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UTILIZATION OF HOLT-WINTERS EXPONENTIAL SMOOTHING MODEL IN FORECASTING 2023 LZNK COLLECTION

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Abstract: *It is critically important to forecast zakat collection in Malaysian zakat organizations. We employ more precise statistical techniques to analyse the pattern of zakat collection since the forecast is crucial to understanding the issues with the fluctuations. Also, a precise zakat distribution budget allocation will be achieved along with the predetermined collections in the year. Focusing on the collection in LZNK, a seasonal trend for four quarters in a year is noticeable from 2016 to 2022. The seasonal forecasting with trend issue was considerable important. This study concentrates on the analysis of seasonal time series data using Holt-Winters exponential smoothing methods. Two models reviewed here are the Multiplicative Seasonal Model and the Additive Seasonal Model to forecast the quarterly 2023 zakat collections. The implementation of collections forecasting using Holt-Winters method in this study can make the prediction more accurate and efficient in the determination of the outcomes in 2023.*

Keywords: *Holt-Winters Multiplicative; Holt-Winters Additive; Forecasting; Zakat Collection Trend*

INTRODUCTION

Zakat institution has become prominent especially in Malaysia. Not all the Muslim countries have attained the title of developed nations, many developing countries, including all of them, have been striving for and adopting development plans to achieve sustainable economic development and raise their standard of life. Planning an effective education strategy to build and deliver human capital in accordance with national needs is one of the difficult undertakings. The Qur'an mentions both the command to pay zakat and to pray together up to 22 times. This demonstrates that zakat is a type of horizontal human interaction (Abdul Wahid et al., 2017). The higher the collection of zakat, the more asnafs will get their aids. The research on zakat has been increased year by year. However, the study on forecasting and its analysis on the collection of zakat was not getting adequate attention. This is crucial because the zakat institution might more efficiently allocate funds by using forecasting to predict the amount of zakat that will be collected. Additionally, being aware of the anticipated value of the zakat

collection beforehand can aid management in developing a more efficient plan for allocating zakat monies in accordance with the collection.

Research Background

Forecasting in a financial institution is not something new; various statistical methods have been implemented to generate the finest outcomes with the fewest errors encountered. Zakat collections in *LZNK* have shown an increase in the amount. From the quarterly collection, there are obvious trends and seasons in the plotted graph. The distribution of zakat in Kedah for the year 2022 is less than the collection. This means that there was a shortage in *LZNK* zakat distribution. This situation has raised a question on the importance of predicting the collection along with appropriate amount of the assistance in the state.

Research Objectives

The aim of this research is to use Holt-Winters model in predicting the zakat collections in *LZNK* of all four quarters in 2023. The objectives of the research are to construct a new time series from historical data of zakat collections in *LZNK*, to apply Multiplicative Seasonal Model and the Additive Seasonal Model to forecast the quarterly 2023 zakat collections, to obtain errors and optimal parameters of the model an to choose the most suitable model for the data.

LITERATURE REVIEW

Zakat is a word that refers to "blessing" (along with "development," "holiness," and "compassion"). The language element then said that zakat, or a percentage of a specified amount of income to be given to those who are deserving of it (musta'iq), is something that Allah requires. The fact that Zakat may grow a principal's wealth and protect it from numerous threats is what gives it its name (Qarḍawī, 1973). Muslims ought to comprehend the significance of paying zakat as it is a primary education topic. It has a significant impact on an impoverished country's economy. The Islamic economic principle of zakat has two purposes: first, as a form of prayer that benefits the giver, and second, as a system that benefits everyone in the surrounding community (Sakti, 2007). It is clear how significant Zakat is to Islam as it is referenced simultaneously with the mandate to pray up to 22 times in the Quran. Zakat is also a distinct and comprehensive system of redistribution (Rivai, 2013). Islamic zakat laws are quite explicit. Therefore, to institutionalize Zakat in the context of Islamic tenets, it must go from being a voluntary system to an obligatory one.

Factors Affecting Seasonality and Trend of Zakat Collection

There are factors affecting the payment of zakat. Ahmad et al. (2017) suggested that the dependent variable, which measures the zakat payer's intention to pay zakat through a zakat institution, is significantly impacted by the zakat payer's attitude, comprehension of zakat, and faith in zakat institutions. Norazlina and Rahim (2011) stated that promoting accountability among zakat institutions through provision of laws on zakat is highly crucial in enhancing the efficiency of zakat administration and strengthening the governance of zakat institutions.

Many supporters of Islamic philanthropy hold the opinion that efficient zakat law enforcement would result in a significant increase in the amount of zakat collected (Ali, 2011). According to Yusoff and Densumite's (2012) research, the Federal Territory's zakat collection has increased because of the various channels of collection available, such as banking instruments, the Zakat Collection Center, post office counters, salary deduction, SMS-Zakat (mobile money), and kiosk machines in the Department of Immigration and the Road Transport Department. A study in research by Aznan et al. (2021) showed that the two key elements determining the effectiveness of zakat collection are the law's provision and the collection technique. However, when it comes to how well zakat is distributed, the method of distribution and public opinion have been identified as the two key determinants.

RESEARCH METHODOLOGY

Data used in this research was obtained from *Hasil Zakat Kedah* and *Scoreboard Report*, a website that displays the statistics in *Lembaga Zakat Negeri Kedah* which contains several elements such as collection, distribution, and Smart SBB. The desired time series data was obtained from the zakat collection part, which is quantitative and therefore is classified as a secondary data. However, the tabulated data does not separate by quarterly in each year, but in a total for the current time it is being accessed. Therefore, the data needs to be collected manually by selecting an interval of three months; January to March, April to June, July to September, and October to December for each available data from year 2016 to 2022. This is due to my preferred data set to be used to obtain the pattern of the graph.

Data Analysis

The collected data from *Hasil Zakat Kedah* and *Scoreboard Report* were to be classified into its categories as in Table 1. This included seven years with 28 total in the quarter column. All calculations were done in Microsoft Excel using the built-in functions.

Table 1. ***The Quarterly Zakat Collection in Kedah from 2016 to 2022***

Year	Quarter	Collections in RM Million
2016	1	26.971969
	2	41.060221
	3	36.174481
	4	46.784727
2017	1	32.759325
	2	47.504678
	3	30.107205
	4	62.601065
2018	1	34.425845
	2	67.704278
	3	30.02347
	4	51.081425
2019	1	42.523279
	2	67.652747
	3	35.096124
	4	42.523279
2020	1	36.534203
	2	83.825118

	3	33.675306
	4	74.074584
2021	1	41.116807
	2	74.44423
	3	42.297299
	4	84.331048
2022	1	55.81263
	2	71.409102
	3	42.787361
	4	82.083464

Table 2 shows the descriptive statistics for the data in **Table 1** to give a picture on how the data behave.

Table 2. ***Summary statistics from Table 1.***

Collections in RM Million	
Mean	50.6209025
Standard Error	3.43497596
Median	42.65532
Mode	42.523279
Standard Deviation	18.1761843
Sample Variance	330.373675
Kurtosis	-0.9963532
Skewness	0.62670692
Range	57.359079
Minimum	26.971969
Maximum	84.331048
Sum	1417.38527
Count	28

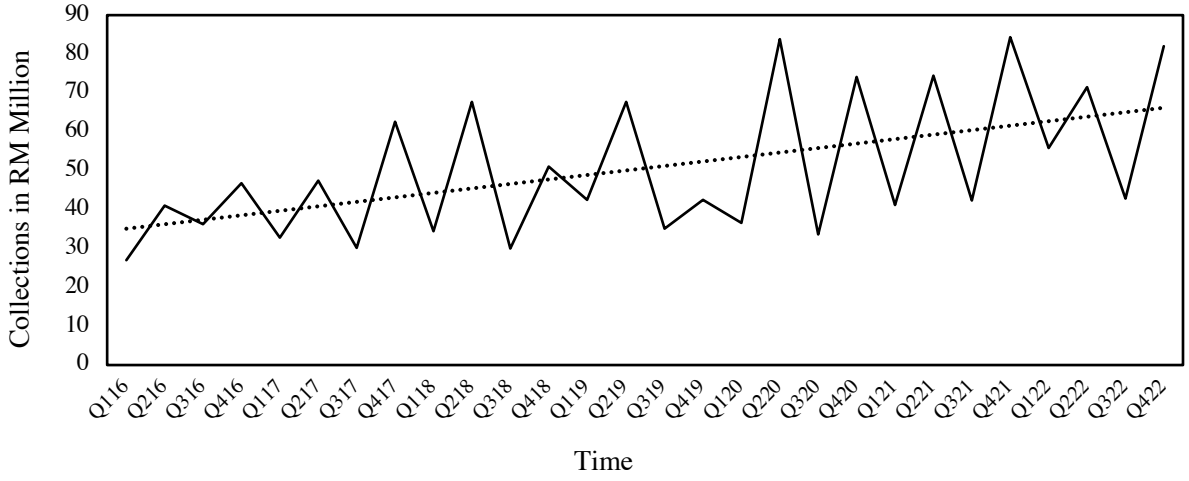

Figure 1. ***Time series plot of quarterly zakat collections in LZNK from 2016 to 2022.***

Figure 1 portrays the pattern in the collection of zakat in Kedah for 28 quarters, which has the same behavior in all four years. The first and last quarters in the year recorded higher collection than the second and third quarter thus creating a fluctuation. The trend line generated indicates a slight increase. Thus Holt-Winters model is the most suitable to predict the data since it captures both trend and seasonal influences.

Mathematical Methods

The graph in **Figure 1** clearly shows the fluctuations between each quarter every year. This shows that there is a seasonal influence in the collection of zakat inside Kedah state. The trendline obtained indicates that the zakat collection has an increasing trend from previous years. Thus, we can conclude that the data has seasonal influence and increasing trend. Therefore, this research utilizes the Holt-Winters exponential smoothing method. However, the graph in **Figure 1** does not portray a clear image whether the seasons are in a constant or increasing variations. Therefore, this study will examine the errors from the forecast values generated by both methods to affirm the most accurate predictions. Holt (1957) and Winters (1960) extended Holt's method to capture seasonality. The Holt-Winters seasonal method comprises the forecast equation and three smoothing equations — one for the level L_t, one for the trend b_t, and one for the seasonal component S_t, with corresponding smoothing parameters α, β and γ. We use m to denote the frequency of the seasonality, i.e., the number of seasons in a year. For example, for quarterly data $m = 4$, and for monthly data $m = 12$.

There are two calculations of this method, and the seasonal component in each one is different. When seasonal fluctuations are essentially constant throughout the series, the additive technique is recommended; when they change proportionally to the level of the series, the multiplicative method is favored. The seasonal component is stated in absolute terms in the scale of the observed series using the additive approach, and the level equation adjusts the series for the season by deducting the seasonal component. The seasonal component will almost equal zero within each year. The seasonal component is stated in relative terms (percentages) when using the multiplicative technique, and the series is seasonally adjusted by dividing through by the seasonal component. Throughout each year, the seasonal component will sum up to approximately m (Hyndman, R.J., & Athanasopoulos, G.,2018).

Table 3. ***The list of formulas used in the calculations.***

Holt-Winters Additive Seasonality	Holt-Winters Multiplicative Seasonality
Level:	***Level:***
$L_t = \alpha(y_t - S_{t-s}) + (1-\alpha)(L_{t-1} + b_{t-1})$	$L_t = \alpha\left(\frac{y_t}{S_{t-s}}\right) + (1-\alpha)(L_{t-1} + b_{t-1})$
Trend: $b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1}$	***Trend:*** $b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1}$
Seasonality: $S_t = \gamma(y_t - L_t) + (1-\gamma)S_{t-s}$	***Seasonality:*** $S_t = \gamma(\frac{y_t}{L_t}) + (1-\gamma)S_{t-s}$
Forecast: $F_{t+m} = L_t + b_t m + S_{t+m-s}$	***Forecast:*** $F_{t+m} = L_t + b_t m(S_{t+m-s})$
$m = 1,2,3 \ldots$	$m = 1,2,3 \ldots$

Notes:
α *– the smoothing constant for level* $0 < \alpha < 1$
β *– the smoothing constant for trend estimate* $0 < \beta < 1$
γ *– the smoothing constant for seasonality estimate* $0 < \gamma < 1$
L_t *– the level of series at time* t
b_t *– trend component estimate at time* t
S_t *– seasonality component estimate at time* t
y_t *– the actual values which include seasonality*
s *– the length of seasonality*
m *– number of periods ahead to forecast*
F_{t+m} *– forecast for m-step-ahead*

RESULTS AND DISCUSSION

Trend and seasonal pattern were detected in the time series data in **Table 1** which can be seen in **Figure 1**. Therefore Holt-Winters exponential smoothing method is applicable to predict future collection of zakat in *LZNK*. Both additive and multiplicative approach were used in this research and the results obtained distinguished from each other. **Table 4** shows the results of additive Holt-Winter method. This includes Level L_t, Trend b_t, Season S_t, and the Forecast F_{t+m}.

Table 4. ***Holt-Winters Additive Method Calculation.***

Collection in RM Million	***Level, L_t***	***Trend, b_t***	***Season, S_t***	***Forecast, F_{t+m}***
26.971969			-10.7758805	
41.060221			3.3123715	
36.174481			-1.5733685	
46.784727	37.7478495	1.373805	9.0368775	
32.759325	39.12165419	1.373805	-8.15125145	28.34577369
47.504678	40.49545888	1.373805	5.510794716	43.80783038
30.107205	41.86926356	1.373805	-7.63232874	40.29589506
62.601065	43.24306825	1.373805	15.17459008	52.27994575
34.425845	44.61687294	1.373805	-9.364255728	36.46562149
67.704278	45.99067763	1.373805	15.14619972	51.50147234
30.02347	47.36448231	1.373805	-13.40584107	39.73215357
51.081425	48.738287	1.373805	7.544045084	63.91287708
42.523279	50.11209169	1.373805	-8.308443968	40.74783596
67.652747	51.48589638	1.373805	15.7531554	66.6320961
35.096124	52.85970106	1.373805	-15.99727814	39.45385999
42.523279	54.23350575	1.373805	-3.905990865	61.77755083
36.534203	55.60731044	1.373805	-14.70992125	47.29886647
83.825118	56.98111513	1.373805	22.34860618	72.73427052
33.675306	58.35491981	1.373805	-21.16044694	42.35764167
74.074584	59.7287245	1.373805	6.947930001	55.82273364
41.116807	61.10252919	1.373805	-17.84730868	46.39260794
74.44423	62.47633388	1.373805	16.17545643	84.82494006
42.297299	63.85013856	1.373805	-21.39379306	42.68969162
84.331048	65.22394325	1.373805	14.17868841	72.17187325
55.81263	66.59774794	1.373805	-13.64759972	48.75043926
71.409102	67.97155263	1.373805	8.600540333	84.14700906
42.787361	69.34535731	1.373805	-24.46481612	47.95156425
82.083464	70.719162	1.373805	12.5050429	84.89785041
>			-13.64759972	58.44536697
>			8.600540333	82.06731171
>			-24.46481612	50.37575994
>			12.5050429	88.71942365

Table 5 depicts the results of multiplicative method of Holt-Winters exponential smoothing. Since this study aims to forecast only for 2023 zakat collection, only 4 rows were added in the Forecast column, same goes to results in **Table 4**.

Table 5. ***Holt-Winters Multiplicative Method Calculation.***

Collection in RM Million	***Level,*** L_t	***Trend,*** b_t	***Season,*** S_t	***Forecast,*** F_{t+m}
26.971969			0.71452995	
41.060221			1.087749939	
36.174481			0.95831899	
46.784727	37.7478495	1.373805	1.239401121	
32.759325	39.12165419	1.373805	0.76220796	27.95359359
47.504678	40.49545888	1.373805	1.120871532	44.04893293
30.107205	41.86926356	1.373805	0.865462109	40.12411036
62.601065	43.24306825	1.373805	1.320230633	53.59550728
34.425845	44.61687294	1.373805	0.765848635	34.00733572
67.704278	45.99067763	1.373805	1.257205235	51.5496413
30.02347	47.36448231	1.373805	0.775579018	40.99216475
51.081425	48.738287	1.373805	1.214599557	64.34577951
42.523279	50.11209169	1.373805	0.797952554	38.37827699
67.652747	51.48589638	1.373805	1.279251022	64.72833846
35.096124	52.85970106	1.373805	0.732252037	40.99687503
42.523279	54.23350575	1.373805	1.047501611	65.87199208
36.534203	55.60731044	1.373805	0.743246208	44.37199539
83.825118	56.98111513	1.373805	1.35371449	72.89314977
33.675306	58.35491981	1.373805	0.672024299	42.73050888
74.074584	59.7287245	1.373805	1.122287032	62.56593513
41.116807	61.10252919	1.373805	0.715948633	45.41422311
74.44423	62.47633388	1.373805	1.290777229	84.57511847
42.297299	63.85013856	1.373805	0.668306868	42.90884459
84.331048	65.22394325	1.373805	1.188524757	73.19998568
55.81263	66.59774794	1.373805	0.763341945	47.68056661
71.409102	67.97155263	1.373805	1.197547193	87.73613236
42.787361	69.34535731	1.373805	0.648400336	46.34397858
82.083464	70.719162	1.373805	1.177723701	84.05147481
>			0.763341945	55.03158539
>			1.197547193	87.97992583
>			0.648400336	48.52665463
>			1.177723701	89.75948254

Table 6. ***Constant for Holt-Winters Additive and Multiplicative Methods.***

	α	β	γ
Additive	0	0	0.594675
Multiplicative	0	0	0.388129

Table 6 stated the three smoothing constants needed in the calculation for both additive and multiplicative method. The $\alpha, \beta,$ and γ are the optimized constant so that the errors will be minimized to choose the best model to forecast the time series data. Next, the best model was chosen by examining the forecast errors as in **Table 7**. Types of accuracy measures include Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), Symmetric Mean Absolute Error (SMAPE), and Theil's U statistics.

Table 7. ***Forecast Accuracy Measures***

Accuracy Measures	Holt-Winters Additive	Holt-Winters Multiplicative
MSE	46.18948	65.52031
RMSE	6.796284	8.094462
MAE	5.827313	6.242827
MAPE	0.135834	0.141039
SMAPE	0.123599	0.12608
U1	0.060469	0.071675
U2	0.241498	0.307145

Findings

Based on the forecast accuracy measure in **Table 7**, the MSE, RMSE, MAE, MAPE, and SMAPE for the Holt-Winters additive model produced a lower value than the Holt-Winters multiplicative model. In determining a better model, the minimum errors will be chosen to predict more accurate forecast. In this case, the Holt-Winters additive model denotes much less error, so this model is best used to predict collection in 2023 for *LZNK*. U1 and U2 is the Theil's U statistic, which stipulated that the forecasting technique is better than guessing since then, if then guessing is better than doing forecasting for the data. The closer the value is to 0, the greater the forecast accuracy, and this shows that the additive model performs better. In predicting the 2023 *LZNK* quarterly zakat collection, the Holt-Winters additive model will be used.

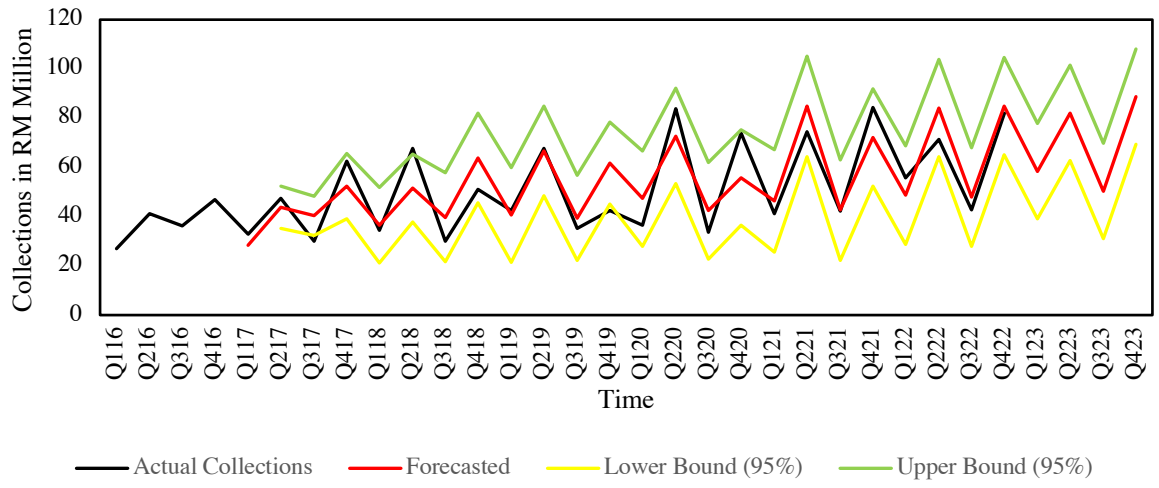

Figure 2. ***Actual and Forecasted Collection Zakat Collection in Kedah against Time using Holt-Winters Model with Confidence Limit Plot***

Table 8. ***The Predicted Data for 2023 Quarterly Collection***

Quarter	Predicted Collection in RM Million
1	58.44536697
2	82.06731171
3	50.37575994
4	88.71942365
Total	279.6078623

By choosing the Holt-Winters Additive Exponential Smoothing Method, the predicted collection for 2023 is shown in **Table 8**. The first quarter in 2023 is estimated to fund *LZNK* with a total of RM58.45M, second quarter with RM82.07M, third quarter with RM50.38M and lastly with RM88.72M for the last quarter. *LZNK* is projected to achieve RM279.61 million in 2023 by the end of December following this mathematical method of forecasting. The sum of the predicted total calculation using the multiplicative method somehow portrays a higher value, which is RM281.29M, and therefore shows that the calculation is correct due to the reason that multiplicative seasons produce a higher difference in the next year. Even with forecasting can help use to be more aware of the future, God's willpower comes in the first place. As in **Figure 2**, the yellow and green lines indicate the uncertainty in the collection based on past time series data. This prediction may or may not be true, as the collection of zakat might be lower or higher than expected.

CONCLUSION

To conclude, the aim is to use Holt-Winters model in predicting the zakat collections in *LZNK* of all four quarters in 2023 in this research is achieved. From the graph in **Figure 1**, the Holt-Winters Exponential Smoothing Method could be used to do forecasting in the zakat collection of *LZNK* for this year, 2023.

Two model of Holt-Winters was being computed in this study to get precise prediction of a time series data: 2016 to 2022 zakat collection in Kedah. Based on the results, the additive seasonal model produced less errors than the multiplicative seasonal model of the Holt-Winters method. This is since the forecast accuracy measure in **Table 7**, the MSE, RMSE, MAE, MAPE, and SMAPE of the additive method, indicates that the model is best used. The minimum errors were obtained by optimizing the constants for smoothing purposes. This resulted the estimated collection of zakat in 2023 to be RM279.61M in total by additive method. This answers a question of whether the actual time series graph portrays an additive or multiplicative seasonal pattern. Therefore, **Figure 1** showed an additive seasonal pattern with a trend.

Based on the *Scoreboard Report, LZNK* is seemed to decree a total of RM273,006,751 collection target for year 2023. That is an approximate 8.33% increment from last year's actual collection. Based on the context of this study where the predicted sum for 2023 will be about RM279.61M, hence there is a high probability that the targeted collection for 2023 will be achieved. This shows positive feedback from this study since the forecasted values are way higher in total thus this is also a good indicator that this year's distribution will be greater.

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