Forecasting and Trend Analysis Bus Transportation During COVID-19 in Bali Land Using Time Series Method

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A R T I C L E   I N F O

A B S T R A C T

Transportation functions as a link between tourist destinations. Since the COVID-19 pandemic hit, the transportation industry has experienced direct impacts. One is a decrease in transportation users due to increased travel costs. This has a direct impact on reducing public interest in visiting. This research aims to find out changes in services for inter-provincial buses in Bali during and after the pandemic. The data used is departure data: the number of autobus suppliers; the number of departing destinations; the number of trips; and the average number of passengers from January 2018 to April 2022. From this data, time series analysis and forecasting were carried out using the Minitab software. The findings of a time series study regarding the number of trips, the number of bus suppliers, and the average number of passengers have decreased over time. Still, the number of departure destinations from the island of Bali has increased. Based on the forecasting results, it is known that the number of bus suppliers and the number of departure destinations has increased. However, it does not match the data for January 2018. This shows that the connectivity of Bali Island and the surrounding islands has increased after the COVID-19 pandemic subsided. It is hoped that it can be used as material for formulating public transportation strategies and policies, especially inter-provincial bus services.

1. Introduction

Bali is famous for its culture and tourism. Bali tourism can be accessed using available modes of transportation. Transportation serves as an important link between tourist destinations and locations outside Bali. The transportation industry is still feeling the impact of the COVID-19 epidemic. This is due to the additional need to utilize the Rapid-Test to travel to and from the island of Bali. As a result, the overall cost of the trip increases. This reduces public interest

in coming to visit. The pandemic has had a major impact on transportation costs and shifts in travel requirements [1].[2], [3].

COVID-19 has made a significant influence on global transportation. Australia's transportation industry suffers a severe financial collapse since public transportation utilization has dropped by 80% [4]. The general population's interest in using public transportation is dwindling [4]–[6][7]. Public transportation is arranged to suit the community's demands for safe, pleasant, and inexpensive transportation [5], [8], [9]. This, however, was not met during the COVID-19 epidemic. Public transportation no longer gives the impression of safety and security. When taking public transportation, people are overwhelmed by their dread of getting the virus [5], [10], [11]. The transportation industry has a dual purpose as a transmission site and is impacted by COVID-19 [12]. On the one hand, public transportation must be protected, but on the other hand, public transit is a source of issues everywhere it grows [12] [13].

The income of the autobus suppliers reduces as the number of passengers declines. Several autobus suppliers are innovating to expand the variety of services available in the transportation of goods packages. This has an impact on the longer trip time. Another tactic used by the Otobus Company is the consolidation of two travel routes to lower operational expenses. This affects the length of the route that must be taken, making travel time greater. Furthermore, the points are not uniformly distributed, thus not all people's transportation demands can be met [14].

Following this, statistical studies that may explain variations in the usage of public transportation in Bali (particularly inter-provincial buses) before and after COVID-19 are required. Time series analysis can be utilized in statistical research [2], [3]. Data time series is a collection of data from a given phenomenon gathered over a defined time[15]. Using the time series analysis approach, we may learn about bus service variations between provinces. The period used for the analysis is from before to after the influence of COVID-19.

This article aims to utilize trend time series analysis to determine changes in the utilization of inter-provincial land transportation services. The study's findings are presented as trends in the use of inter-provincial buses [3]. Furthermore, the study's findings may be utilized to develop a policy plan for public transportation (Inter-Provincial Buses) and improve services

2. Research Method

2.1   Research Data

This study is quantitative. The demographic data utilized is secondary data received from the Terminal's registration officer for daily departures of Inter-Provincial buses from Terminal Type A, Mengwi, Badung, Bali, from January 2018 to April 2022. The data includes information on the number of trips, the number of destinations departing, the number of trips, and the average number of passengers. The Mengwi Terminal was chosen since it is Bali's only Type A terminal. Interprovincial bus departure data was chosen as the data sample because it is more consistent, making analysis easier [16]. Monthly departure data is derived from the total daily data. From this data, an analysis of the inter-provincial bus travel service departing from Mengwi Terminal Bali. It was carried out using the time series method of the number of trips, the number of departing destinations, the number of trips, and the average number of passengers, and forecasting using the four results of the time series analysis.

2.2   Instrument Test

A preliminary examination of the reliability and validity of the SPSS-aided data was performed before the statistical test. The validity test is used to determine the precision of the variables utilized in the study. A reliability test determines the dependability or consistency of study findings. If the significance value of the validity findings is less than 0.05 and the data is correlated, it is determined that the data is legitimate. Cronbach's Alpha Based on a Standardized test with a value greater than 0.7 was utilized for the reliability analysis [17].

2.3   Time Series Analysis

The next step is to test the Trend method for time series analysis. Time series analysis determines the development of one or several events and their relationship with or influence on other events [2]. The trend method was chosen based on the initial analysis of the data using scatter charts. Trend analysis shows the general direction of development (an upward or decreasing trend) [2]. This analysis determines the trend of inter-provincial bus services leaving the Mengwi Bali Terminal. The variables used in this analysis are the number of bus suppliers, the number of departing destinations, the number of trips, and the average number of passengers. The results of the analysis are trends for the four variables. The level of accuracy of the model can be seen from the lowest MAPE value. If the MAPE value is less than 10%, forecasting ability is very good; if it is between 10% and 20%, forecasting ability is good; if it is between 20% and 50%, forecasting ability is reasonable; and if it is greater than 50%, forecasting ability is poor [18].

2.4   Minitab Software

Time series analysis was carried out using Minitab software. Minitab is one of the software programs created to perform statistical analysis. One of the statistical analyses can be done as a time series analysis. The software has a time series feature that can be used to find estimates of forecasting models and their forecasting results. Minitab software is considered capable of finding model estimates and time series forecasts [19], [20]. Four variables regarding bus services were analyzed using Minitab software. The items used are trend analysis with the four model types: linear, quadratic, exponential growth, and s-curve (pearl-reed logistics).

The four variables are the number of trips, the number of bus suppliers, the number of departing destinations, and the average number of passengers. The data used is monthly data from January 2018 to April 2022 (52 data points). The analysis results are time series function equations, actual and fitted graphs, curve parameters, and accuracy measures. Forecasting is done with the curve that has the lowest MAPE value. Forecasting is carried out from May 2022 (53rd data) to December 2022 (60th data). To obtain forecasting results, Minitab software generates forecasts on Trend Analysis items. There are eight forecasts used (from data 53 to 60).

3. Results and Discussions

3.1   Instrument Test

Before time series analysis, validity and reliability were assessed. The SPSS program was used to conduct the analysis. **Table 1** and **Table 2** show the results of the Validity Test and Reliability Test performed with SPSS.

Table 1. Validity Test Results with SPSS

		The Number of Departing Destinations	The Number of Trips	The Average Number of Passengers	The Number of Otobus Suppliers
The Number of Departing Destinations	Pearson Correlation	1	.617**	.415**	.786**
	Sig. (2-tailed)		.000	.003	.000
	N	48	48	48	48
The Number of Trips	Pearson Correlation	.617**	1	.860**	.805**
	Sig. (2-tailed)	.000		.000	.000
	N	48	48	48	48
The Average Number of Passengers	Pearson Correlation	.415**	.860**	1	.646**
	Sig. (2-tailed)	.003	.000		.000
	N	48	48	48	48
The Number of Otobus Suppliers	Pearson Correlation	.786**	.805**	.646**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	48	48	48	48

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Research Data (SPSS, 2022).

Table 1 shows that the significance value of all variables is below 0.05 and correlated. Therefore, the three variables are declared valid.

Table 2. Results of Reliability Test Analysis with SPSS

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.135	.898	4

Source: Research Data (SPSS, 2022)

Table 2 shows that the value of Cronbach's Alpha Based on Standardized Items is more than 0.7, which is 0.898. As a result, it is said that all data is trustworthy.

3.2   Annual Data Analysis

Table 3 shows the annual average statistics for comparison each year. The data in 2022 is the smallest of the four because it is only available through April 2022. The following four variables are used: the number of autobus suppliers, the number of departing destinations, the number of trips, and the average number of passengers.

Table 3. Annual Data Average Comparison

	2018	2019	2020	2021	2022
The number of autobus suppliers	**117**	101	77	82	70
The number of departing destinations	**25**	24	19	24	19
The number of trips	1654	**1757**	896	862	842
The average number of passengers	58.65	**65.71**	48.23	40.57	28.46

Source: Research Data (2022)

According to **Table 3**, the number of bus suppliers and the number of departing destinations had the highest value in 2018. However, it fell in 2019 and 2020 before rising again in 2021. The drop in 2019 was due to the efficiency of bus suppliers' transportation modalities. Whereas 58.65% of capacity was occupied in 2018, this increased to 65.71% in 2019. Population density data by city or district in Bali from 2018 to 2021 is explained in **Table 4** [21].

Table 4. Population Density Data in Bali

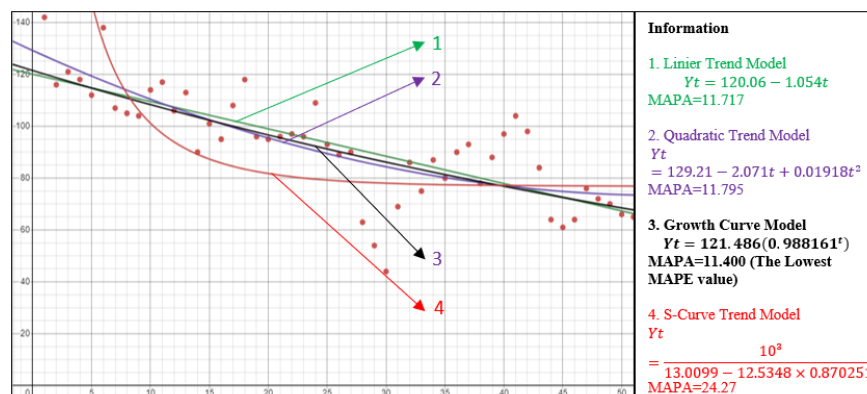|	2018	2019	2020	2021
Population Density Data (person/km2)	746	750	747	755

Source: BPS (2022)

The increase in population density values from 2018 to 2019 indicates an increase in the population in Bali that year. Furthermore, the number of trips in 2019 has increased according to the increase in density values (**Table 4**). Due to the influence of COVID-19, all variables decreased in 2020. Along with reducing the COVID-19 epidemic, the transportation industry will begin to recover in 2021, although not to the level seen in 2018 and 2019.

3.3   Time-Series Analysis

Time series analysis was performed on monthly data from January 2018 to April 2022 (the data used are 52 datums), using the Minitab software and the Trend method. The trend approach model types employed were linear, quadratic, exponential growth, and S-Curve (pearl-reed logistics). The model used is based on the lowest MAPE value. The linear trend model shows forecasting data going up or down with a constant value. The quadratic trend model shows forecasting data going up or down, then reversing (a turning point marks this graph). The exponential trend model shows that forecasting data tend to fall closer to the x-axis (this graph is indicated by the asymptote $y = 0$). The S-curve model shows that forecasting data tends to decrease to a certain value (this graph is marked by the asymptote $y = a$, for a positive number).

3.3.1   The Number of Bus Suppliers

Figure 1 depicts a time series analysis of the number of bus suppliers from Terminal Type A Mengwi, Badung, Bali, using the Minitab software.

Information

1. Linier Trend Model
$$Yt = 120.06 - 1.054t$$
MAPA=11.717

2. Quadratic Trend Model
$$Yt = 129.21 - 2.071t + 0.01918t^2$$
MAPA=11.795

3. Growth Curve Model
$$Yt = 121.486(0.988161^t)$$
MAPA=11.400 (The Lowest MAPE value)

4. S-Curve Trend Model
$$Yt = \frac{10^a}{13.0099 - 12.5348 \times 0.870251^t}$$
MAPA=24.27

Source: Research Data (Minitab, 2022)

Figure 1. Results of Time Series Analysis on the Number of Bus Suppliers

According to **Figure 1**, the Growth Curve Model curve has the lowest MAPE value of 11.400 (a good forecast), and the model equation is as follows:

$$Y_t = 121.486(0.98861^t)$$

With:

Y_t = forecasting the number of bus suppliers

t = period

Based on the Growth Curve Model equation, the trend decreases every time. Furthermore, the model is used for forecasting until the end of 2022 (the 53rd to 60th data points are used) with Minitab software, as shown in the forecasting results in **Table 5**. Forecasting can be done

because the MAPE value (11.400) is still in the range that can provide results for good fortune telling [18].

Table 5. Forecasting the Number of Bus Suppliers May 2022 to December 2022

May	June	July	August	September	October	November	December
66.19	65.44	64.69	63.96	63.23	62.51	61.80	61.09

Source: Research Data (Minitab, 2022)

Based **on Table 5**, In December 2022, the number of bus suppliers is forecasted to decrease to 61.09, or 61 bus suppliers. While in January 2018, there were 142 bus suppliers, down 57.04% from December 2022. In January 2022, there were 70 bus suppliers, down 12.85% from December 2022. There is a decrease in the comparison value between January 2018 and January 2022. This can be interpreted as an increase in bus suppliers after COVID-19 begins to subside.

Service improvement refers to existing bus providers providing excellent service to customers. So, people choose bus providers as transportation service providers. It would be wise to study evidence-based policy responses to transport service delivery [22]. Research related to improving infrastructure, systems, and services provided to users of transportation services needs to be carried out. Various service innovations, ranging from competitive prices to easy access connected to the internet or computer [5], [23] have added to the attractiveness of this mode of transportation for consumers. For example, an intelligent information system lets passengers know the arrival time and availability of bus seats that go to their positions [24]. Furthermore, it is critical to improving the safety factor. Perceived safety has a positive effect on overall satisfaction [14].

3.3.2   The Number of Departing Destinations

Figure 2. depicts a time series analysis of the number of departing destinations from Terminal Type A Mengwi, Badung, Bali using the Minitab software.
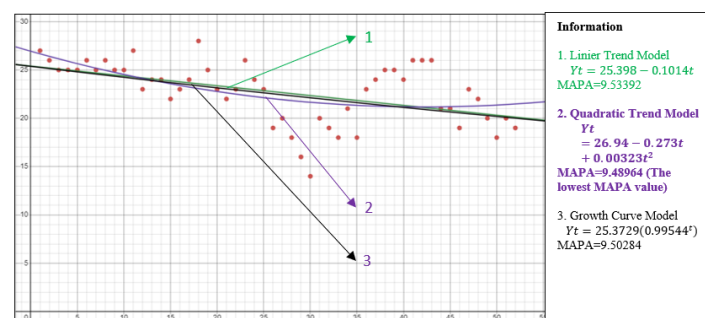
Source: Research Data (Minitab, 2022)

Figure 2. Results of Time Series Analysis on the Number of Departing Destinations

According to **Figure 2**, the Quadratic Trend Model curve has the lowest MAPE value of 9.48964 (an extremely excellent forecast), and the model equation is as follows:

$Y_t = 26.94 - 0.273t + 0.00323t^2$

With:

Y_t = forecasting the number of departing destinations

t = period

Based Quadratic Trend Model equation, a tendency to experience a turning point in the 42nd data. Furthermore, the model is used for forecasting until the end of 2022 (the 53rd to 60th data points are used) with Minitab software, as shown in the forecasting results in **Table 6**. Forecasting can be done because the MAPE value (9.48964) is in the range that can provide excellent forecasting results [18].[18]

Table 6. Forecasting the Number of Departing Destinations May 2022 to December 2022

May	June	July	August	September	October	November	December
21.57	21.64	21.72	21.81	21.90	22.00	22.10	22.21

Source: Research Data (Minitab, 2022)

Forecasting results in **Table 6** tend to be the same until December 2022. When used for forecasting the original condition before COVID-19 in 2018 (a total of 25 destination cities), the results obtained are t = 8 or t = 77. Thus, it is predicted that conditions will return 77 months after January 2018 or May 2023. Forecasting determines the number of destination cities departing from Mengwi Terminal, Bali, until December 2022. The MAPE value is less than 10, so the forecast results can be used as a good picture of the future.

Meanwhile, judging from the comparison of the forecast value of December 2022 with the value of January 2018 (27 Destination Cities), it decreased by 18.52%. Furthermore, the comparison of the forecast value of December 2022 with the value of January 2022 (20 Destination Cities) decreased by 9.09%. Although it is still experiencing a decline after COVID-19 has subsided, there is an improvement in the number of departing destinations.

The tendency of the number of destination cities for interprovincial buses to increase at any time can be considered a pretty good opportunity. The increase in the number of destination cities indicates increasing connectivity between the island of Bali and the surrounding areas. Efforts need to improve inter-provincial bus services so that the community's public transportation needs are fulfilled. Service improvement can take the form of using an automated bus system or evaluating bus route management to shorten travel time. The development of public transport services can use three mobility principles: agility, integrated

movement, and public-based partnerships [10]. In addition, tangibility, reliability, and responsiveness factors also need to be developed, which are service quality factors that significantly affect the satisfaction of public bus users [23].

3.3.3 Number of Trips

Figure 3 depicts a time series analysis of the number of inter-provincial bus journeys departing from Terminal Type A, Mengwi, Badung, and Bali using the Minitab software.
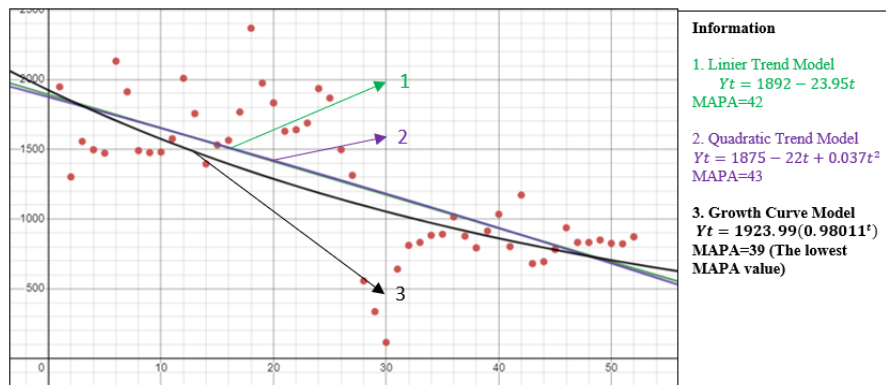
Source: Research Data (Minitab, 2022)

Figure 3. Results of Time Series Analysis on the Number of Trips

According to **Figure 3**, the Growth Curve Model curve has the lowest MAPE value of 39 (fair forecast), and the model equation is as follows:

$$Y_t = 1923.99(0.98011^t)$$

With:

Y_t = forecasting the number of trips

t = period

Based on the Growth Curve Model equation, the trend decreases every time. Before being affected by COVID-19, public interest in using inter-provincial bus public transportation had decreased (see data values 1 to 24) in **Figure 3**. This is because public transportation does not meet the needs of public transportation services [4], [18]. Furthermore, the model is used for forecasting until the end of 2022 (the 53rd to 60th data points are used) with Minitab software, as shown in the forecasting results in **Table 7**. Forecasting can be done because the MAPE value (of 39) is in the range that provides good forecasting results [18].

**Table 7.** Forecasting the Number of Trips May 2022 to December 2022

May	June	July	August	September	October	November	December
663.49	650.29	637.36	624.68	612.26	600.09	588.15	576.45

Source: Research Data (Minitab, 2022)

Forecasting results are in **Table 7**. Forecasting is carried out to find out the number of trips departing from Mengwi Terminal, Bali, until December 2022. However, considering the relatively large MAPE results, the forecasting results have not been able to provide a good (but reasonable) picture of future conditions.

3.3.4   The Average Number of Passengers

Figure 4 depicts a time series analysis of the average number of passengers on inter-provincial bus journeys departing from Terminal Type A, Mengwi, Badung, Bali, using the Minitab program.
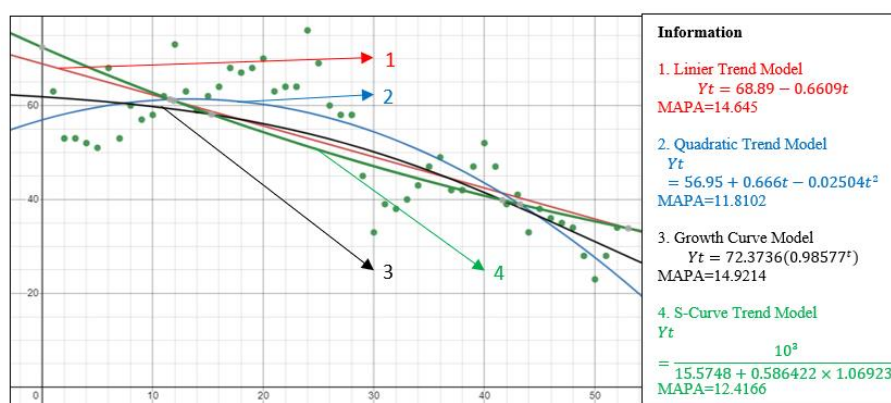
Source: Research Data (Minitab, 2022)

Figure 4. Results of Time Series Analysis on the Average Number of Passengers

According to **Figure 4**, it is known that the lowest MAPE value is the Quadratic Trend Model curve with a value of 11.8102 (good forecast), and the model equation is as follows:

$Y_t = 56.95 + 0.666t - 0.02504t^2$

With:

Y_t = forecasting the number of trips

t = period

Based on the Quadratic Trend Model, the trend decreases every time. Furthermore, the model is used for forecasting until the end of 2022 (the 53rd to 60th data points are used) with Minitab software, as shown in the forecasting results in **Table 8.** Forecasting can be done because the MAPE value (11.8102) is in the range of giving results for good fortune telling [18].

Table 8. Forecasting the Average Number of Passengers May 2022 to December 2022

May	June	July	August	September	October	November	December
21.92	19.91	17.85	15.73	13.57	11.36	9.09	6.78

Source: Research Data (Minitab, 2022)

It is known that the forecasting results in **Table 8** tend to decrease every time. Forecasting is done to determine the number of trips departing from Mengwi Terminal, Bali, until December 2022. The comparison of the average number of passengers in January 2018 (down by 62.615%) with forecasted results in December 2022 decreased by 89.17%. This decline is very sharp because it is more than 50%. Furthermore, the comparison of January 2022 (by 28.410%) with forecasted results in December 2022 decreased by 76.14%. Thus, the average number of passengers decreased the most among other variables.

4. Conclusion

The results of a time series analysis with four variables show that the number of bus suppliers, the number of trips, and the average number of passengers tend to decrease over time. The trend for the number of destination cities shows good results and continues to increase over time. Based on the forecasting results, the number of bus suppliers and trips has increased, although they have not yet matched January 2018. forecasting departures to increase constantly. Thus, the connectivity of the island of Bali with the surrounding area is becoming increasingly good. The findings are expected to be used as material for formulating strategies and policies on public transportation, especially inter-provincial buses. The development of further research is still wide open, such as determining the connectivity between the island of Bali and the surrounding area or the factors that make an autobus provider more attractive to the public.

5. Acknowledgement

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