CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter focus on the application of the Seasonal Autoregressive Integrated Moving Average (SARIMA) and the Holt-Winters methods on the zakat institutions in Malaysia, namely Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS), and Pusat Pungutan Zakat (PPZ), using monthly data of zakat collection from January 2010 to December 2019 containing 120 observations. While the yearly data of the zakat collection for Majlis Agama Islam dan Adat Melayu Perak (MAIPk) from 1991 to 2019 contains 29 observations.

4.2 Descriptive Statistics

The behavior of the data set is evaluated in this section using descriptive statistical analyses. The use of descriptive statistics allows for an in-depth analysis of the data. Table 4.1 shows descriptive statistics of the zakat institutions used in the analyses. The average amount of the zakat collection at LZS, PZNS, PPZ, and MAIPk are approximately 50 million per month, 8 million per month, 43 million per month, and 61 million per year, respectively. The minimum monthly zakat collection for LZS was approximately 12 million (January 2011), 2 million for PZNS (May 2010), and 15 million for PPZ (January 2010). Whereas for MAIPk, the lowest yearly zakat collection was 7 million in the year 1991.

The maximum amount of the zakat collection at LZS, PZNS, PPZ, and MAIPk over the study period is approximately 227 million per month, 29 million per month, 146 million per month, and 207 million per year, respectively. This was experienced in December 2019 for LZS, as well as December 2019 for PZNS and December 2019 for PPZ and year 2019 for MAIPk. The standard deviation of 39.3 million, 4.8 million, 25.3 million, and 60.2 million for LZS, PZNS, PPZ, and MAIPk respectively. The PZNS have a low standard deviation as 4.8 indicates that data points tend to be very close to the mean, whereas the LZS have a high standard deviation as 39.3 indicates that the data points are spread out over a large value.

Table 4.1: Descriptive Statistics of zakat collection in LZS, PZNS, PPZ and MAIPk

Zakat Institution	(RM Million)				
	N	**Min**	**Mean**	**Max**	**Standard Deviation**
LZS	120	11.8	49.9	226.6	39.3
PZNS	120	1.9	7.5	28.5	4.8
PPZ	120	15.4	42.7	145.6	25.3
MAIPk	29	6.7	61.2	207.2	60.2

4.3 Time Series Plot of Zakat Collection

Figure 4.4 time series plot shown a clear upward trend. There may also be a slight curve in the data, because the increase in the data values seems to accelerate over time. Seasonality in a time series can be identified by regularly spaced peaks and troughs which have a consistent direction and approximately the same magnitude every year, relative to the trend. The following diagram depicts a strongly seasonal series. There is an obvious large seasonal increase in December zakat collection in LZS, PZNS and PPZ due to tax exemption. In this example, the magnitude of the seasonal component increases over time, as does the trend.

The time series of the zakat collection in Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS) and Pusat Pungutan Zakat (PPZ) from January 2010 to December 2019 is presented in Figure 4.4 below.

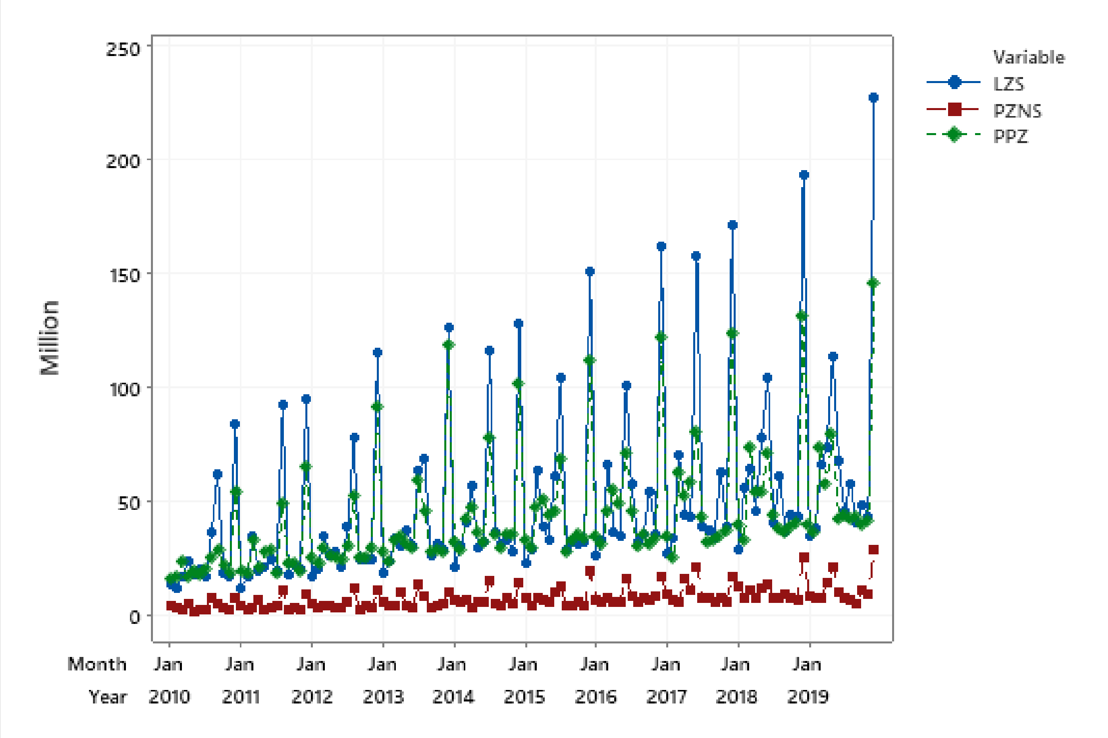


Figure 4.1: Time Series Plot of Zakat Collection for LZS, PZNS and PPZ

From Figure 4.1, we can see two main patterns, the first is an obvious uprising trend and the second is a seasonal pattern that appears to be multiplicative for all zakat institutions. The pattern repeats every 12 months. The collection of zakat for LZS and PPZ is higher than PZNS.

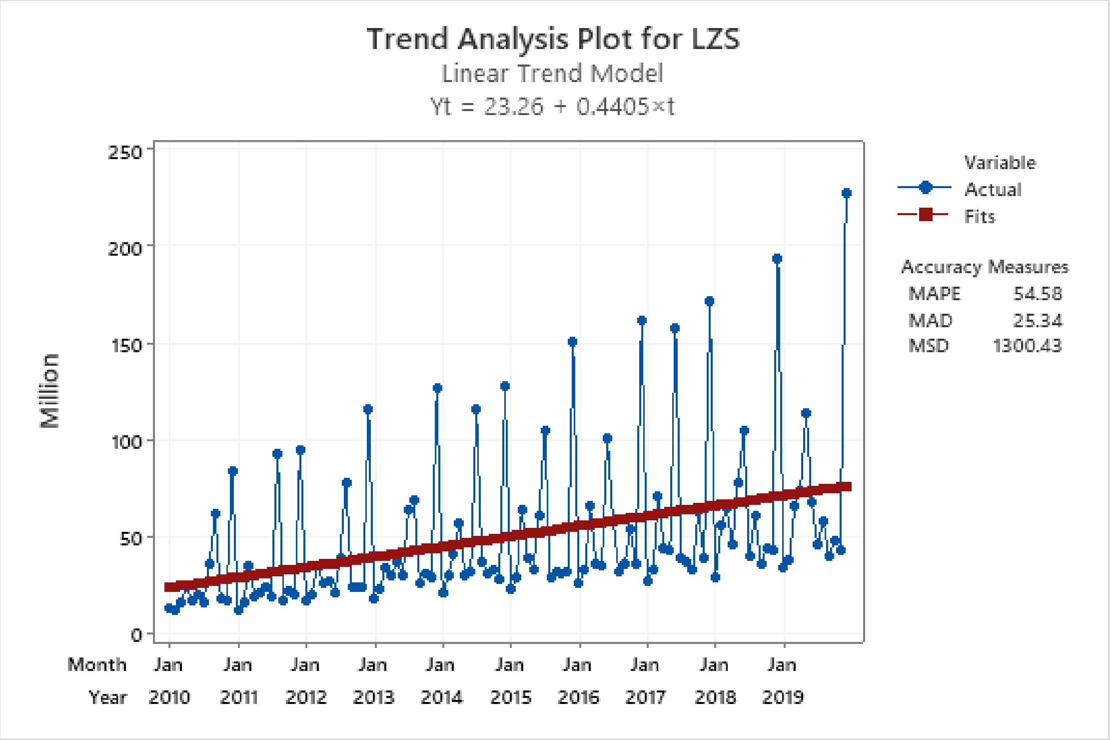


Figure 4.2: Trend analysis of zakat collection for LZS

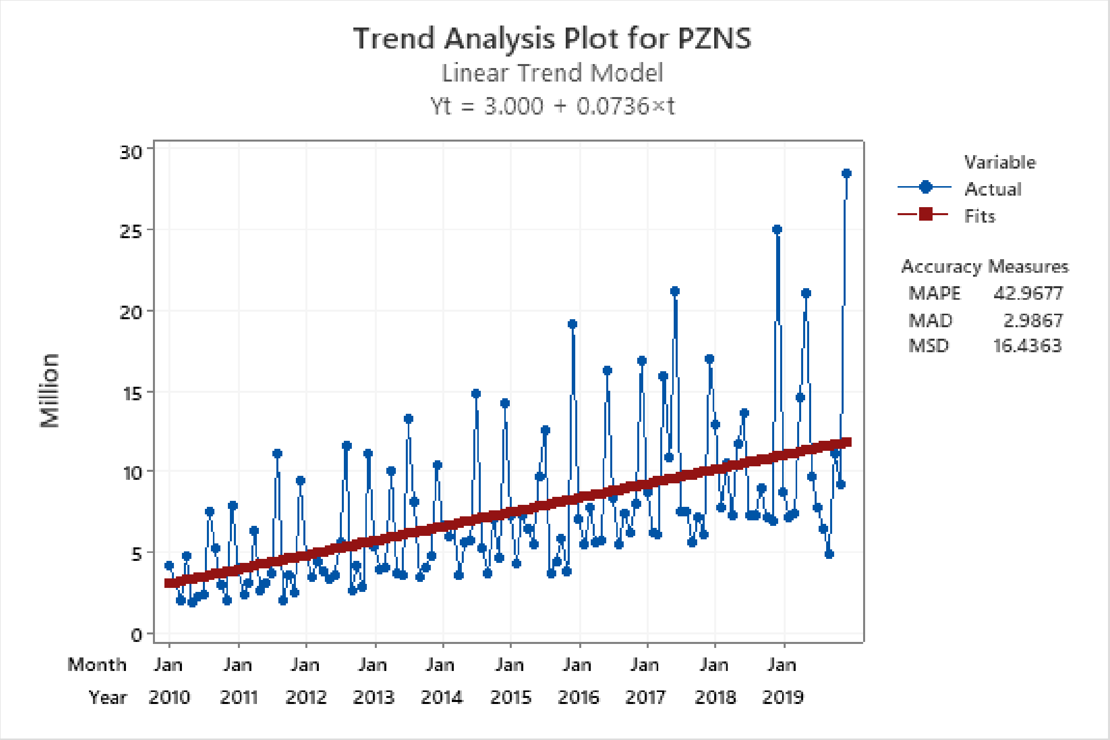


Figure 4.3: Trend analysis of zakat collection for PZNS

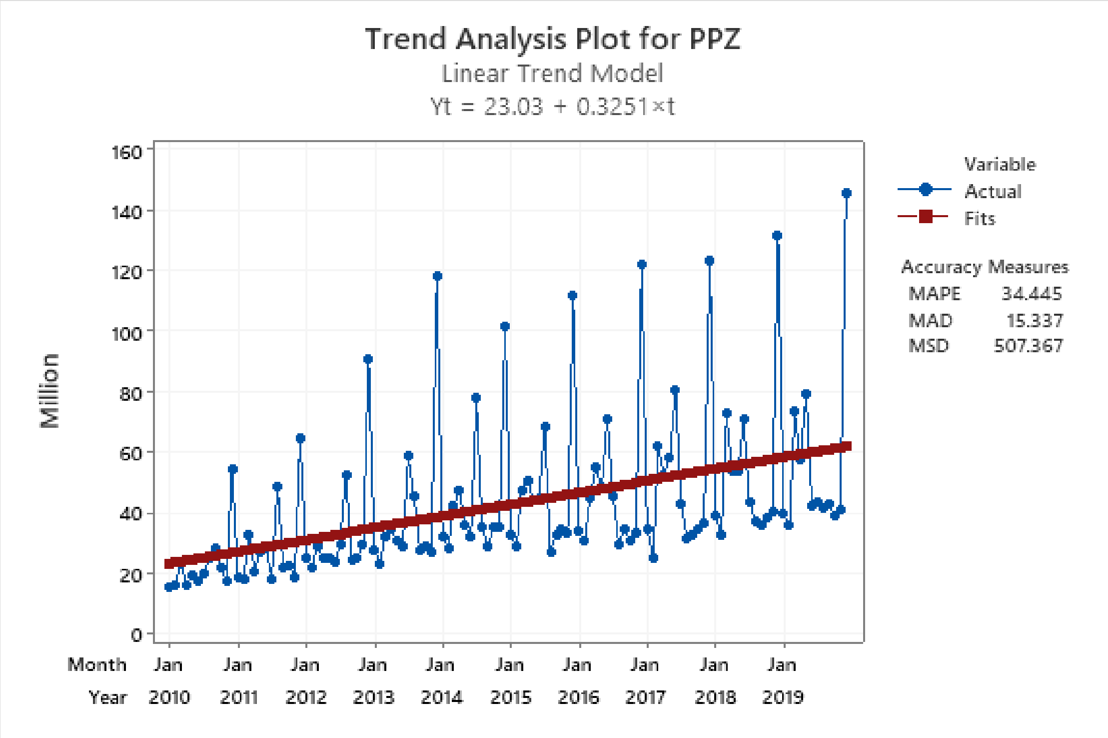


Figure 4.4: Trend analysis of zakat collection for PPZ

Figure 4.2-4.4 shows the graph of monthly zakat collection versus the month for LZS, PZNS, and PPZ for 2010-2018. The trend analyses as in Figure 4.2-4.4 show an increasing trend of zakat collection for all the zakat institutions. The seasonal pattern also clearly shown in June, the number of zakat collections began to rise, peaked in December, and then slowly decreased. The time series plot of the stated zakat collection for all zakat institutions displayed seasonal fluctuations and therefore they are considered nonstationary. Also, the graph has an upward trend.

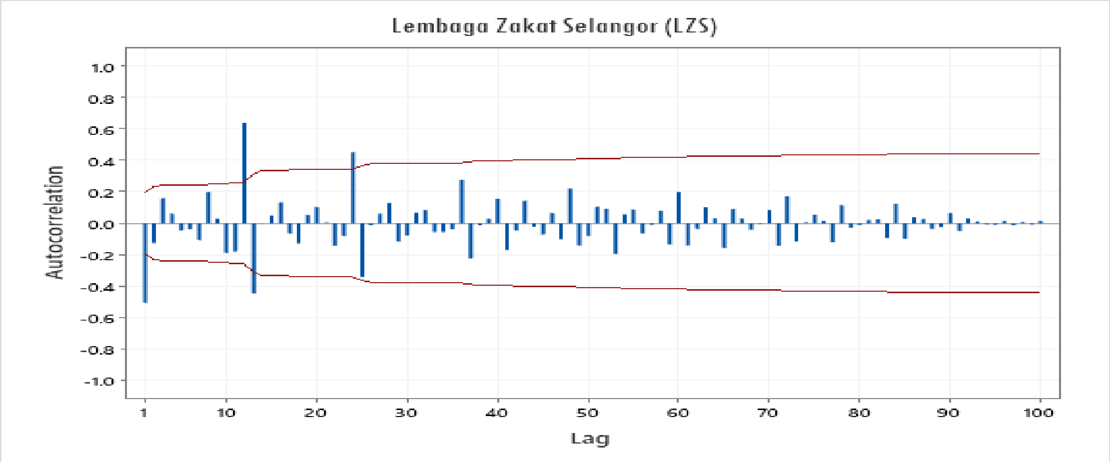
4.4 The Modelling Process with In-Sample Data

The forecasting process for zakat collection of LZS, PZNS, PPZ, and MAIPk is divided into three processes which are modelling process, model validation, and forecasting. This section has been reported and discussed the process involved in modelling using in-sample data and validation of the model using out-of-sample data. The first subsection discusses the Seasonal-ARIMA model for LZS, PZNS, and PPZ that use monthly data from January 2010 until December 2018 for in-sample data and January 2019 until December 2019 for out-of-sample data. The modelling process for MAIPk has been discussed separately in the following section. MAIPk has no monthly data, hence the modelling process used the normal ARIMA model using yearly data from 1991 to 2014 for modelling process and 2015 to 2019 for validation purposes.

4.4.1 The Application of Seasonal-ARIMA models in Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS) and Pusat Pungutan Zakat (PPZ)

4.4.1.1 The Application of SARIMA models in Lembaga Zakat Selangor (LZS)

The study started with the modelling process for LZS using in-sample data. First, we observe the ACF and PACF plot for LZS's time-series data. Since the data are not stationary at the level, we use the differencing data. Based on the ACF and PACF plots, the identification of the model can be made.



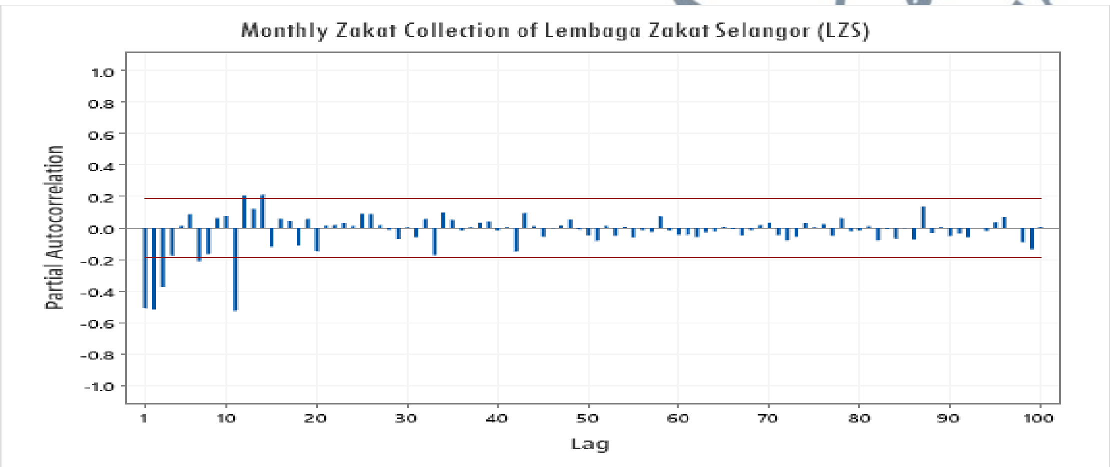
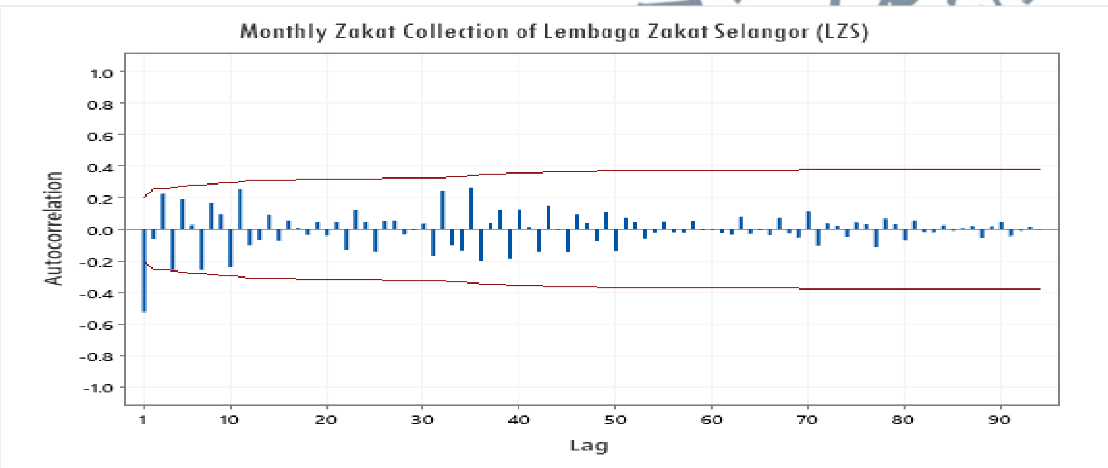


Figure 4.5: ACF and PACF plots after difference at lag 1

The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) for a stationary time series are shown in Figure 4.5, respectively. There is a significant positive spike in the ACF plot lags 12 and 24. Because the ACF cuts after lag 1 while the PCF shows a slowly decreasing trend, the initial assumptions of ARIMA(p,d,q) can be q = 1 and d = 1. However, we were informed about the value of p, so we had to test for all possible values of p = 1 or 2 to obtain the model parameters. Because it has just cut off at the sixth lag, the Partial Autocorrelation Function (PACF) shows a decay pattern. However, there was a significant increase in lag 12. Similarly, for lag 24. This means that we can conclude that there is a seasonal occurrence with a repeating pattern of 12 lags. There was a need to include a first-lag difference term in the Seasonal Autoregressive Integrated Moving Average (SARIMA) model structure (d = 1) as presented in Figure 4.6.

Next, we examined the ACF and PACF plot in time series differencing at lag 12 to determine the suitable parameter of the seasonal component.



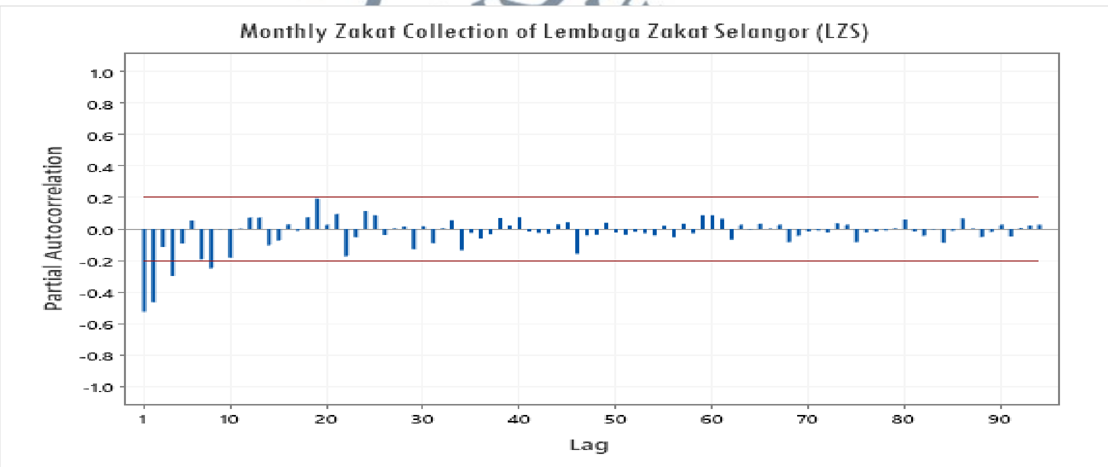


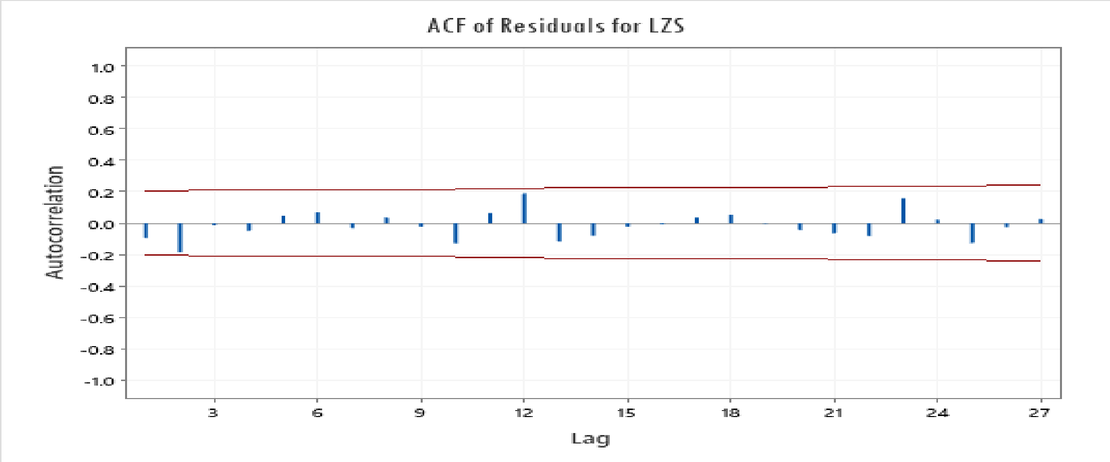
Figure 4.6: ACF and PACF plots after difference at lag 12

In figure 4.6, there is a significant negative spike in the ACF plot at lag 1. In the PACF plot, there are significant negative spikes at lags 1 and 2 (lags are slower to decay). These characteristics a potential parameter starting point of SARIMA (0,1,1) $(0,1,0)_{12}$.

The regression output of the SARIMA model's predictor variables is statistically significant because their p-values equal to 0.000 and 0.001 (see Appendix B). It is standard practice to use the coefficient p-values to decide whether to include variables in the final model. If the p-value is higher than 0.05 then predictor variables are not statistically significant and it can reduce the model's precision (Erlina & Azhar, 2020). Also, comparing five different combinations of p, d, q and P, D, Q of SARIMA model with a p-value less than 0.05 as presented in Table 4.2. Among the models, SARIMA (1,1,1) $(0,1,0)_{12}$ was selected as the best model with the lowest Mean Square Error (MSE) value obtained is 254 and p-value (L Jung-Box) is 0.097. Ljung-Box test > 0.05 suggested that there was no significant autocorrelation between residuals at different lag times and the residuals were white noise (Lwesya & Kibambila, 2017). This was further corroborated by plotting the ACF and PACF of the residuals as presented in Figure 4.7.

Table 4.2: Comparison of In-Sample Forecasting Accuracy Summary for LZS

No	**Model**	***p-value***						**MSE**	**P-Value at Lag 12 (Ljung Box)**
		AR1	AR2	SAR	MA1	MA2	SMA		
1	$(1,1,1)(0,1,0)_{12}$	0.000	-	-	0.000	-	-	254	0.097
2	$(0,1,1)(0,1,0)_{12}$	-	-	-	0.000	-	-	289	0.016
3	$(0,1,2)(0,1,0)_{12}$	-	-	-	0.000	0.001	-	260	0.138



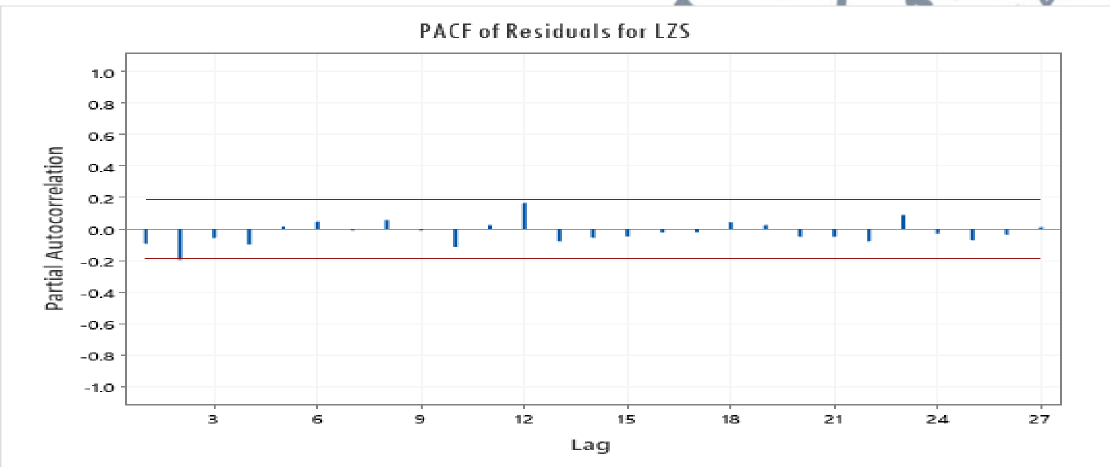


Figure 4.7: ACF and PACF of the residual of SARIMA (1,1,1)(0,1,0)12

The SARIMA model was constructed using in-sample data collected between January 2010 until December 2018 and was verified using out-of-sample data collected from January 2019 to June 2019. The validity of the model was tested and used to forecast the monthly zakat collection of LZS in 2019. The result shows that the actual value and the predicted value matched reasonably well as presented in Figure 4.8.

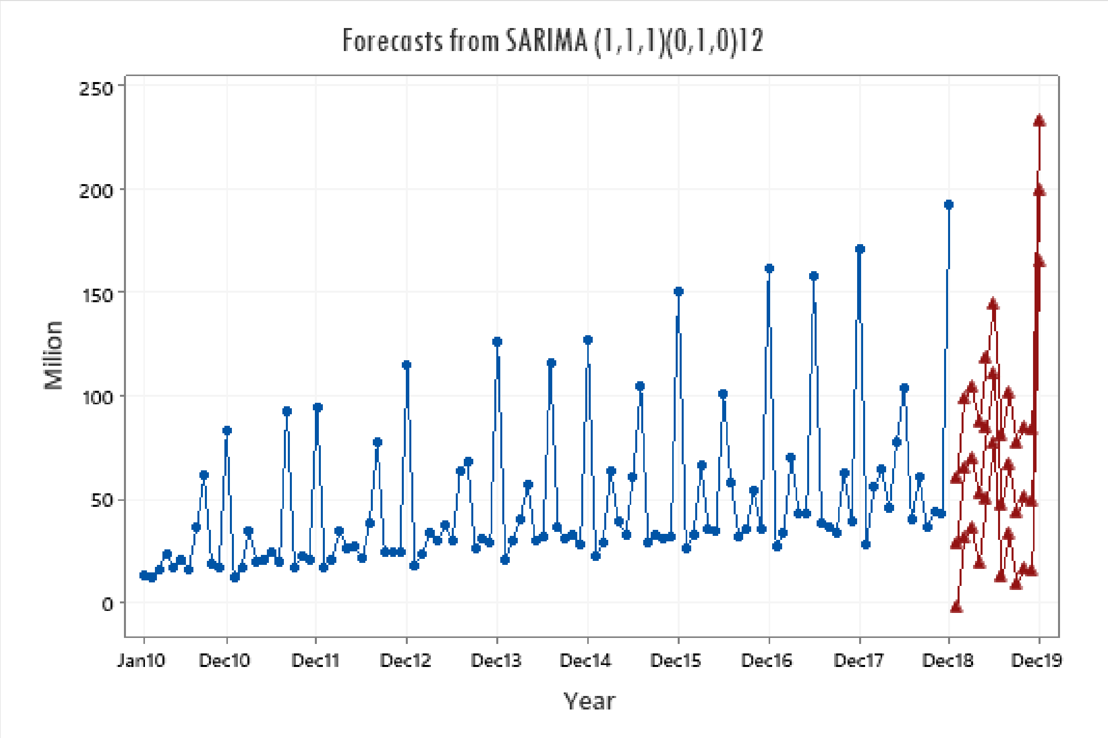


Figure 4.8: Forecast plot of monthly zakat collection in LZS

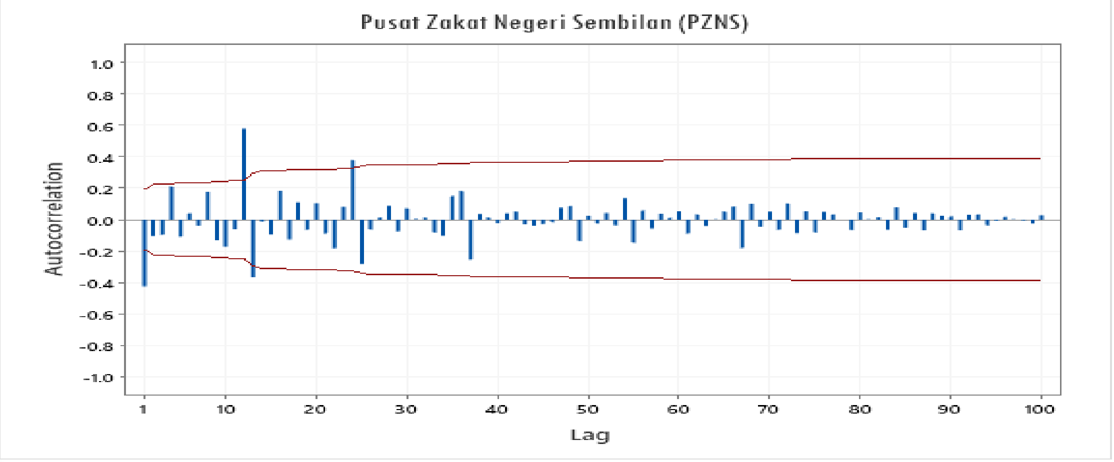
The ability to estimate future values is one of the goals of fitting a SARIMA model to zakat collection data. Table 4.3 shows the results of a twelve (12) month out-of-sample forecast for model SARIMA (1,1,1) (0,1,0)12 from January to December 2019.

Table 4.3: Forecast Value of 2019 Monthly Zakat Collection in LZS using SARIMA (1,1,1)(0,1,0)12

Period	Forecast	Lower	Upper
January	28.301	-2.969	59.571
February	64.463	30.866	98.061
March	69.521	35.518	103.525
April	52.4	18.348	86.452
May	83.742	49.674	117.809
June	110.358	76.291	144.426
July	46.184	12.114	80.253
August	66.554	32.484	100.624
September	42.474	8.404	76.545
October	50.102	16.031	84.173
November	48.862	14.79	82.934
December	199.071	164.998	233.144

The accuracy of the models developed in this section has been discussed further in section 4.5 in comparison with the Holt-Winters model to determine the suitability of the model for forecasting value.

4.4.1.2 The Application of SARIMA models in Pusat Zakat Negeri Sembilan (PZNS)



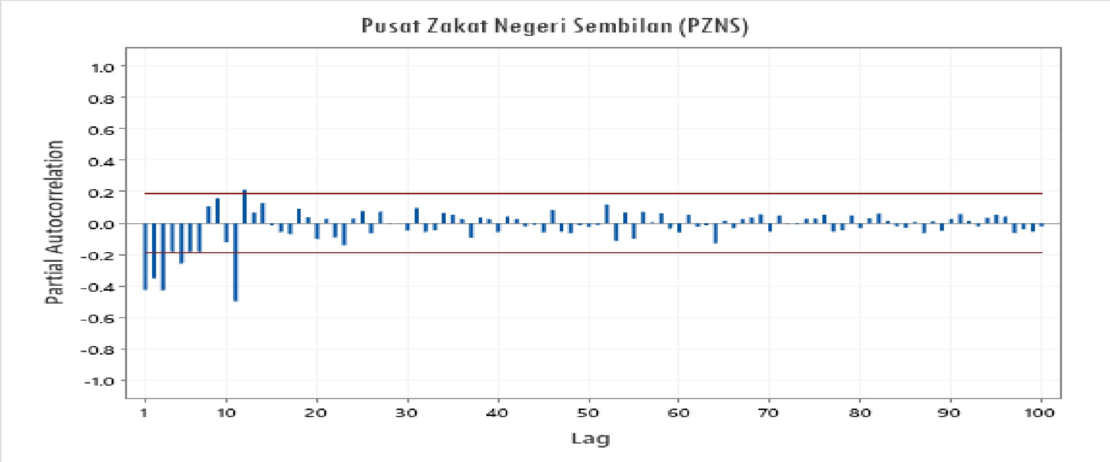
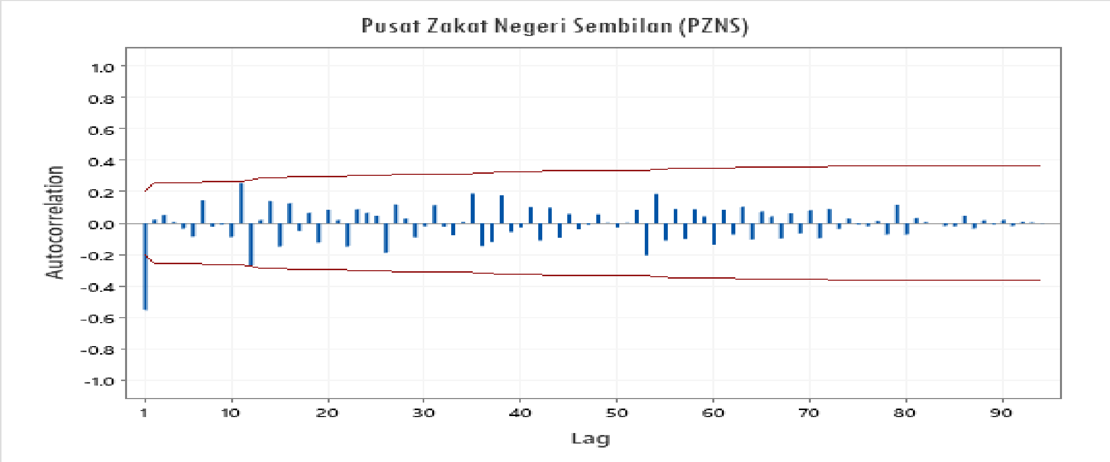


Figure 4.9: ACF and PACF plots after difference at lag 1

Figure 4.9 shows the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF) for a stationary time series, respectively. There is a significant positive spike in the ACF plot lags 12 and 24. Initial assumption can be taken as q = 1 and d = 1 of ARIMA(p,d,q) since ACF cuts after lag 1 while the PCF shows a slowly decreasing trend. For the value of p, we had to test for all possible values of p = 1 or 2 to get the model parameters. The Partial Autocorrelation Function (PACF) shows a decay pattern because it has just cut off at the eighth lag. But in lag 12 there was a significant spike. Likewise, for lag 24. This means that we can conclude that there is a seasonal occurrence with a repeating pattern of 12 lags. There was a need to include a first-lag difference term in the Seasonal Autoregressive Integrated Moving Average (SARIMA) model structure (d = 1) as presented in Figure 4.10. Next, the series is differencing at lag 12 and the ACF and PACF plots are also inspected.



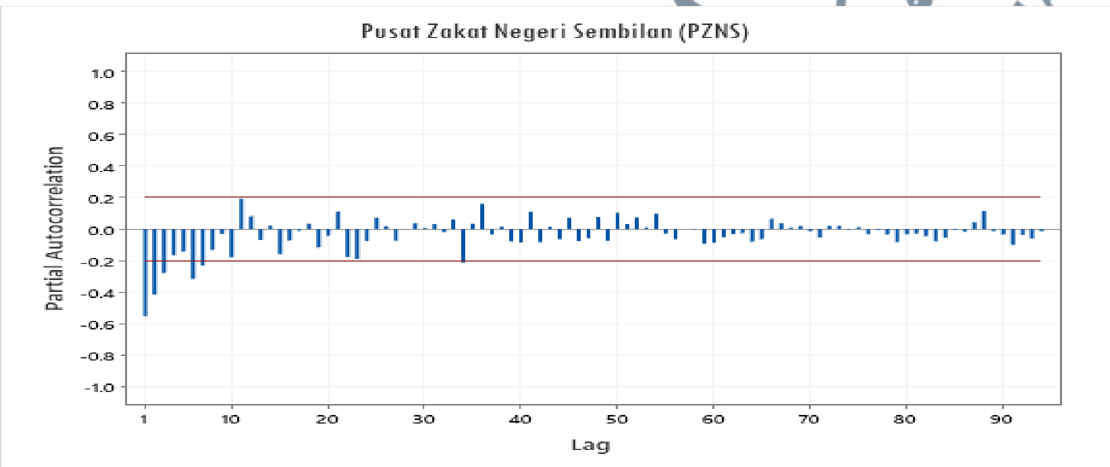


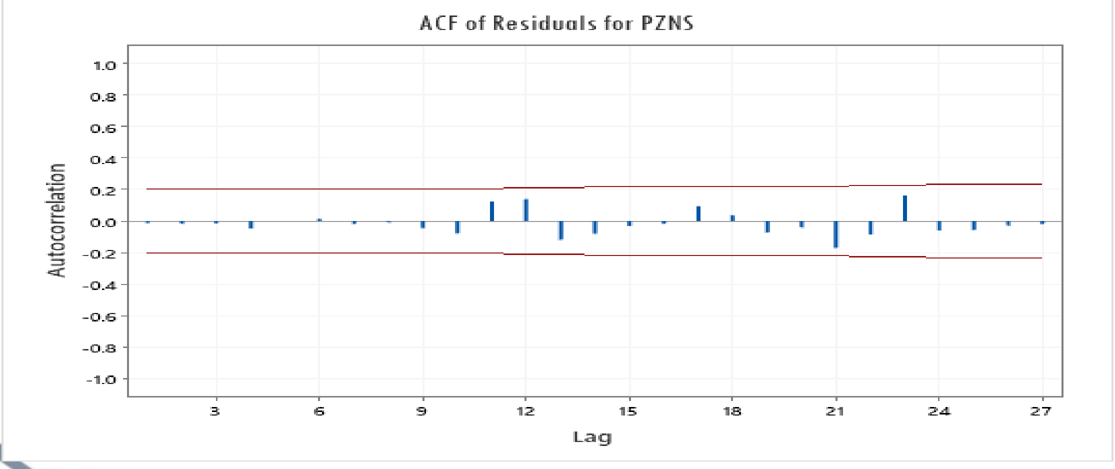
Figure 4.10: ACF and PACF plots after difference lag 12

In figure 4.10, there is a significant negative spike in the ACF plot at lag 1. In the PACF plot, there are significant negative spikes at lags 1 and 2 (lags are slower to decay). These characteristics a potential parameter starting point of SARIMA (0,1,1) $(0,1,0)_{12}$.

All the coefficients of the estimated model are highly significant because p-values are less than 0.05 (see Appendix C). It is standard practice to use the coefficient p-values to decide whether to include variables in the final model. If the p-value is higher than 0.05 then predictor variables are not statistically significant and it can reduce the model's precision (Erlina & Azhar, 2020). Also, comparing five different combinations of p, d, q and P, D, Q of SARIMA model with a p-value less than 0.05 as presented in Table 4.4. Among the models, SARIMA (1,1,1) $(1,1,1)_{12}$ was selected as the best model with the lowest mean square error (MSE) value obtained is 6.3 and p-value (L Jung-Box) is 0.625. Ljung-Box test > 0.05 suggested that there was no significant autocorrelation between residuals at different lag times and the residuals were white noise (Lwesya & Kibambila, 2017). This was further corroborated by plotting the ACF of the residuals as presented in Figure 4.11.

Table 4.4: Comparison of In-Sample Forecasting Accuracy Summary for PZNS

No	Model	*p-value*				MSE	P-Value at Lag 12 (Ljung Box)
		AR	SAR	MA	SMA		
1	$(0,1,1)(0,1,0)_{12}$	-	-	0.000	-	8.3	0.135
2	$(1,1,1)(1,1,1)_{12}$	0.005	0.000	0.000	0.000	6.3	0.625
3	$(0,1,1)(1,1,1)_{12}$	-	0.000	0.000	0.000	6.9	0.880



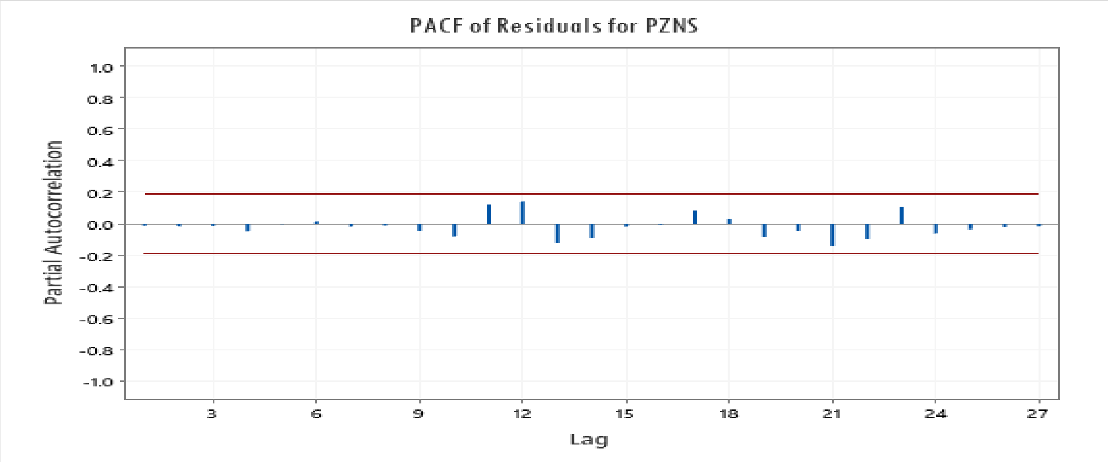


Figure 4.11: ACF and PACF of the residual of SARIMA (1,1,1)(1,1,1)12

The SARIMA model was constructed using in-sample data collected between January 2010 until December 2018 and was verified using out-of-sample data collected from January to June 2019. The validity of the model was tested and used to forecast the monthly zakat collection of PZNS in 2019 as presented in Figure 4.12.

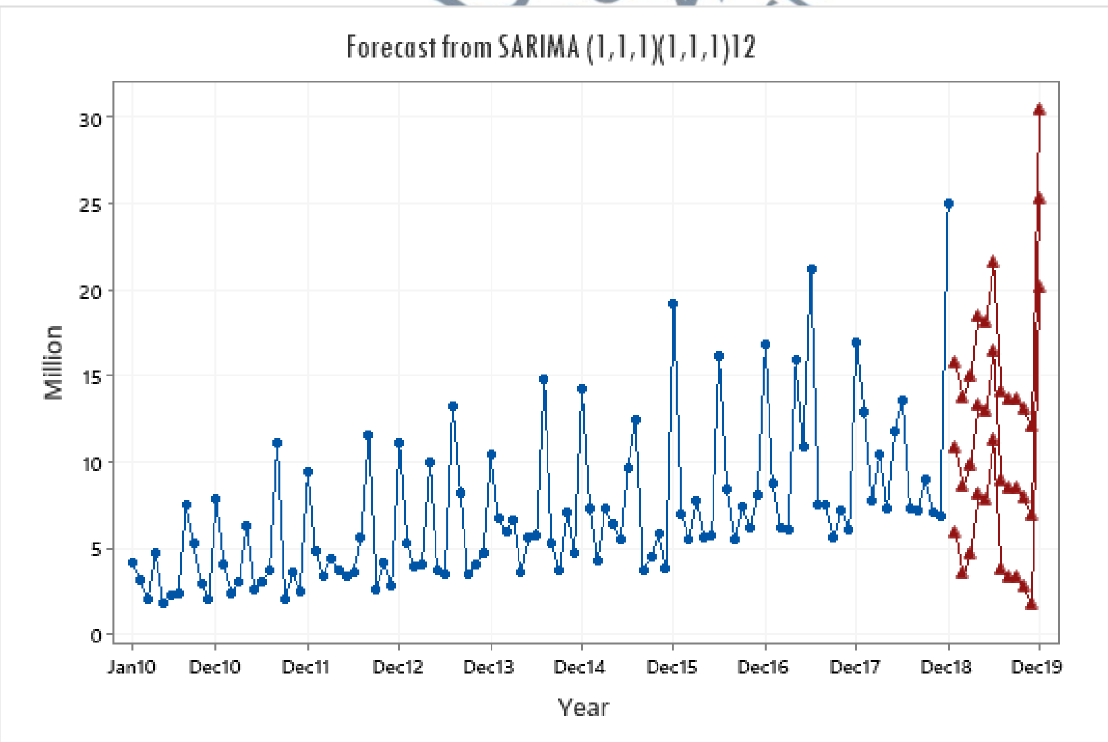


Figure 4.12: Forecast plot of monthly zakat collection in PZNS

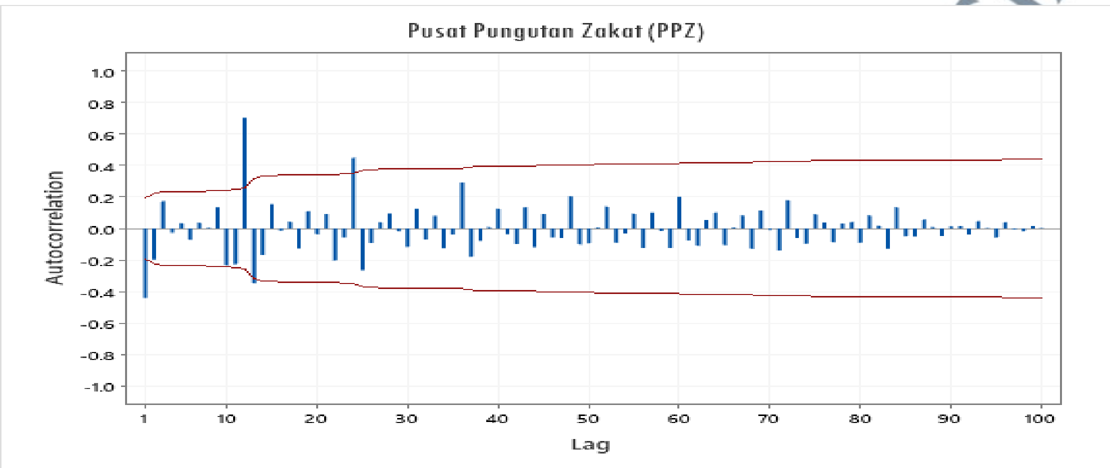
One of the purposes of the fitting SARIMA model of data is to be able to forecast its future values. A twelve (12) months out-of-sample forecast results for model SARIMA $(1,1,1)(1,1,1)_{12}$ from January 2019 to December 2019 period are presented in Table 4.5.

Table 4.5: Forecast Value of 2019 Monthly Zakat Collection in PZNS using SARIMA $(1,1,1)(1,1,1)_{12}$

Period	Forecast	Lower	Upper
January	10.8028	5.8809	15.7247
February	8.5736	3.4401	13.707
March	9.7852	4.6264	14.9441
April	13.2907	8.1309	18.4504
May	12.9425	7.782	18.103
June	16.3516	11.1909	21.5122
July	8.8977	3.7368	14.0586
August	8.3709	3.2098	13.532
September	8.4305	3.2692	13.5918
October	7.8412	2.6797	13.0027
November	6.8772	1.7155	12.0389
December	25.2346	20.0727	30.3965

The accuracy of the models developed in this section has been compared to the Holt-Winters model in section 4.5 to determine the model's suitability for forecasting value.

4.4.1.3 The Application of ARIMA models in Pusat Pungutan Zakat (PPZ)



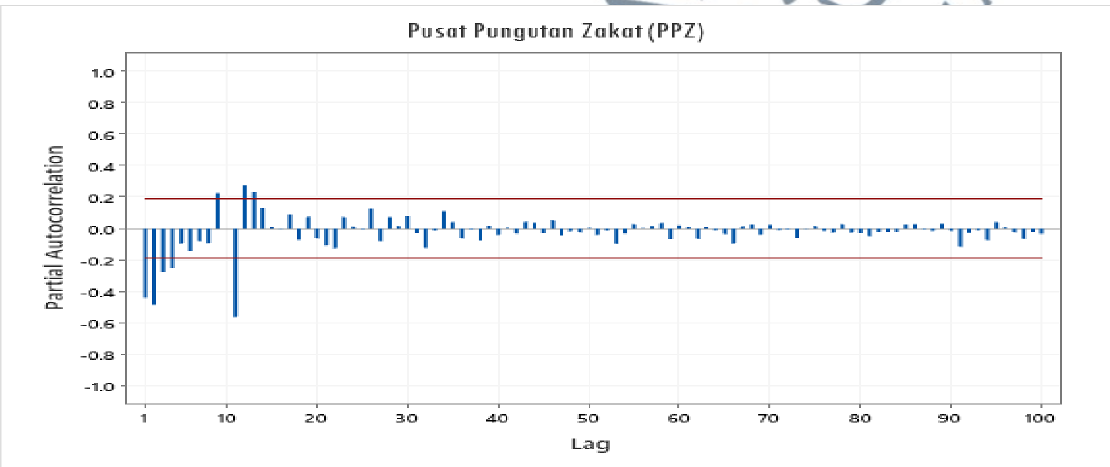
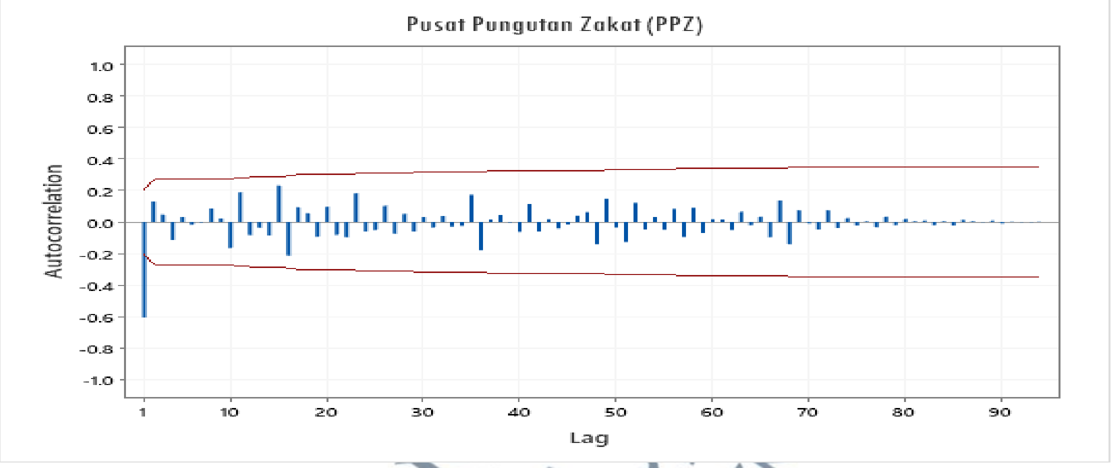


Figure 4.13: ACF and PACF plots after difference at lag 1

Figure 4.13 shows the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF) for a stationary time series, respectively. There is a significant positive spike in the ACF plot lags 12 and 24. Initial assumption can be taken as q = 1 and d = 1 of ARIMA(p,d,q) since ACF cuts after lag 1 while the PCF shows a slowly decreasing trend. For the value of p, we had to test for all possible values of p = 1 or 2 to get the model parameters. The Partial Autocorrelation Function (PACF) shows a decay pattern because it has just cut off at the eighth lag. But in lag 12 there was a significant spike. Likewise, for lag 24. This means that we can conclude that there is a seasonal occurrence with a repeating pattern of 12 lags. There was a need to include a first-lag difference term in the Seasonal Autoregressive Integrated Moving Average (SARIMA) model structure (d = 1) as presented in Figure 4.14. Next, the series is differencing at lag 12 and the ACF and PACF plots are also inspected.



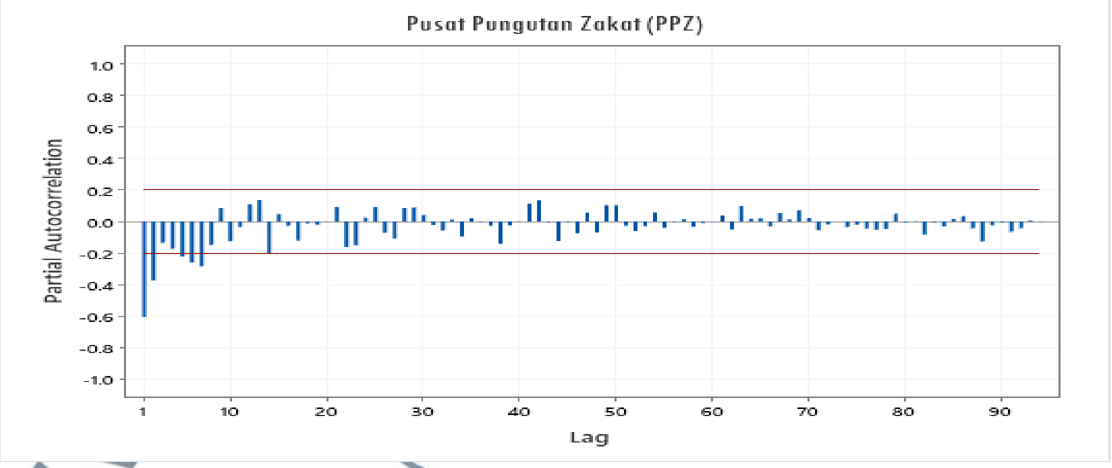


Figure 4.14: ACF and PACF plots after difference at lag 12

In figure 4.14, there is a significant negative spike in the ACF plot at lag 1. In the PACF plot, there are significant negative spikes at lags 1 and 2 (lags are slower to decay). These characteristics a potential parameter starting point of SARIMA (0,1,1) $(0,1,0)_{12}$.

All the coefficients of the estimated model are highly significant because p-values are less than 0.05 (see Appendix D). It is standard practice to use the coefficient p-values to decide whether to include variables in the final model. If the p-value is higher than 0.05 then predictor variables are not statistically significant and it can reduce the model's precision (Erlina & Azhar, 2020). Also, comparing five different combinations of p, d, q and P, D, Q of SARIMA model with a p-value less than 0.05 as presented in Table 4.6. Among the models, SARIMA (0,1,1) $(0,1,1)_{12}$ was selected as the best model with the lowest mean square error (MSE) value obtained is 63 and p-value (L Jung-Box) is 0.331. Ljung-Box test > 0.05 suggested that there was no significant autocorrelation between residuals at different lag times and the residuals were white noise (Lwesya & Kibambila, 2017). This was further corroborated by plotting the ACF and PACF of the residuals as presented in Figure 4.15.

Table 4.6: Comparison of In-Sample Forecasting Accuracy Summary for PPZ

No	**Model**	***p-value***				**MSE**	**P-Value at Lag 12 (Ljung Box)**
		AR	SAR	MA	SMA		
1	$(0,1,1)(0,1,0)_{12}$	-	-	0.000	-	70	0.149
2	$(0,1,1)(0,1,1)_{12}$	-	-	0.000	0.000	63	0.331
3	$(1,1,0)(0,1,1)_{12}$	0.000	-	-	0.000	96	0.003

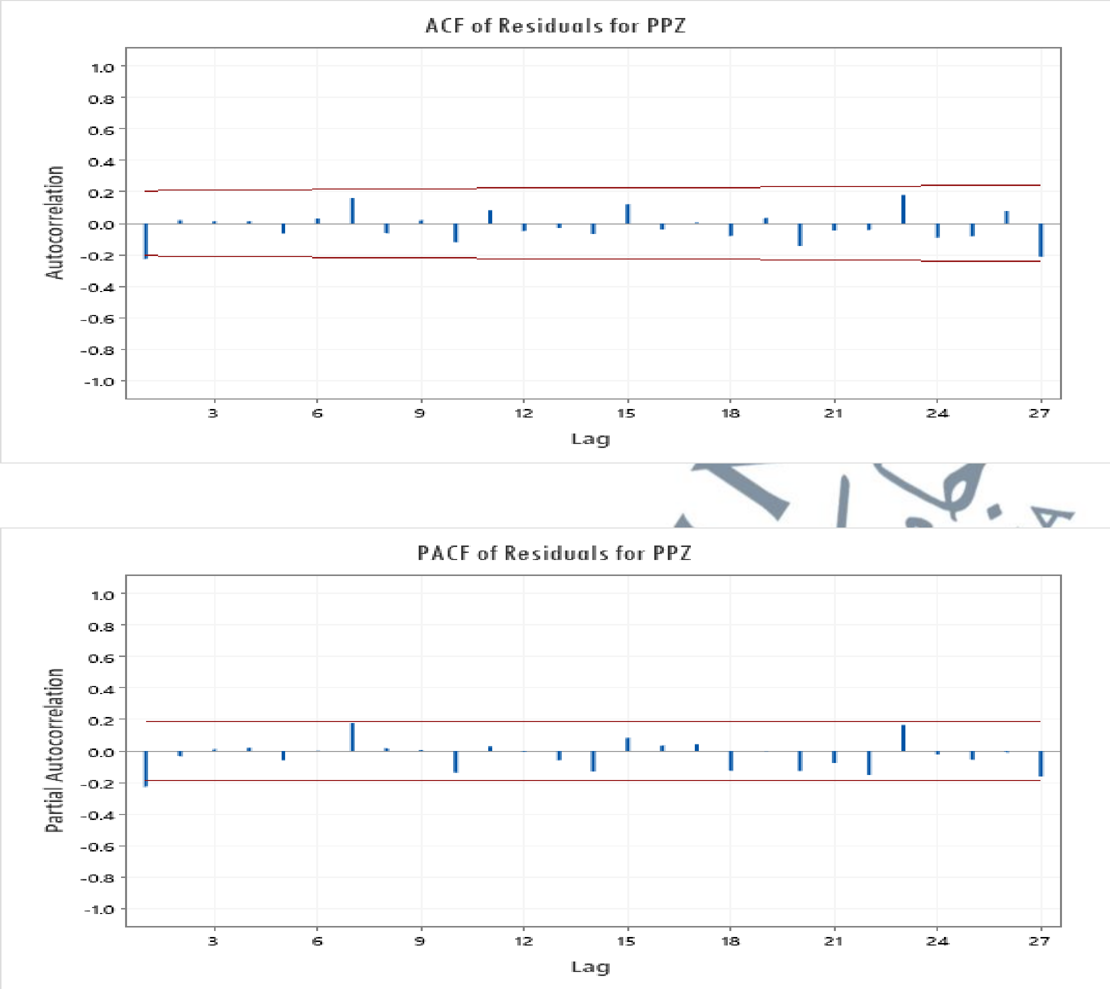


Figure 4.15: ACF and PACF of the residual of SARIMA (0,1,1)(0,1,1)12

The SARIMA model was constructed using in-sample data collected between January 2010 until December 2018 and was verified using out-of-sample data collected from January to June 2019. The validity of the model was tested and used to forecast the monthly zakat collection of PPZ in 2019 as presented in Figure 4.16.

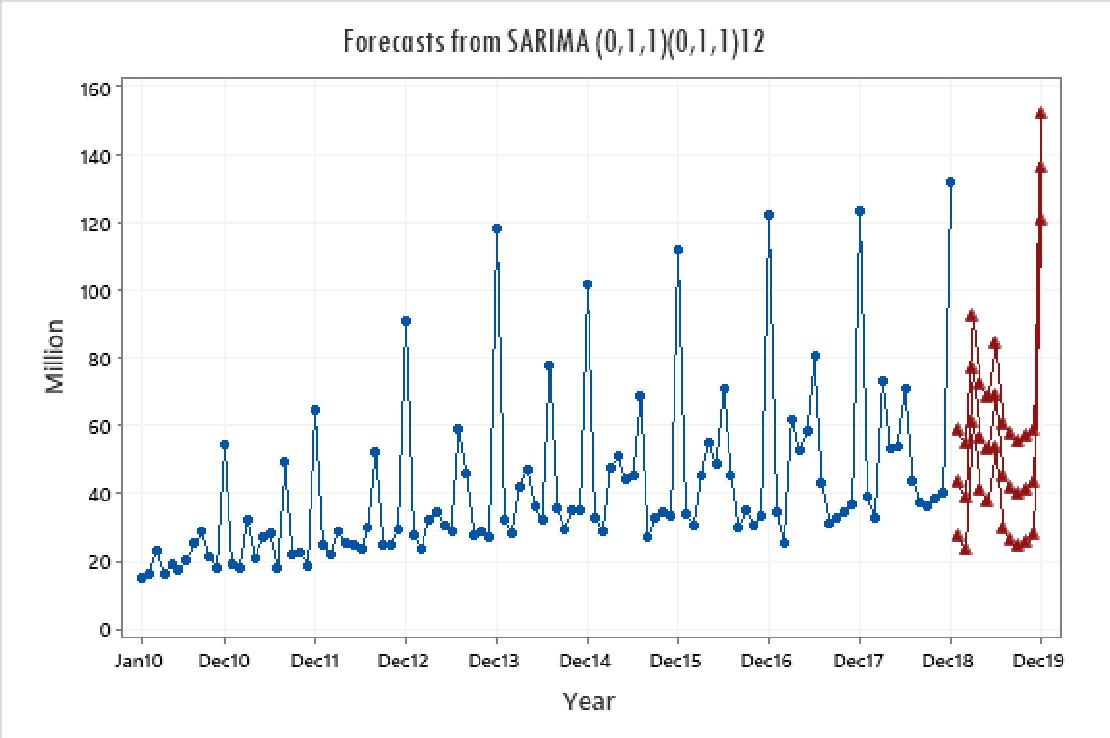


Figure 4.16: Forecast plot of monthly zakat collection in PPZ

One of the purposes of the fitting SARIMA model of data is to be able to forecast its future values. A twelve (12) months out-of-sample forecast results for model SARIMA (0,1,1)(0,1,1)12 from January 2019 to December 2019 period are presented in Table 4.7.

Table 4.7: Forecast Value of Monthly Zakat Collection in PPZ using SARIMA (0,1,1)(0,1,1)12

Period	Forecast	Lower	Upper
January	42.658	27.114	58.201
February	38.52	22.977	54.064
March	76.327	60.784	91.87
April	56.244	40.701	71.788
May	52.634	37.091	68.177
June	68.668	53.124	84.211
July	44.744	29.201	60.287
August	41.405	25.862	56.948
September	39.412	23.869	54.955
October	40.831	25.288	56.374
November	42.947	27.404	58.49
December	136.113	120.57	151.657

To determine the model's suitability for forecasting value, the accuracy of the models developed in this section has been compared to the Holt-Winters model in Section 4.5.

4.4.2 The Application of ARIMA models in Majlis Agama Islam dan Adat Melayu Perak (MAIPk)

For Majlis Agama Islam dan Adat Melayu Perak (MAIPk) only can be collected due to limited access to get monthly data. The 29 years data points were used to develop forecasting models for MAIPk zakat collection from 1991 to 2019 as presented in Figure 4.17 below. The figure shows a steady positive upward trend in MAIPk's yearly zakat collection. The observation is divided into two groups:

i. In-Sample data 1991 to 2014 (24 observations)

ii. Out-Of-Sample data 2015 to 2019 (5 observations)

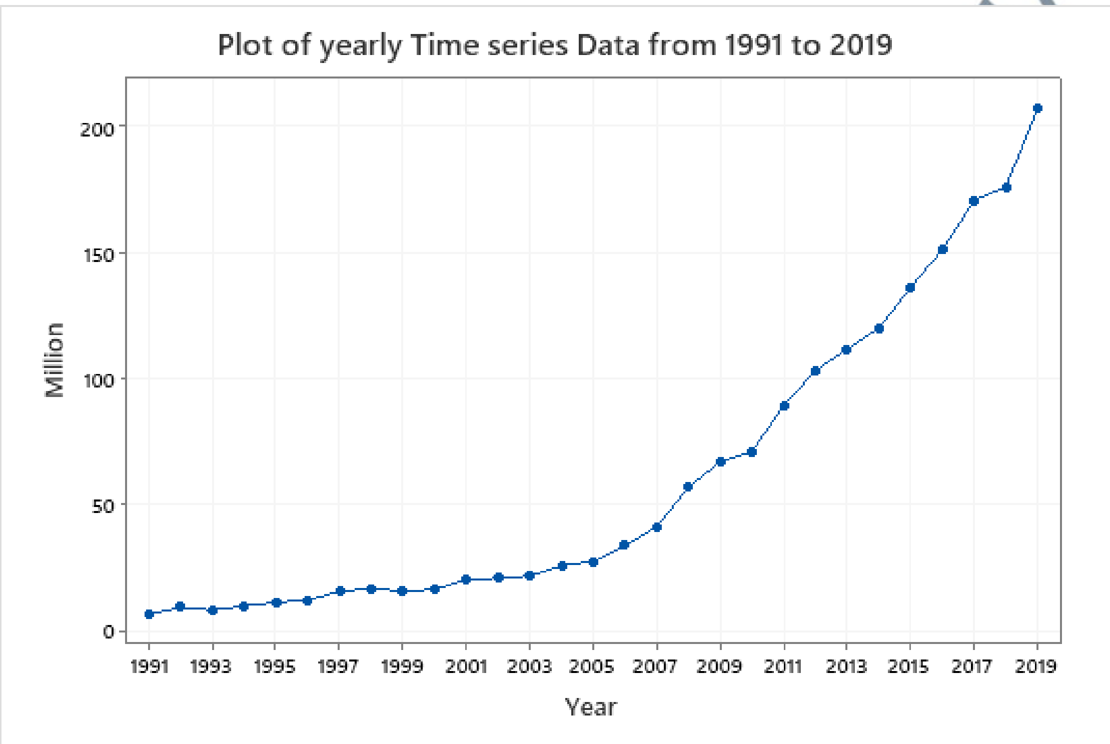


Figure 4.17: Yearly number of zakat collection for MAIPk

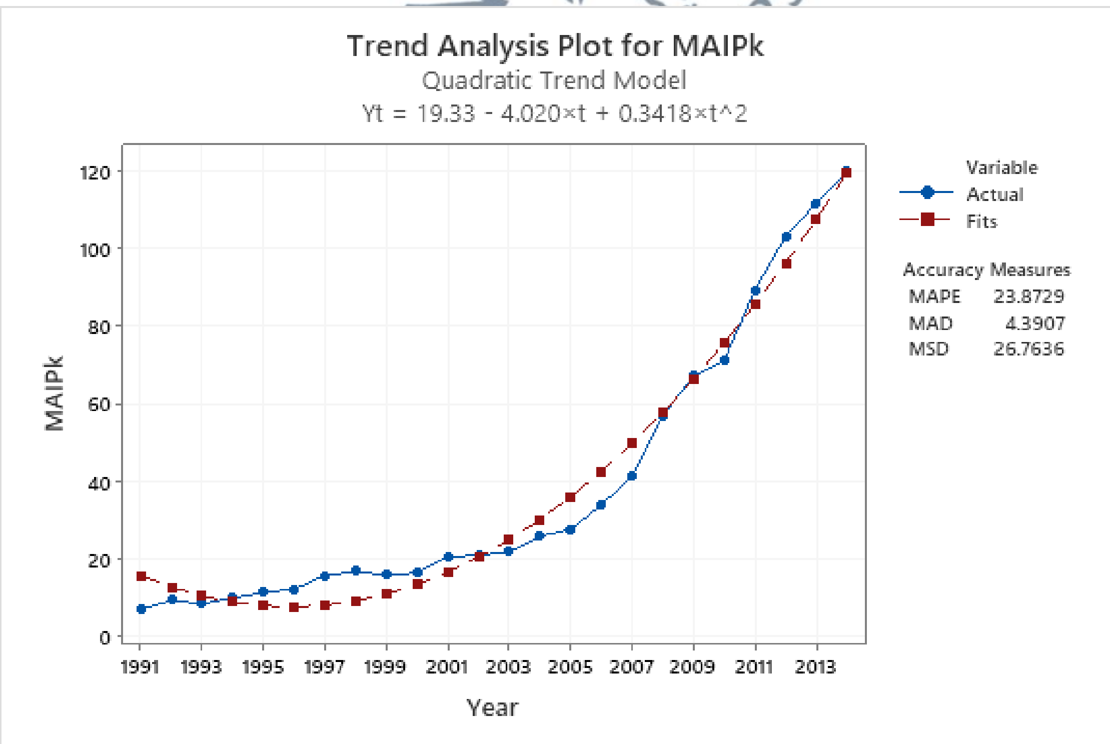
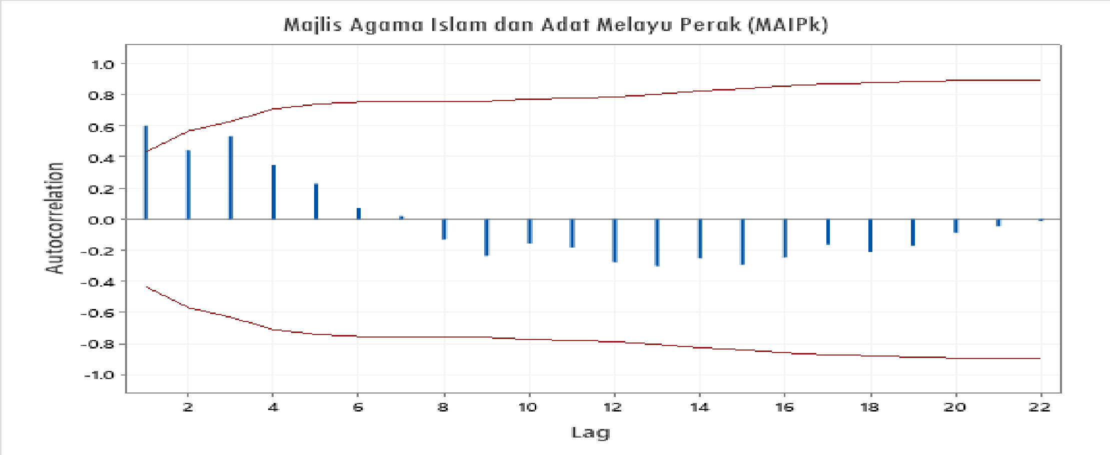


Figure 4.18: Trend analysis of zakat collection for MAIPk

Figure 4.18 shows the graph of trend analysis of MAIPk's zakat collection for 1991-2019 and it shows an increasing trend. Therefore, it has a no seasonal pattern and increased significantly during the study period.



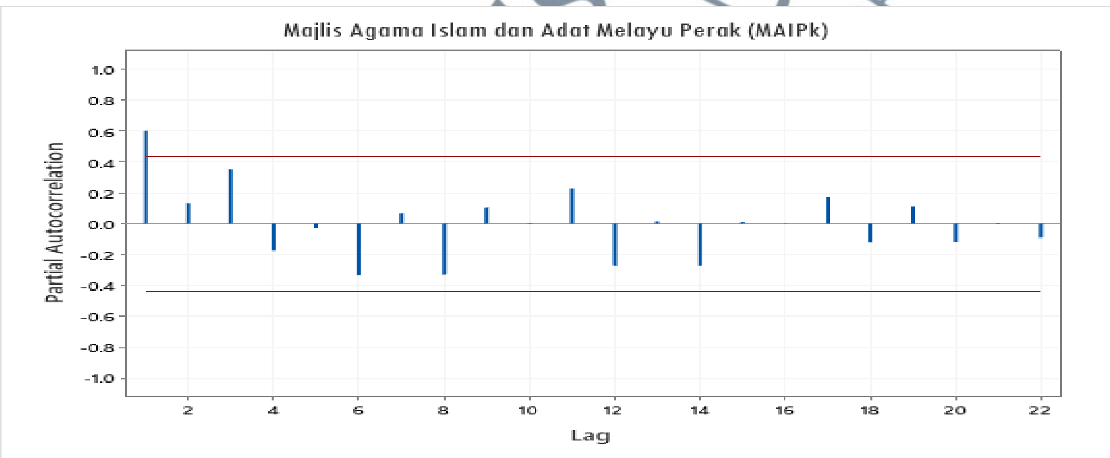


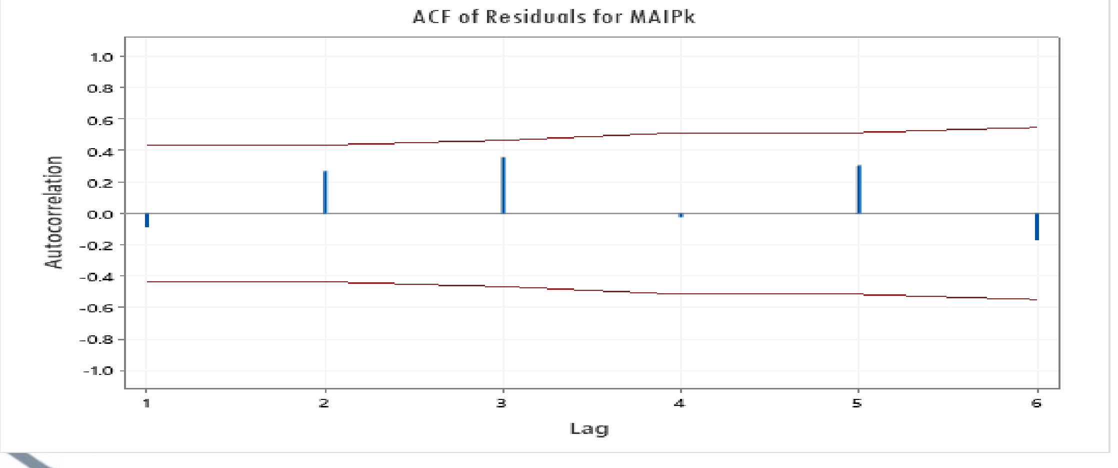
Figure 4.19: ACF and PACF plots after difference at lag 1

Figure 4.19 show the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF) for a stationary time series, respectively. There is one significant positive spike in the ACF and PACF plots. Therefore, for the value of p, d, and q of ARIMA(p,d,q), we had to test for possible values to get the model parameters.

All the coefficients of the estimated model are highly significant because p-values are less than 0.05 (see Appendix E). It is standard practice to use the coefficient p-values to decide whether to include variables in the final model. Also, comparing seven different combinations of p, d, q of ARIMA model with a p-value less than 0.05 as presented in Table 4.8. Among the models, ARIMA (0,1,1) was selected as the best model with the lowest Mean Square Error (MSE) value obtained is 17.6 and p-value (L Jung-Box) is 0.201. Ljung-Box test > 0.05 suggested that there was no significant autocorrelation between residuals at different lag times and the residuals were white noise (Lwesya & Kibambila, 2017). This was further corroborated by plotting the ACF and PACF of the residuals as presented in Figure 4.20.

Table 4.8: Comparison of In-Sample Forecasting Accuracy Summary for MAIPk

No	**Model**	***p-value***		**MSE**	**P-Value at Lag 12 (Ljung Box)**
		AR	MA		
1	(0,1,1)	-	0.000	17.6	0.201
2	(1,1,0)	0.002	-	18.8	0.434



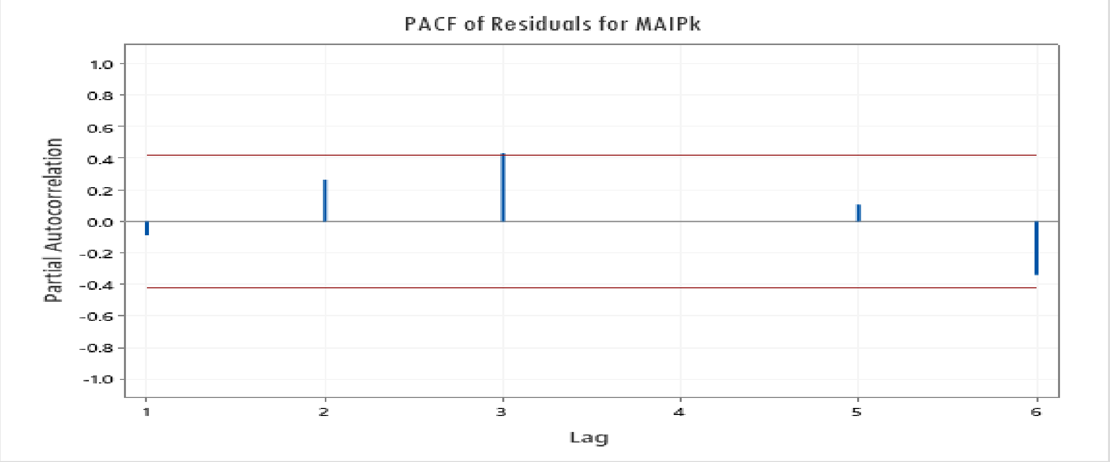


Figure 4.20: ACF and PACF of the residual of ARIMA(0,1,1)

The ARIMA model was constructed using in-sample data collected between 1991 until 2014 and was verified using out-of-sample data collected from 2015 to 2019. The validity of the model was tested and used to forecast the yearly zakat collection of MAIPk in 2019 as presented in Figure 4.21.

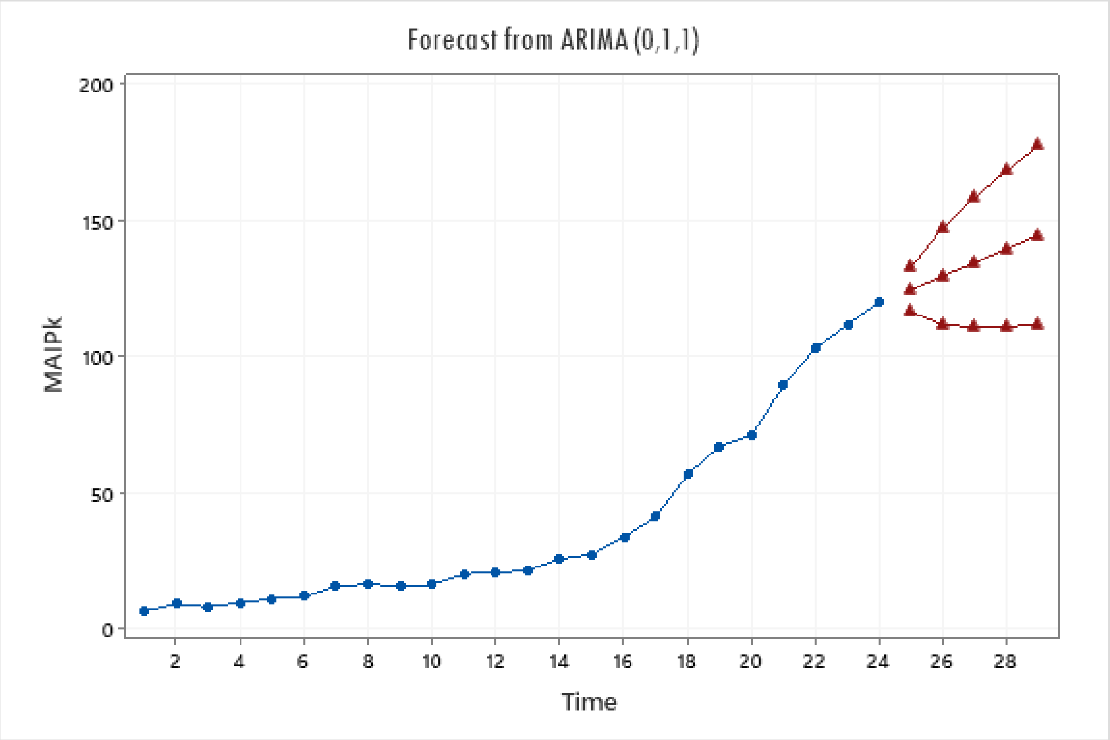


Figure 4.21: Forecast plot of yearly zakat collection in MAIPk

A five (5) years out-of-sample forecast results for model ARIMA (0,1,1) from 2015 to 2019 period are presented in Table 4.9.

Table 4.9: Forecast Value of 2015-2019 yearly Zakat Collection in MAIPk using ARIMA (0,1,1)

Period	Forecast	Lower	Upper
2015	124.656	116.439	132.873
2016	129.673	111.783	147.562
2017	134.690	110.761	158.618
2018	139.706	110.982	168.431
2019	144.723	111.896	177.550

The accuracy of the models developed in this section has been compared to the Holt-Winters model in Section 4.5 to determine the model's suitability for forecasting value.

4.4.3 The Application of Seasonal Holt-Winters model in Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS) and Pusat Pungutan Zakat (PPZ)

4.4.3.1 The Application of Seasonal Holt-Winters model in Lembaga Zakat Selangor (LZS)

The Holt-Winters setting assigned smoothing parameters of 0.1, 0.2, and 1.0. Excel solvers was used to determine the optimum values of smoothing the level parameter (α), the trend parameter (β), and the seasonal parameter (γ) constants to minimize the Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), and Mean Square Error (MSE) in the Holt-Winters (HW) smoothing exponential forecasting technique. The pattern in the data is obscured by the fact that it contains both a consistent seasonality pattern and some seasonal fluctuations as the series level increases in time. Therefore, both methods Multiplicative Holt-Winter (MHW) and Additive Holt-Winter (AHW) were applied and the one with smaller accuracy measures were selected (Razali et al., 2018).

The lowest MAPE and MAE values are Multiplicative models with smoothing parameters $\alpha = 0.2$, $\beta = 0.1$, $\gamma = 1.0$. The MAPE value is 32 % while MAE is 13 values, all these three numbers are lower for MHW compared to AHW as presented in Table 4.10.

Table 4.10: Comparison of In-Sample Forecasting Accuracy Summary for LZS using Holt-Winters

Parameter	Multiplicative HW $\alpha = 0.2, \beta = 0.1, \gamma = 1.0$	Additive HW $\alpha = 0.2, \beta = 0.1, \gamma = 0.1$
MAPE	32	39
MAE	13	15
MSE	424	489

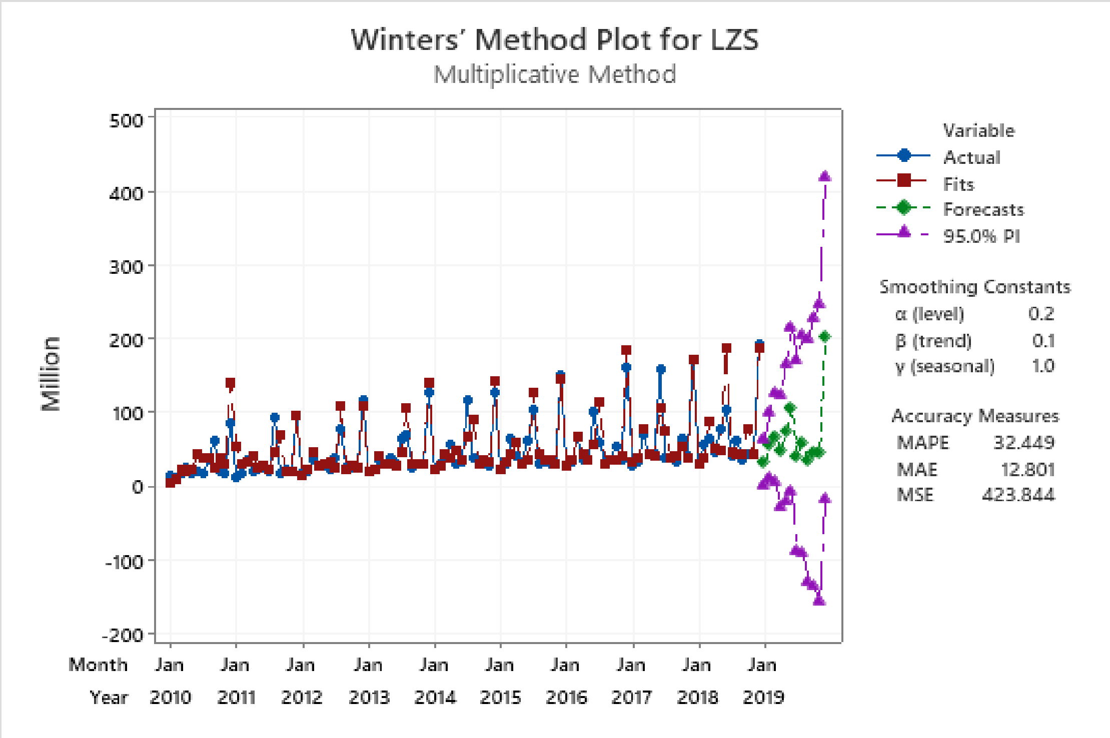


Figure 4.22: Multiplicative Holt-Winters Forecast when α = 0.2, β = 0.1, γ = 1.0

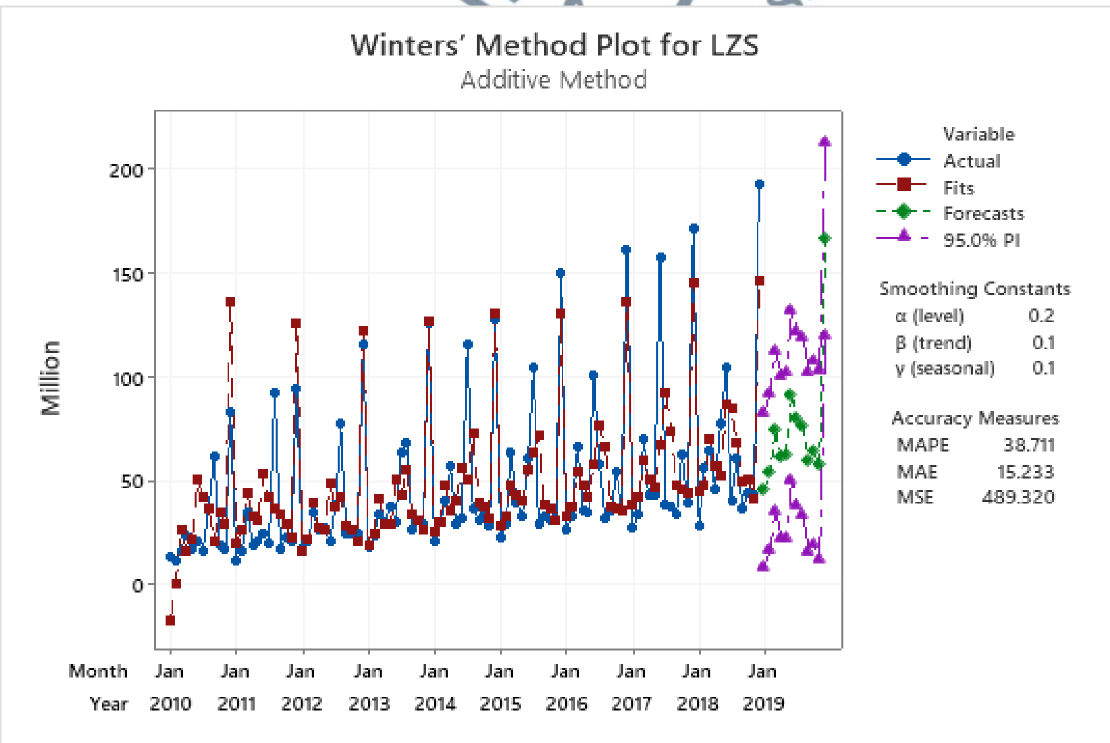


Figure 4.23: Additive Holt-Winters Forecast when α = 0.2, β = 0.1, γ = 0.1

Figure 4.22 displayed the Minitab output when $\alpha = 0.2$, $\beta = 0.1$, $\gamma = 1.0$ using the Multiplicative Holt-Winters (MHW) method and the fits are closely following the actual data. However, Figure 4.23 displayed the Minitab output when $\alpha = 0.2$, $\beta = 0.1$, $\gamma = 0.1$ using Additive Holt-Winters (AHW) method and the actual values are seeming quite different from fitted. Therefore, the MHW was used to predict a twelve (12) months out-of-sample from January 2019 to December 2019 of a zakat collection for Lembaga Zakat Selangor (LZS) are presented in Table 4.11.

Table 4.11: Forecast Value of 2019 Monthly Zakat Collection of LZS using MHW, when $\alpha = 0.2$, $\beta = 0.1$, $\gamma = 1.0$

Period 2019	Forecast	Lower	Upper
January	31.5	0.139	62.861
February	55.456	11.105	99.807
March	66.714	6.662	126.766
April	48.162	-28.656	124.981
May	72.719	-21.364	166.802
June	105.167	-6.448	216.781
July	41.223	-88.082	170.528
August	57.104	-89.992	204.201
September	35.152	-129.804	200.108
October	46.12	-136.745	228.985
November	44.91	-155.899	245.719
December	201.685	-17.095	420.464

4.4.3.2 The Application of Seasonal Holt-Winters model in Pusat Zakat Negeri Sembilan (PZNS)

The Holt-Winters setting assigned smoothing parameters of 0.1, 0.2, and 0.7. Excel solvers was used to determining the optimum values of smoothing the level parameter (α), the trend parameter (β), and the seasonal parameter (γ) constants to minimize the Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), and Mean Square Error (MSE) in the Holt-Winters (HW) smoothing exponential forecasting technique. The pattern in the data is obscured by the fact that it contains both a consistent seasonality pattern and some seasonal fluctuations as the series level increases in time. Therefore, both methods Multiplicative Holt-Winter (MHW) and Additive Holt-Winter (AHW) were applied and the one with smaller accuracy measures were selected (Razali et al., 2018).

The lowest MAPE and MAE values are Additive models with smoothing parameters $\alpha = 0.1$, $\beta = 0.1$, $\gamma = 0.7$. The MAPE value is 31 % while MAE is 1.9 values, all these three numbers are lower for AHW compared to MHW as presented in Table 4.12.

Table 4.12: Comparison of In-Sample Forecasting Accuracy Summary for PZNS using Holt-Winters

Parameter	Multiplicative HW $\alpha = 0.1, \beta = 0.2, \gamma = 0.7$	Additive HW $\alpha = 0.1, \beta = 0.1, \gamma = 0.7$
MAPE	32	31
MAE	2	1.9
MSE	9	8

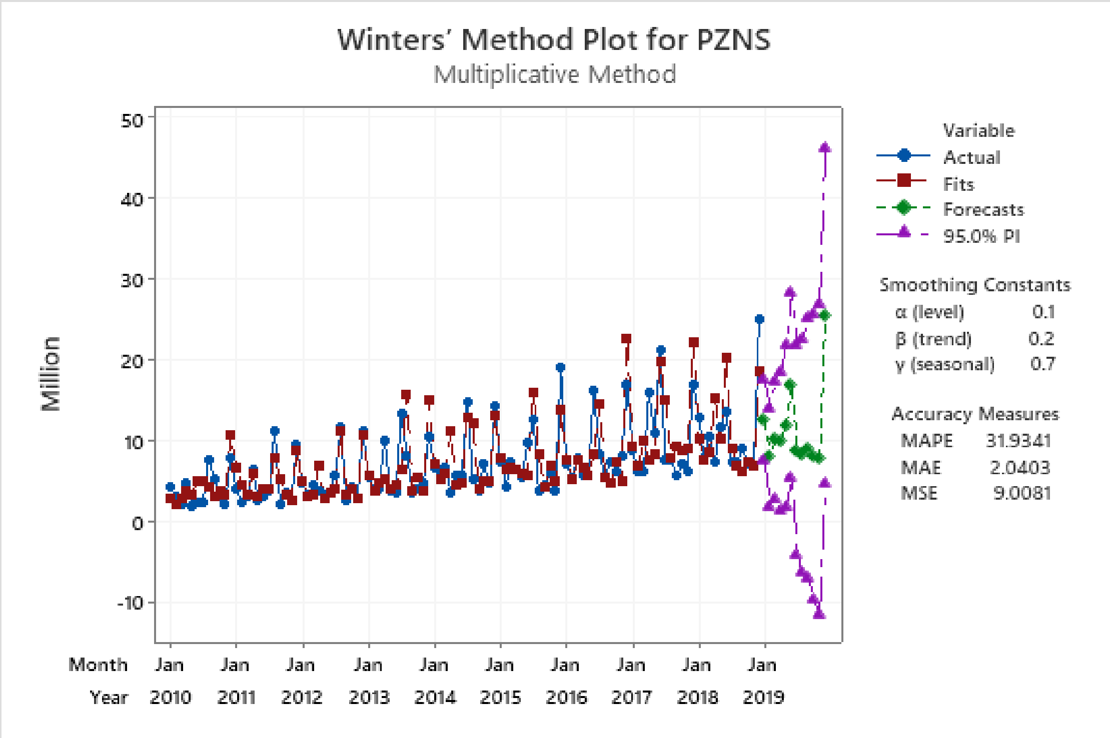


Figure 4.24: Multiplicative Holt-Winters Forecast when α = 0.1, β = 0.2, γ = 0.7

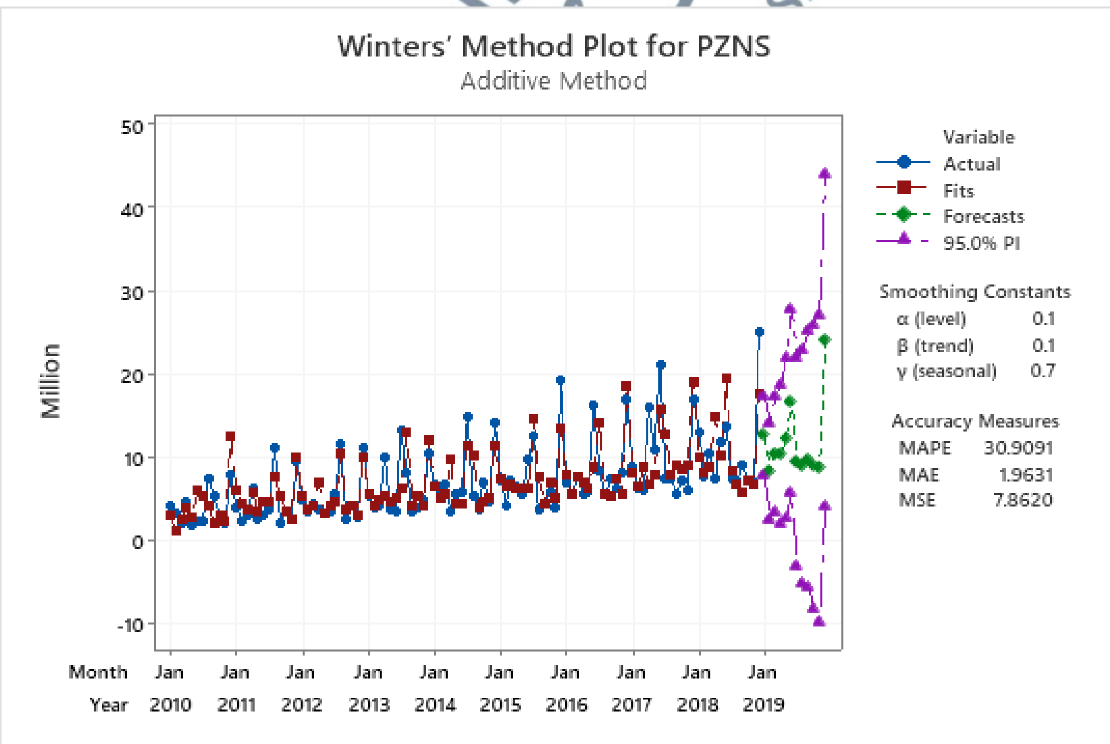


Figure 4.25: Additive Holt-Winters Forecast when α = 0.1, β = 0.1, γ = 0.7

Figure 4.24 displayed the Minitab output when α = 0.1, β = 0.2, γ = 0.7 using the Multiplicative Holt-Winters (MHW) method and the actual values are seeming quite different from fitted. However, Figure 4.25 displayed the Minitab output when α = 0.1, β = 0.1, γ = 0.7 using Additive Holt-Winters (AHW) method and the fits is closely following the actual data. Therefore, the AHW was used to predict a twelve (12) months out-of-sample from January 2019 to December 2019 of zakat collection for Pusat Zakat Negeri Sembilan (PZNS) are presented in Table 4.13.

Table 4.13: Forecast Value of 2019 Monthly Zakat Collection of PZNS using AHW, when α = 0.1, β = 0.1, γ = 0.7

Period 2019	Forecast	Lower	Upper
January	12.6417	7.83215	17.4511
February	8.3565	2.57415	14.1388
March	10.385	3.41736	17.3526
April	10.4255	2.15093	18.7001
May	12.3208	2.66687	21.9747
June	16.7918	5.71316	27.8704
July	9.4069	-3.12637	21.9401
August	8.9648	-5.04371	22.9732
September	9.7925	-5.70587	25.291
October	8.9274	-8.07182	25.9266
November	8.696	-9.81223	27.2042
December	24.1472	4.12363	44.1707

4.4.3.3 The Application of Seasonal Holt-Winters model in Pusat Pungutan Zakat (PPZ)

The Holt-Winters setting assigned smoothing parameters of 0.2, 0.3, and 0.9. Excel solvers was used to determining the optimum values of smoothing the level parameter (α), the trend parameter (β), and the seasonal parameter (γ) constants to minimize the Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), and Mean Square Error (MSE) in the Holt-Winters (HW) smoothing exponential forecasting technique. The pattern in the data is obscured by the fact that it contains both a consistent seasonality pattern and some seasonal fluctuations as the series level increases in time. Therefore, both methods Multiplicative Holt-Winter (MHW) and Additive Holt-Winter (AHW) were applied and the one with smaller accuracy measures were selected (Razali et al., 2018).

The lowest MAPE and MAE values are Multiplicative models with smoothing parameters $\alpha = 0.2$, $\beta = 0.3$, $\gamma = 0.9$. The MAPE value is 19 % while MAE is 7 values, all these three numbers are lower for MHW compared to AHW as presented in Table 4.14.

Table 4.14: Comparison of In-Sample Forecasting Accuracy Summary for PPZ using Holt-Winters

Parameter	**Multiplicative HW** $\alpha = 0.2, \beta = 0.3, \gamma = 0.9$	**Additive HW** $\alpha = 0.2, \beta = 0.3, \gamma = 0.9$
MAPE	19	23
MAE	7	8
MSE	108	123

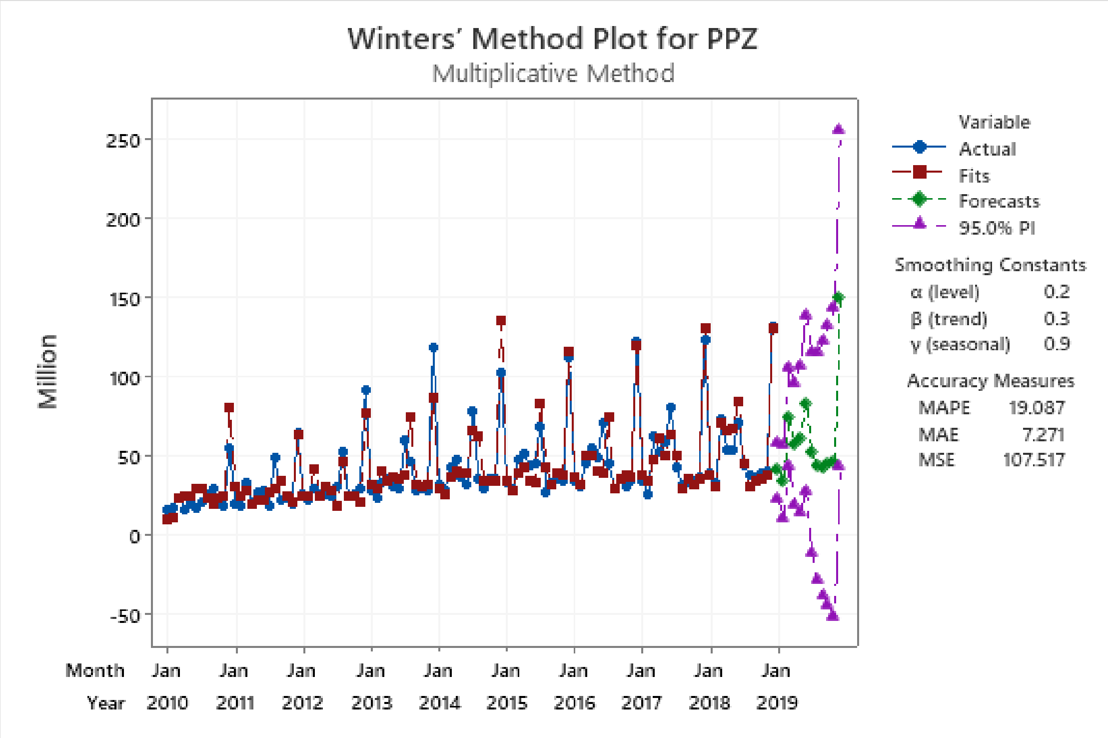


Figure 4.26: Multiplicative Holt-Winters Forecast when α = 0.2, β = 0.3, γ = 0.9

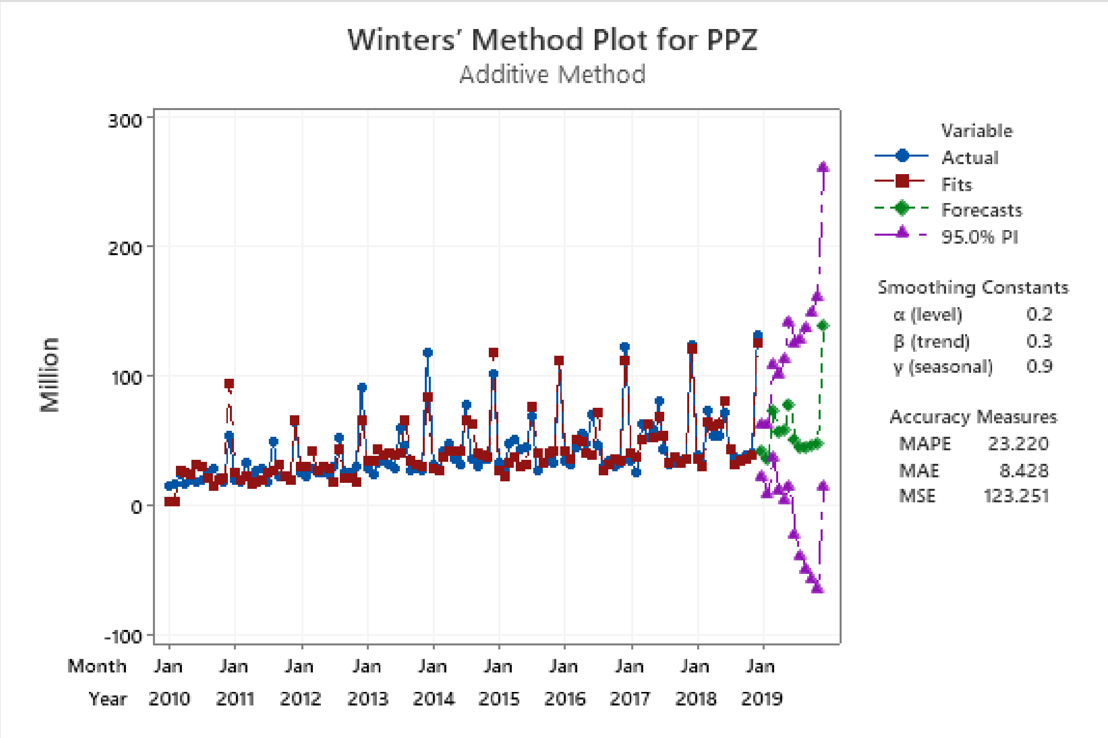


Figure 4.27: Additive Holt-Winters Forecast when α = 0.2, β = 0.3, γ = 0.9

Figure 4.26 displayed the Minitab output when α = 0.2, β = 0.3, γ = 0.9 using Multiplicative Holt-Winters (MHW) method and Figure 4.27 displayed the Minitab output when α = 0.2, β = 0.3, γ = 0.9 using Additive Holt-Winters (AHW) method, the fits for both are closely following the actual data. The MHW was used to predict a twelve (12) months out-of-sample from January 2019 to December 2019 of zakat collection for Pusat Pungutan Zakat (PPZ) is presented in Table 4.15.

Table 4.15: Forecast Value of 2019 Monthly Zakat Collection of PPZ using MHW, when α = 0.2, β = 0.3, γ = 0.9

Period 2019	Forecast	Lower	Upper
January	41.012	23.1976	58.827
February	33.802	10.0086	57.595
March	74.578	43.5276	105.629
April	57.478	18.6006	96.355
May	60.733	13.7442	107.723
June	83.252	27.9908	138.513
July	51.999	-11.6314	115.63
August	43.233	-28.8305	115.297
September	42.131	-38.4094	122.672
October	44.217	-44.8314	133.265
November	45.896	-51.6832	143.475
December	150.107	43.9789	256.234

4.4.4 The Application of Single Exponential Smoothing in Majlis Agama Islam dan Adat Melayu Perak (MAIPk)

The Single Exponential Smoothing (SES) setting assigned smoothing parameters of 1.0, 0.9, 0.8, and 0.7. The Trial-and-Error method was used to determine the optimum values of smoothing the level parameter (α) constants to minimize the

Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), and Mean Square Error (MSE) in the Single Exponential Smoothing forecasting technique.

The lowest MAPE and MAE values are SES models with smoothing parameter α = 1. The MAPE value is 14 while MAE is 5 values as presented in Table 4.16.

Table 4.16: Comparison of In-Sample Forecasting Accuracy Summary for MAIPk using Single Exponential Smoothing

Parameter	**Single Exponential Smoothing (SES)**			
	α = 1	**α = 0.9**	**α = 0.8**	**α = 0.7**
MAPE	14	14.7	15	17
MAE	5	5.4	6	6.7
MSE	50	59	71	88

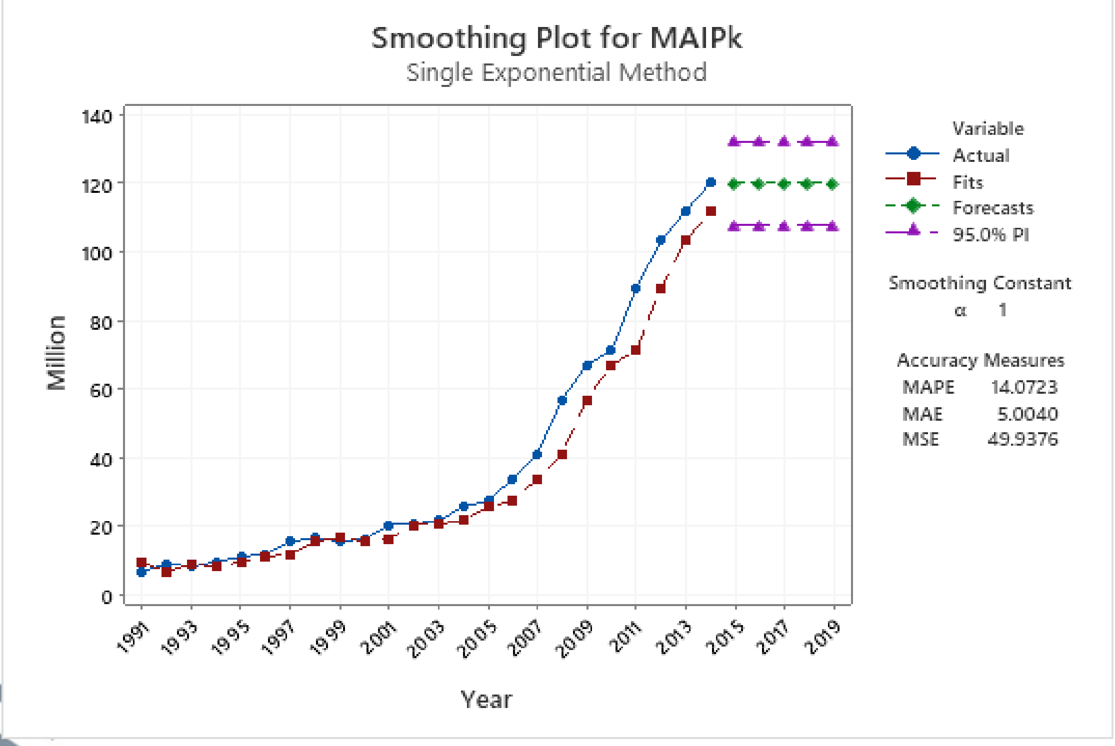


Figure 4.28: Single Exponential Smoothing when α = 1

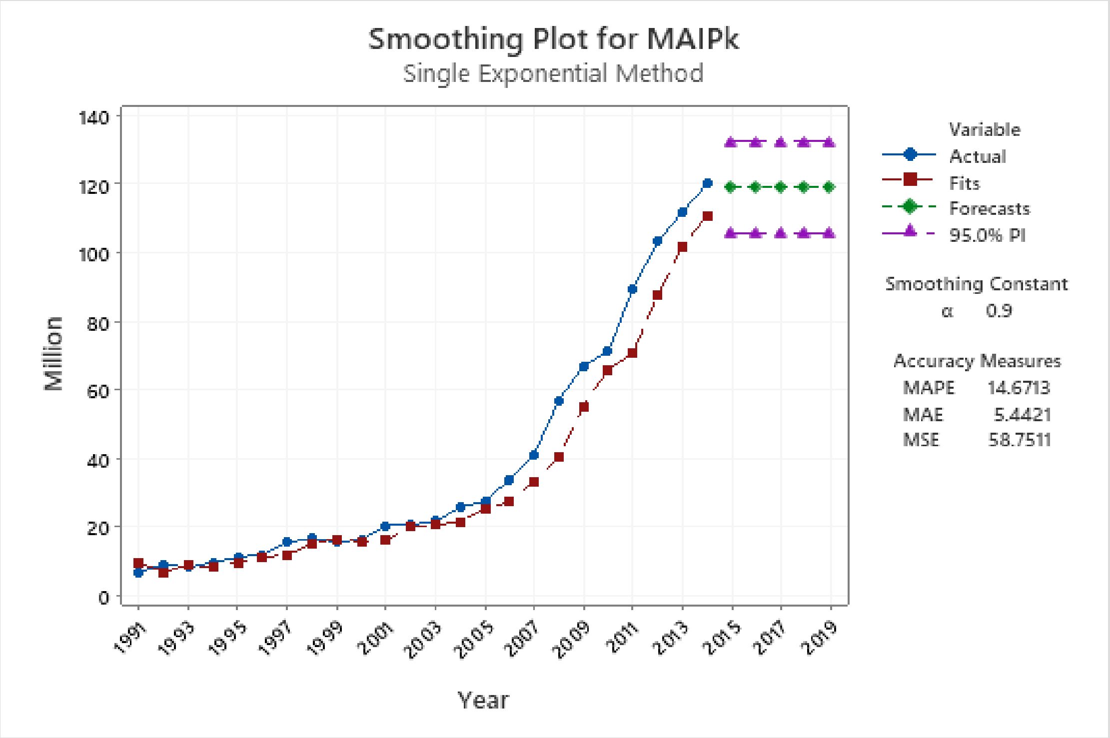


Figure 4.29: Single Exponential Smoothing when α = 0.9

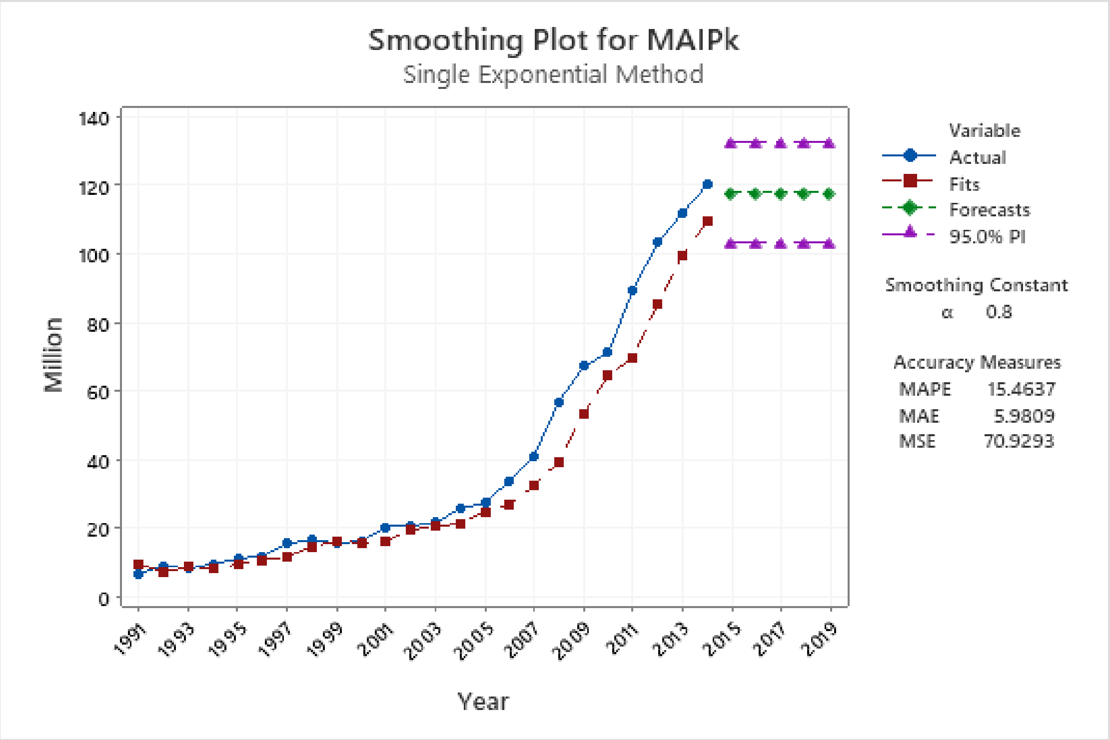


Figure 4.30: Single Exponential Smoothing when α = 0.8

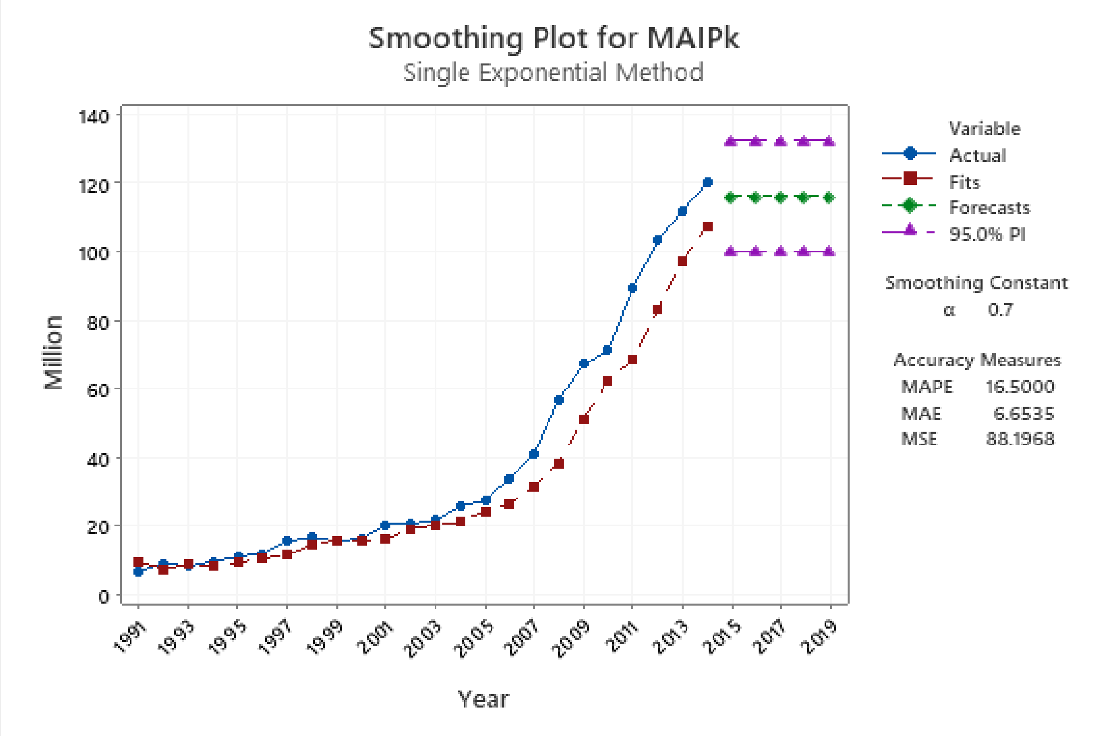


Figure 4.31: Single Exponential Smoothing when α = 0.7

Figure 4.28-4.31 displayed the Minitab output when α = 1, α = 0.9, α = 0.8 and α = 0.7. The Single Exponential Smoothing (SES) with smoothing parameter α = 1 is the lowest MAPE and MAE results of 14 % and 5 % respectively. Figure 4.28-4.29 shows the fits is closely following the actual data. However, Figure 4.30-4.31 displayed the Minitab output when α = 0.8 and 0.7 and the actual values are seeming quite different from fitted. Therefore, the SES with smoothing parameter α = 1 was used to predict a twelve (5) years out-of-sample from 2015 to 2019 of zakat collection for Majlis Agama Islam dan Adat Melayu Perak (MAIPk) are presented in Table 4.17.

Table 4.17: Forecast Value of SES when α = 1

Period 2019	Forecast	Lower	Upper
2015	120.041	107.781	132.3
2016	120.041	107.781	132.3
2017	120.041	107.781	132.3
2018	120.041	107.781	132.3
2019	120.041	107.781	132.3

4.5 Forecasting Accuracy Measurement in the Out-of-Sample Data

4.5.1 Forecasting Accuracy Measurement in the Out-of-Sample Data for Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS) and Pusat Pungutan Zakat (PPZ)

4.5.1.1 Out-of-Sample Forecast for Seasonal Autoregressive Integrated Moving Average (SARIMA)

The selected Seasonal-ARIMA models were then used to obtain an out-of-sample forecast for the zakat collection for Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS), and Pusat Pungutan Zakat (PPZ) as presented in Table 4.18-4.20. A nine (12) month out-of-sample forecast results from each of the Seasonal-ARIMA models and the actual zakat collection of 2019 values (test set) for that period. Critical observation from the table indicates that almost all the five candidate models forecast the zakat collection with fewer error margins. Yet, the MAE, RMSE, MAPE, and MASE were best used to assess the performances of each forecast model.

Table 4.18: Short-term Forecast of Selected Seasonal-ARIMA Models for LZS

Test Set		Out-of-Sample Forecast		
2019 Month	**Actual Data**	**ARIMA (1,1,1) (0,1,0)12**	**ARIMA (0,1,1) (0,1,0)12**	**ARIMA (0,1,2) (0,1,0)12**
January	34.42	28.30	32.09	28.72
February	37.88	64.46	59.37	59.88
March	65.69	69.52	67.95	68.47
April	73.90	52.40	49.35	49.88
May	113.53	83.74	81.23	81.77
June	67.78	110.36	107.58	108.12
July	45.98	46.18	43.46	44.01
August	57.47	66.55	63.75	64.31
September	40.24	42.47	39.65	40.21
October	48.39	50.10	47.23	47.80
November	43.24	48.86	45.96	46.53
December	226.62	199.07	196.13	196.71

Table 4.19: Short-term Forecast of Selected Seasonal-ARIMA Models for PZNS

Test Set		Out-of-Sample Forecast		
2019 Month	**Actual Data**	**ARIMA (1,1,1) (1,1,1)12**	**ARIMA (0,1,1) (0,1,0)12**	**ARIMA (0,1,1) (1,1,1)12**
January	8.70	10.80	13.51	13.21
February	7.15	8.57	8.34	7.97
March	7.46	9.79	11.08	10.13
April	14.56	13.29	7.92	13.19
May	21.08	12.94	12.33	13.05
June	9.73	16.35	14.21	16.40
July	7.75	8.90	7.93	8.98
August	6.52	8.37	7.82	8.46
September	4.89	8.43	9.54	8.59
October	11.12	7.84	7.72	7.89
November	9.15	6.88	7.49	7.21
December	28.46	25.23	25.62	25.54

Table 4.20: Short-term Forecast of Selected Seasonal-ARIMA Models for PPZ

Test Set		Out-of-Sample Forecast		
2019 Month	Actual Data	ARIMA (0,1,1) $(0,1,1)_{12}$	ARIMA (0,1,1) $(0,1,0)_{12}$	ARIMA (1,1,0) $(0,1,1)_{12}$
January	39.79	42.66	41.90	46.34
February	35.92	38.52	35.64	44.71
March	73.34	76.33	75.78	79.36
April	57.58	56.24	56.24	61.31
May	79.38	52.63	56.70	55.19
June	42.28	68.67	73.66	72.09
July	43.61	44.74	46.21	48.34
August	41.83	41.41	40.02	46.75
September	42.75	39.41	38.73	44.56
October	39.30	40.83	41.02	45.37
November	40.91	42.95	42.82	48.09
December	145.59	136.11	134.00	141.37

4.5.1.2 Out-of-Sample Forecast for Holt-Winters

Results from Table 4.21-4.23 give a nine (12) month out-of-sample forecast for the Multiplicative Holt-Winters and Additive Holt-Winters models for Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS), and Pusat Pungutan Zakat (PPZ). Table 4.21 shows the test set for LZS over 12 months. In terms of error margins, a comparison of the actual data (test set) and the forecast values reveals that the Multiplicative HW and Additive HW forecast values are good.

Table 4.22 presents the test set for the nine (12) month period for PZNS. A comparison between the actual data (test set) and the forecasts mostly reveals that the Additive HW and Multiplicative HW forecast values are not particularly accurate in terms of error margins.

Table 4.23 shows the test set for the 12-month period for PPZ. In terms of error margins, a comparison of the actual data (test set) and the forecast values reveals that the Multiplicative HW and Additive HW forecast values are not very accurate.

Meanwhile, the forecast accuracy of the Seasonal Additive HW and Seasonal Multiplicative HW for all zakat institutions was evaluated using three accuracy measure statistics: MAPE, MAE, and MSE

Table 4.21: Short-term forecast from the Holt-Winters Models for LZS

Test Set		**Out-of-Sample Forecast**	
2019 Month	**Actual Data**	**Multiplicative HW** $\alpha = 0.2, \beta = 0.1, \gamma = 1.0$	**Additive HW** $\alpha = 0.2, \beta = 0.1, \gamma = 0.1$
January	34.42	31.50	45.99
February	37.88	55.46	54.52
March	65.69	66.71	74.37
April	73.90	48.16	61.70
May	113.53	72.72	62.73
June	67.78	105.17	91.35
July	45.98	41.22	80.19
August	57.47	57.10	76.36
September	40.24	35.15	59.35
October	48.39	46.12	63.94
November	43.24	44.91	57.67
December	226.62	201.69	166.98

Table 4.22: Short-term forecast from the Holt-Winters Models for PZNS

Test Set		Out-of-Sample Forecast	
2019 Month	**Actual Data**	**Multiplicative HW** $\alpha = 0.1, \beta = 0.2, \gamma = 0.7$	**Additive HW** $\alpha = 0.1, \beta = 0.1, \gamma = 0.7$
January	8.70	12.56	12.64
February	7.15	7.93	8.36
March	7.46	10.08	10.39
April	14.56	10.04	10.43
May	21.08	11.94	12.32
June	9.73	16.90	16.79
July	7.75	8.85	9.41
August	6.52	8.18	8.96
September	4.89	9.07	9.79
October	11.12	8.07	8.93
November	9.15	7.74	8.70
December	28.46	25.47	24.15

Table 4.23: Short-term forecast from the Holt-Winters Models for PPZ

Test Set		Out-of-Sample Forecast	
2019 Month	**Actual Data**	**Multiplicative HW** $\alpha = 0.2, \beta = 0.3, \gamma = 0.9$	**Additive HW** $\alpha = 0.2, \beta = 0.3, \gamma = 0.9$
January	39.79	41.012	42.082
February	35.92	33.802	35.579
March	73.34	74.578	73.532
April	57.58	57.478	56.283
May	79.38	60.733	58.793
June	42.28	83.252	78.257
July	43.61	51.999	51.252
August	41.83	43.233	44.384
September	42.75	42.131	43.889
October	39.30	44.217	46.226
November	40.91	45.896	48.24
December	145.59	150.107	138.263

4.5.1.3 Comparison between SARIMA and Holt-Winters for Lembaga Zakat Selangor (LZS)

From Table 4.24, the out-of-sample forecast performances of the Seasonal-ARIMA models and that of the Holt-Winters were ranked using accuracy measure statistics: MSE. The best model for obtaining a much more accurate short-term out-of-sample forecast for Lembaga Zakat Selangor (LZS) of zakat collection was determined to be ARIMA(0,1,1)(0,1,0)$_{12}$. This was followed by ARIMA(0,1,2)(0,1,0)$_{12}$, Multiplicative Holt-Winters (MHW) model, ARIMA(0,1,1)(0,1,0)$_{12}$, and ARIMA(1,1,1)(0,1,0)$_{12}$ in the accuracy measure order respectively. The last ranked model was the Additive Holt-Winters (AHW). From the rankings, it is clear that the selected ARIMA(0,1,1)(0,1,0)$_{12}$ model forecast PZNS zakat collection with greater certainty compare to other Seasonal-ARIMA models and the two Holt-Winters models.

Table 4.24: Comparison of Out-of-Sample Forecasting Accuracy Summary for LZS

Summary of Accuracy Measurement Statistics					
Forecasting Models		**MAE**	**MSE**	**RMSE**	**MAPE**
Seasonal-ARIMA Models	ARIMA (1,1,1) (0,1,0)$_{12}$	14.73	400.16	20.00	21.87
	ARIMA (0,1,1) (0,1,0)$_{12}$	13.87	390.51	19.76	18.94
	ARIMA (0,1,2) (0,1,0)$_{12}$	14.10	391.13	19.78	19.76
Holt-Winters	Seasonal Multiplicative	13.71	393.57	19.84	18.80
	Seasonal Additive	23.77	805.87	28.39	36.11

4.5.1.4 Comparison between SARIMA and Holt-Winters for Pusat Zakat Negeri Sembilan (PZNS)

The out-of-sample forecast performances of the Seasonal-ARIMA models and the Holt-Winters models were ranked using accuracy measure statistics: MAE, MSE, RMSE, and MAPE, as shown in Table 4.25. The ARIMA(1,1,1)(1,1,1)$_{12}$ model was chosen as the best model for obtaining a much more accurate short-term out-of-sample forecast for Pusat Zakat Negeri Sembilan (PZNS) of zakat collection. This was followed by ARIMA(0,1,1)(1,1,1)$_{12}$, Multiplicative Holt-Winters (MHW) and ARIMA(0,1,1)(0,1,0)$_{12}$ and in the accuracy measure order respectively. The last ranked model was Additive Holt-Winters (MHW). From the rankings, it is clear that the selected ARIMA(1,1,1)(1,1,1)$_{12}$ model forecast PZNS zakat collection with greater precision, compared to other Seasonal-ARIMA models and the two Holt-Winters models.

Table 4.25: Comparison of Out-of-Sample Forecasting Accuracy Summary for PZNS

Summary of Accuracy Measurement Statistics					
Forecasting Models		**MAE**	**MSE**	**RMSE**	**MAPE**
Seasonal-ARIMA Models	ARIMA (1,1,1) (1,1,1)$_{12}$	3.10	13.93	3.73	30.98
	ARIMA (0,1,1) (0,1,0)$_{12}$	3.63	18.68	4.32	35.79
	ARIMA (0,1,1) (1,1,1)$_{12}$	3.25	15.05	3.88	33.06
Holt-Winters	Seasonal Multiplicative	3.54	18.29	4.28	34.75
	Seasonal Additive	3.67	18.79	4.33	36.90

4.5.1.5 Comparison between SARIMA and Holt-Winters for Pusat Pungutan Zakat (PPZ)

The accuracy measure statistics MAE, MSE, RMSE, and MAPE were used to rank the out-of-sample forecast performances of the Seasonal-ARIMA and Holt-Winters models in Table 4.26. The ARIMA(0,1,1)(0,1,1)12 model was shown to be the best model for getting a substantially more accurate short-term out-of-sample forecast for Pusat Pungutan Zakat (PPZ) of zakat collection. This was followed by ARIMA(0,1,1)(0,1,0)12, ARIMA(1,1,0)(0,1,0)12, and Additive Holt-Winters (MHW) in the accuracy measure order respectively. The last ranked model was the Multiplicative Holt-Winters (MHW). From the rankings, it is clear that the selected ARIMA(0,1,1)(0,1,1)12 model forecast PPZ zakat collection with greater reliability, compared to other Seasonal-ARIMA models and the two Holt-Winters models.

Table 4.26: Comparison of Out-of-Sample Forecasting Accuracy Summary for PPZ

Summary of Accuracy Measurement Statistics					
Forecasting Models		**MAE**	**MSE**	**RMSE**	**MAPE**
Seasonal-ARIMA Models	ARIMA (0,1,1) (0,1,1)12	6.74	128.85	11.35	11.98
	ARIMA (0,1,1) (0,1,0)12	6.99	139.86	11.83	12.60
	ARIMA (1,1,0) (0,1,0)12	9.00	149.99	12.25	18.28
Holt-Winters	Seasonal Multiplicative	7.43	181.34	13.47	15.26
	Seasonal Additive	7.80	162.24	12.74	15.59

Table 4.27 shows the comparison between In-Sample and Out-of-Sample forecasting accuracy summary for LSZ, PZNS, and PPZ. Based on the in-sample, the ARIMA(1,1,1)(0,1,0)12 model has an MSE value of 254 that is lower than other methods for LZS. According to in-sample and out-of-sample error accuracy measurement, the ARIMA(1,1,1)(1,1,1)12 and the ARIMA(0,1,1)(0,1,1)12 models have been chosen as the best model to forecast zakat collection in PZNS and PPZ respectively. Since the MSE value is minimized

Table 4.27: Comparison of In-Sample and Out-of-Sample Forecasting Accuracy Summary for LZS, PZNS, and PPZ

No	**Zakat Institution**	**In-sample**			
		SARIMA	**MSE**	**Holt-Winters**	**MSE**
1	LZS	(1,1,1)(0,1,0)12	254	Multiplicative α = 0.2, β = 0.1, γ= 1.0	424
2	PZNS	(1,1,1)(1,1,1)12	6.3	Additive HW α = 0.1, β = 0.1, γ = 0.7	8
3	PPZ	(0,1,1)(0,1,1)12	63	Multiplicative α = 0.2, β = 0.3, γ = 0.9	108
No	**Zakat Institution**	**Out-of-Sample**			
		SARIMA	**MSE**	**Holt-Winters**	**MSE**
1	LZS	(0,1,1) (0,1,0)12	391	Multiplicative α = 0.2, β = 0.1, γ = 1.0	394
2	PZNS	(1,1,1)(1,1,1)12	14	Multiplicative α = 0.1, β = 0.1, γ = 0.7	18
3	PPZ	(0,1,1)(0,1,1)12	129	Additive α = 0.2, β = 0.3, γ = 0.9	162

4.5.2 Forecasting Accuracy Measurement in the Out-of-Sample Data for Majlis Agama Islam dan Adat Melayu Perak (MAIPk)

The selected ARIMA models were then used to an obtain out-of-sample forecast for the zakat collection for Majlis Agama Islam dan Adat Melayu Perak (MAIPk) as presented in Table 4.28. A five (5) years out-of-sample forecast results from each of the ARIMA models and the actual zakat collection of 2015-2019 values (test set) for that period. Critical observation from the table indicates that almost all the five candidate models forecast the zakat collection with fewer error margins. Yet, the MAE, RMSE, MAPE, and MASE were best used to assess the performances of each forecast model.

Table 4.28: Short-Term Forecast of Selected Arima Models for MAIPk

Test Set		Out-of-Sample Forecast	
Year	**Actual Data**	**ARIMA (0,1,1)**	**ARIMA (1,1,0)**
2015	136.31	124.66	127.03
2016	151.18	129.67	133.25
2017	170.8	134.69	138.99
2018	176.25	139.71	144.45
2019	207.19	144.72	149.73

Results from Table 4.29 give a five (5) years out-of-sample forecast for the Single Exponential Smoothing (SES) models for Majlis Agama Islam dan Adat Melayu Perak (MAIPk). Table 4.29 presents the test set for the five (5) year period. A comparison between the actual data (test set) and the forecasts mainly shows that the forecast values from the Single Exponential Smoothing (SES) are good in terms of error margins. Meanwhile, the forecast accuracy of the SES model was later assessed using four accuracy measure statistics.

Table 4.29: Short-term forecast from the Single Exponential Smoothing Models for MAIPk

Test Set		Out-of-Sample Forecast			
Year	**Actual Data**	**Single Exponential Smoothing α = 1.0**	**Single Exponential Smoothing α = 0.9**	**Single Exponential Smoothing α = 0.8**	**Single Exponential Smoothing α = 0.7**
2015	136.305	120.04	119.12	117.91	116.26
2016	151.185	120.04	119.12	117.91	116.26
2017	170.805	120.04	119.12	117.91	116.26
2018	176.246	120.04	119.12	117.91	116.26
2019	207.187	120.04	119.12	117.91	116.26

4.5.2.1 Comparison between ARIMA and Holt-Winters for Majlis Agama Islam dan Adat Melayu Perak (MAIPk)

From Table 4.30, the out-of-sample forecast performances of the ARIMA models and the Single Exponential Smoothing (SES) were compared using accuracy measure statistics: MAE, MSE, RMSE, and MAPE. Unanimously, the best model for obtaining a much more accurate short-term out-of-sample forecast for Majlis Agama Islam dan Adat Melayu Perak (MAIPk) of zakat collection was determined to be ARIMA (0,2,1) model. This was followed by ARIMA (1,1,0), and ARIMA (0,1,1) in that order respectively. The last ranked models were the Single Exponential Smoothing (SES) models with parameters α = 1.0, α = 0.8, α = 0.9 and α = 0.7 respectively.

Table 4.30: Comparison of Out-of-Sample Forecasting Accuracy Summary for MAIPk

Summary of Accuracy Measurement Statistics					
Forecasting Models		MAE	MSE	RMSE	MAPE
	ARIMA (0,1,1)	33.66	1427.94	37.79	18.96
	ARIMA (1,1,0)	29.66	1146.53	33.86	16.61
Single Exponential Smoothing	α = 1.0	48.3	2912.98	53.97	27.24
	α = 0.9	51.52	3271.57	57.2	29.11
	α = 0.8	50.44	3123.4	55.89	28.53
	α = 0.7	52.09	3292.87	57.38	29.53

Table 4.31 shows the comparison between In-Sample and Out-of-Sample forecasting accuracy summary for MAIPk. According to in-sample and out-of-sample error accuracy measurement, the ARIMA(0,1,1) model has been chosen as the best model to forecast zakat collection in MAIPk because the MSE value is the lowest.

Table 4.31: Comparison of In-Sample and Out-of-Sample Forecasting Accuracy Summary for MAIPk

No	Zakat Institution	In-sample			
		ARIMA	MSE	SES	MSE
1	MAIPk	(0,1,1)	17.6	α = 1	50
No	**Zakat Institution**	**Out-of-Sample**			
		ARIMA	**MSE**	**SES**	**MSE**
1	MAIPk	(1,1,0)	1146.53	α = 1	2912.98

4.6 The Forecast for Zakat Collection

Table 4.32-4.34 display the prediction, monthly zakat collection data of fit model from January 2020 to December 2020 for Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS), and Pusat Pungutan Zakat (PPZ) using the Seasonal

Autoregression Integrated Moving Average (SARIMA) with 95% confidence interval. According to the MAE, MSE, RMSE, and MAPE value for both the 2010-2019 period and SARIMA model have more forecasting capacity, then Holt-Winters method were ARIMA (1,1,1) $(1,1,1)_{12}$ and ARIMA (0,1,1) $(0,1,1)_{12}$ can be chosen as the best model to forecast zakat collection in PZNS and PPZ respectively, since both models' MAE, MSE, RMSE and MAPE values are minimized. While the SARIMA model has more forecasting capacity, then Holt-Winters method was ARIMA (1,1,1) $(0,1,0)_{12}$ can be chosen as the best model to forecast zakat collection in LZS based on MSE. Since, all of MAE, MSE, RMSE, and MAPE values are minimized.

Table 4.32: The prediction zakat collection of fit models for the year 2020 for LZS

Period 2020	ARIMA (1,1,1) $(0,1,0)_{12}$		
	Forecast LZS	**Lower**	**Upper**
January	29,062,000	-3,168,000	61,292,000
February	47,013,000	12,799,000	81,227,000
March	69,457,000	34,920,000	103,994,000
April	79,667,000	45,106,000	114,227,000
May	118,562,000	83,989,000	153,136,000
June	73,100,000	38,526,000	107,673,000
July	51,196,000	16,620,000	85,773,000
August	62,731,000	28,154,000	97,308,000
September	45,502,000	10,923,000	80,082,000
October	53,662,000	19,081,000	88,243,000
November	48,513,000	13,931,000	83,095,000
December	231,908,000	197,324,000	266,492,000

Table 4.33: The prediction zakat collection of fit models for the year 2020 for PZNS

Period 2020	ARIMA (1,1,1) (1,1,1)12		
	Forecast PZNS	Lower	Upper
January	10,234,600	4,897,900	15,571,400
February	9,431,600	3,923,900	14,939,300
March	10,340,900	4,810,000	15,871,800
April	10,109,900	4,579,000	15,640,800
May	19,976,500	14,444,100	25,509,000
June	10,470,100	4,936,900	16,003,300
July	8,366,900	2,832,800	13,901,000
August	7,742,500	2,207,500	13,277,500
September	8,154,400	2,618,500	13,690,300
October	11,797,700	6,260,900	17,334,500
November	10,602,700	5,065,000	16,140,300
December	30,049,600	24,511,000	35,588,100

Table 4.34: The prediction zakat collection of fit models for the year 2020 for PPZ

Period 2020	ARIMA (0,1,1) (0,1,1)12		
	Forecast PPZ	Lower	Upper
January	41,544,000	25,035,000	58,053,000
February	37,770,000	21,261,000	54,279,000
March	74,977,000	58,468,000	91,486,000
April	60,877,000	44,368,000	77,386,000
May	92,357,000	75,848,000	108,866,000
June	34,864,000	18,354,000	51,373,000
July	45,859,000	29,350,000	62,368,000
August	44,676,000	28,167,000	61,185,000
September	46,687,000	30,178,000	63,196,000
October	41,326,000	24,817,000	57,836,000
November	42,723,000	26,214,000	59,233,000
December	151,804,000	135,295,000	168,314,000

Table 4.35 shows that the yearly prediction zakat collection data of fit model from 2020 to 2031 for Majlis Agama Islam dan Adat Melayu Perak (MAIPk) using the Autoregression Integrated Moving Average (ARIMA) and Single Exponential Smoothing (SES) models with 95% confidence interval. According to the MAE, MSE, RMSE, and MAPE value for the 2010-2019 period and ARIMA model has more forecasting capacity than the SES method. Therefore, ARIMA (0,1,1) was chosen to be the best model to forecast zakat collection in MAIPk. Since, all of MAE, MSE, RMSE, and MAPE values are minimized.

Table 4.35: The prediction zakat collection data of fit model for MAIPk

Year	ARIMA (0,1,1)		
	Forecast MAIPk	Lower	Upper
2020	222,720,000	208,157,000	237,284,000
2021	230,140,000	206,009,000	254,271,000
2022	237,559,000	206,696,000	268,422,000
2023	244,979,000	208,609,000	281,348,000
2024	252,398,000	211,253,000	293,544,000
2025	259,818,000	214,396,000	305,240,000
2026	267,237,000	217,908,000	316,567,000
2027	274,657,000	221,708,000	327,606,000
2028	282,076,000	225,740,000	338,413,000
2029	289,496,000	229,964,000	349,027,000
2030	296,915,000	234,351,000	359,479,000
2031	304,335,000	238,879,000	369,790,000

4.7 Conclusion

Using the best models from SARIMA(1,1,1) $(0,1,0)_{12}$, SARIMA(1,1,1) $(1,1,1)_{12}$, and SARIMA(0,1,1) $(0,1,1)_{12}$, the total forecasted value for LZS, PZNS and PPZ in 2020 is 1.77 billion. The forecasted value of the LZS yearly collection based on the fitted model is 910.4 million. For PZNS, the zakat collection for the year 2020 is projected to be 147.3 million. The zakat collection for PPZ is expected to be 715.5 million in 2020. While the total zakat collection for MAIPk is expected to increase between 222.7 million and 304.3 million from 2020 to 2031.

The best model to foresee the next period with software Minitab namely with the following equation:

LZS: $Y_t = 0.0093 - 0.3705\,Y_{t-1} + u_t + 0.9857\,u_{t-1}$ (3.24)

PZNS: $Y_t = 0.0093 - 0.2788\,Y_{t-1} - 0.9949\,Y_{t-12} + u_t + 0.9763\,u_{t-1} - 0.816\,u_{t-12}$ (3.25)

PPZ: $Y_t = -0.022 + u_t + 0.99767\,u_{t-1} - 0.384\,u_{t-12}$ (3.26)

MAIPk: $Y_t = 5.02 + u_t - 0.934\,u_{t-1}$ (3.27)