the number of passengers and plan mature policies to manage it in the future. This action allows companies to adjust their activities effectively. Knowing the forecast for the number of arriving and departing passengers in 2022 and 2023, airlines are able to adjust airport management to provide policies to attract people so that when traveling they can use air transportation.

CONCLUSION

Forecasting carried out to predict the number of passengers at Sentani International Airport over the next 2 years resulted in a decrease in the number of arriving passengers and a decrease in the number of departing passengers. The results of the research and analysis that have been carried out state that the ARIMA model is a method that can provide accurate forecasting if done over a short period of time or over a short period of time. The best results in modeling the number of arriving passengers and the number of departing passengers is the ARIMA model (1.1.1). Suggestions for further research are optimizing the ARIMA method by adding other methods.

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