FORECASTING ZAKAT COLLECTION IN MALAYSIA USING TIME SERIES ANALYSIS

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UNIVERSITI SAINS ISLAM MALAYSIA

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AUTHOR DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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ABSTRAK

Model Holt-Winters dan Seasonal Auto-Regressive Integrated Moving Average (SARIMA) telah digunakan untuk meramalkan kutipan zakat bulanan di Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS), dan Pusat Pungutan Zakat (PPZ) menggunakan data kutipan zakat dari Januari 2010 hingga Disember 2019. Model bukan musim seperti Auto-Regressive Integrated Moving Average (ARIMA) dan Single Smoothing Exponential telah digunakan untuk meramalkan kutipan zakat tahunan dalam Majlis Agama Islam dan Adat Melayu Perak (MAIPk) menggunakan data kutipan zakat dari tahun 1991 hingga 2019. Dalam kajian ini, kita membandingkan nilai-nilai yang diramalkan kedua-dua model dan memilih model terbaik berdasarkan pada paling kurang *Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE) dan Mean Absolute Percentage Error (MAPE).* Objektif kajian ini adalah untuk mencari model terbaik untuk ramalan kutipan zakat untuk sebuah institusi Zakat. Menurut keputusan yang diperolehi menggunakan *MSE, RMSE, MAE dan MAPE, SARIMA(1,1,1)(1,1,1)*$_{12}$ *dan SARIMA(0,1,1)(0,1,1)*$_{12}$ model didapati telah menjadi model yang lebih baik untuk PZNS dan PPZ. *SARIMA(1,1,1)(0,1,0)*$_{12}$ telah didapati menjadi model yang lebih baik untuk LZS berdasarkan MSE. Model *ARIMA* ditemui telah menjadi yang terbaik untuk MAIPk dan boleh digunakan untuk meramalkan nilai masa depan dari 2020 hingga 2031. Kajian menunjukkan bahawa model-model ini boleh meramalkan kutipan zakat di masa depan untuk menyediakan strategi yang sesuai dan merancang untuk pengagihan zakat tanpa meninggalkan lebihan kutipan zakat tersebut. Model-model ini juga boleh digunakan untuk membina strategi bagi mengendalikan dana zakat berdasarkan jumlah Asnaf yang berdaftar.

Kata kunci: Holt-Winters, SARIMA, ARIMA, Single Exponential Smoothing, Ramalan, Trend Zakat, Zakat.

ABSTRACT

Holt-Winters and Seasonal Auto-Regressive Integrated Moving Average (SARIMA) models are used to predict monthly zakat collection in Lembaga Zakat Selangor (LZS), Pusat Zakat Negeri Sembilan (PZNS), and Pusat Pungutan Zakat (PPZ) using zakat collection data from January 2010 to December 2019. Nonseasonal models such as the Auto-Regressive Integrated Moving Average (ARIMA) and the Single Smoothing Exponential are used to predict yearly zakat collections in Majlis Agama Islam dan Adat Melayu Perak (MAIPk) using zakat collection data from year 1991 to 2019. In this research, we compare the forecasted values of both models and select the best model based on the least Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). The objective of this study is to find the best model for forecasting zakat collection for a zakat institution. According to the results obtained using MSE, RMSE, MAE, and MAPE, the ARIMA(1,1,1) $(1,1,1)_{12}$ and ARIMA(0,1,1) $(0,1,1)_{12}$ models were found to be a better model for PZNS and PPZ, respectively. The ARIMA(1,1,1) $(1,1,1)_{12}$ was found to be a better model for LZS based on MSE error. The ARIMA model was found to be the best fit for MAIPk and could be used to forecast future values from 2020 to 2031. The study shows that these models can accurately predict future zakat collection to prepare the appropriate strategies and plan for zakat distribution without leaving any surplus. These models can also be used to create a strategy to handle zakat funds based on the amount of asnaf registered.

Keywords: Holt-Winters, SARIMA, ARIMA, Single Exponential Smoothing, Forecasting, Zakat Trend, Zakat.

ملخص

هولت–وينترس (Holt-Winters) والانحدار الذاتي المتوسط المتحرك المتكامل الموسمي (Seasonal Auto-Regressive Integrated Moving Average-SARIMA) نموذجان يُطبَّقان لتنبؤ جباية الزكاة الشهرية في ثلاثة مراكز وهي هيئة زكاة سلانجور (LZS-Lembaga Zakat Selangor)، وهيئة زكاة نجري سمبيلان (PZNS-Pusat Zakat Negeri Sembilan)، وهيئة جباية الزكاة (PPZ-Pusat Pungutan Zakat) باستخدام بيانات جباية الزكاة من يناير ٢٠١٠م حتى ديسمبر ٢٠١٩م. وأما الانحدار الذاتي المتوسط المتحرك المتكامل (ARIMA Auto-Regressive Integrated Moving Average) والانسيابية الأسية المفردة (Single Exponential Smoothing) فإنهما من النماذج غير الموسمية يُستخدَمان لتنبؤ جباية الزكاة السنوية في مجلس الدين الإسلامي والثقافة الملايوية بيراك (MAIPk) من خلال الاستعانة ببيانات جباية الزكاة من عام ١٩٩١م حتى عام ٢٠١٩م. ففي هذا البحث، تتم المقارنة بين القِيَم المتَنَبَّأَة من النموذجين السابقين واختيار أفضل النموذج من خلال تطبيق الخطأ التربيعي المتوسط الأقل (Mean Square Error -MSE)، والجذر التربيعي لمتوسط الخطأ (RMSE-Root Mean Square Error)، ومتوسط الخطأ المطلق (MAE -Mean Absolute Error)، ونسبة متوسط الخطأ المطلق (Mean Absolute Percentage MAPE-Error). ويهدف البحث إلى كشف أفضل نموذج في تنبؤ جباية الزكاة في مؤسسة زكاة. وبناءً على النتائج تتحصل خلال تطبيق MSE، وRMSE، وMAE، وMAPE، فيتبلور أن ARIMA (1,1,1) (0,1,1)12 وARIMA (0,1,1) (1,1,1)12 أفضل النموذج يمكن تطبيقها عند هيئة زكاة نجري سمبيلان وهيئة جباية الزكاة. ومن جهة أخرى، يُستنتَج من خلال تطبيق MSE أن ARIMA (1,1,1) (1,1,1)12 أفضل النموذج لهيئة زكاة سلانجور. وهذا يستخلص أن نموذج ARIMA يعتبر أكثر ملاءمة لتطبيقه في مجلس الدين الإسلامي والثقافة الملايوية بيراك حيث يمكن استخدامه في تنبؤ القيَّم المستقبلية ابتداء من عام ٢٠٢٠م حتى عام ٢٠٣١م. ومن خلال إدراء هذا البحث يتبين إلى أن هذه النماذج تتمكن من تنبؤ نسبة جباية الزكاة في المستقبل بدقة، حيث يمكن بها تخطيط الاستراتيجيات والخطط لصرف الزكاة بدون إفراط. وفضلا عن ذلك، فإن هذه النماذج يمكن تطبيقها في سبيل إعداد استراتيجية في إدارة صناديق الزكاة اعتمادا على عدد الأصناف المسجلين.

كلمات مفتاحية: هولت-وينترس *Holt-Winters*، والانحدار الذاتي المتوسط المتحرك المتكامل الموسمي *SARIMA*، الانحدار الذاتي المتوسط المتحرك المتكامل *ARIMA*، *الانسيابية الأسية المفردة، التنبؤ، اتجاه الزكاة، الزكاة*

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LIST OF SYMBOLS

Y_t	Actual value
u_t	Standard errors
Θ/ϕ	Coefficient
$\Phi(\beta)$	Non-seasonal AR operator
$\theta(\beta)$	Non-seasonal MA operator
d	Order of integration/differencing
ϵ_t	Gaussian white noise
μ	Constant
M_t	The forecast value for the period
M_{t-1}	The forecast value for the previous period $t-1$
N_{t-1}	The actual zakat collection value for the previous period $t-1$
L_t	The level of the series periods ahead
b_t	Growth
$\alpha, \beta \text{ and } \gamma$	Smoothing parameters of Holt-Winters method
S_t	Seasonal element
F_{t+m}	The forecast for m between 0 and 1
y_j	Actual load
$\hat{y}_j$	Predicted load
ρ_k	The autocorrelation functions
γ_k	The covariance at lag *k*
γ_0	The variance
BL	The Ljung-Box statistic
n	The size of the sample
m	The number of lags
$\hat{\rho}_k$	The autocorrelation at the *k*th lag
p	Autoregressive
d	Differencing term
q	Moving average
P	Seasonal autoregressive
D	Seasonal differencing
Q	Seasonal moving average

LIST OF EQUATIONS

LIST OF ABBREVIATIONS

ACF	Autocorrelation Function
AHW	Additive Holt-Winters
ANN	Artificial Neural Network
AR	Autoregressive
ARIMA	Auto-Regressive Integrated Moving Average
BP	Back Propagation
BSE	Bombay Stock Exchange
CPI	Consumer Price Index
DES	Double Exponential Smoothing
EAHW	Extended Additive Holts-Winters
et al.	and others
FDI	Foreign Direct Investment
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
HW	Holt-Winters
HWES	Holt-Winters Exponential Smoothing
LM	Levenberg-Marquardt
LSTM	Long Short-Term Memory
LZS	Lembaga Zakat Selangor
MA	Moving Average
MAE	Mean Absolute Error
MAIPk	Majlis Agama Islam dan Adat Melayu Perak
MAPE	Mean Absolute Percentage Error
MHW	Multiplicative Holt-Winters
MPE	Mean Percentage Error
MSE	Mean Square Error
PACF	Partial Autocorrelation Function
PBUH	Peace Be Upon Him
PPZ	Pusat Pungutan Zakat
PZM	Pusat Zakat Melaka
PZNS	Pusat Zakat Negeri Sembilan
PZP	Pusat Zakat Pahang
RMSE	Root Mean Square Error
SAR	Seasonal Autoregressive
SARIMA	Seasonal Auto-Regressive Integrated Moving Average
SES	Single Exponential Smoothing
SIRC	State Islamic Religions Council
SIRCs	State Islamic Religious Counters
SMA	Seasonal Moving Average
SSE	Sum Square Error