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MODELLING AND PREDICTION OF DENGUE CASES AT TWO PROGRESSIVE REGIONS IN MALAYSIA

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ABSTRACT

Time series analysis method has been used to model and forecast the weekly number of dengue cases in Malaysia. Dengue fever is one of the pressing public-health problems in Malaysia and causes substantial economic burden. Forecasting results of dengue cases could be useful in preparedness programme to facilitate the planning of public health interventions. The analysis is conducted in Selangor and Wilayah Persekutuan, two states in Peninsular Malaysia with high dengue occurrences. Two time series models, Double Exponential Smoothing and Holt-Winters Method are fitted to dengue data (2010-2015) from both regions to determine the best model to represent the cases. Both models are able to represent the data very well, however closer inspections using MAPE, MAP and MSD indicated that Holt-Winters method is most appropriate. Forecasting results using Holt-Winters method exhibit a substantial increase for Selangor and a more gradual increase for Wilayah Persekutuan.

Keywords: Dengue, Exponential Smoothing Models, Forecasting

1. INTRODUCTION

The management of infectious diseases, such as dengue, is a public health liability in many tropical and subtropical regions. Wiwanitkit [6] reported that dengue is highly endemic in tropical countries especially in Southeast Asia and South Asia.

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In Malaysia, dengue outbreaks seem to be escalating despite the diverse efforts by relevant parties. Analysis of dengue cases based on ninety articles with clinical relevance and future research implications for year 2000 – 2013 showed there is evidence of an exponential increase in the disease epidemic[1]. Recent statistics reported that number of cases displayed an increase trend, such as from 108,698 cases in 2014 to 120,836 cases in 2015, an increase of 11.2% or 12,138 cases [4]. 70% – 80% of the reported dengue cases came from urban areas where factors such as high population density and rapid development tend to expedite transmissions of dengue [4].

Generally, mathematical modelling of dengue cases could provide the means to critically analyse the dynamics of dengue spread and its growth trend. Forecasting of dengue cases could be used in preparedness programme to facilitate the planning of public health interventions. Statistical techniques being implemented to examine and forecast the number of cases include regression methods, spatial temporal modelling and time series methods. With the increasing number of cases over time, many research works on forecasting (e.g[2], [3], [5], [7])applied time series method.

It is the objective of this study to apply time series models to forecast weekly dengue incidences in two regions in Malaysia, namely Wilayah Persekutuan and Selangor. The selected regions are two states in Peninsular Malaysia which recorded the most outbreaks for many years. Coincidently these regions are also the most developed state in Malaysia with high population density. Two exponential smoothing methods are individually fitted into historical data of both regions to identify the best model to represent the cases and the appropriate model is then used to make forecasting. Forecasting results could be beneficial in furnishing useful information to related parties to devise plan and prepare resources to minimize morbidity and mortality.

2. MODEL DEVELOPMENT

Wilayah Persekutuan (WP)and Selangor are two of the most progressive states in Malaysia. They are situated next to each other in the western part of the Peninsular. In terms of population, Selangor it is the most populous state while WP has the highest population density. Dengue data of about six years (2010 – 2015) from both regions is obtained from the official Malaysia i-Dengue Data Portal, provided by the Ministry of Health Malaysia. The collected data are based on the data availability at the time of study. Specifically, 280 weekly data from week 8 of 2010 to week 27 of 2015 are used. However there is the problem of missing data for some of the weeks, and these data are in filled using Minitab. The completed

data sets are then analysed by using two exponential methods, the Double exponential method and Holt-Winters method, to model the observed data and make forecasting on future pattern of dengue cases.

In general, Exponential smoothing approach to forecasting make use of exponentially weighted average of past observations to make forecasting, with the weights declining over time. Subsequently, the assigned weights tend to be lower for older observations. The Double exponentialtechnique smooths out the data when a trend is present. On the other hand, Holt-Winters exponential smoothing method is used to manage time series when there are presence of trend and seasonal variations. In this study, the additive form of Holt-Winters method is adopted. In order to compare models' performance, three main numerical assessments are calculated, namely Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD).For each assessment, the lowest value would indicate a better fitted between observed and predicted values.

3. RESULTS AND DISCUSSION

The number of observed cases for the period 2010-2015 is plotted as Figure 1. Selangor experienced a dramatic increase for year 2012 to 2015 and decline for 2015 while Wilayah Persekutuan experienced a more gradual increase for 2011 to 2014 and decrease for the year of 2015. It should be acknowledged that the cases for 2015 only covered up to week 27. The two techniques, Double exponential and Holt-Winters methods are fitted to the dengue data of both regions. The results in the form of graphs are given in Figure2 (Selangor) and Figure 3(WP). From the graphs, it can be seen that the performance of the two methods are almost identical in both regions, thus making it difficult to determine which model is more appropriate. Hence, numerical comparisons based on the three main criteria, MAPE, MAD and MSD are conducted using, with the results shown in Table 1. The lowest value, given in bold, indicates the better model. Results show that the values of all three criteria for both models are almost similar, nevertheless the best model is Holt-Winters method for both regions. Using Holt-Winters, forecasting of future dengue cases is conducted for 13 weeks and the results are presented in the graphical form (Figure 4). The forecasted values exhibit a substantial increase for Selangor and a more gradual increase for Wilayah Persekutuan.

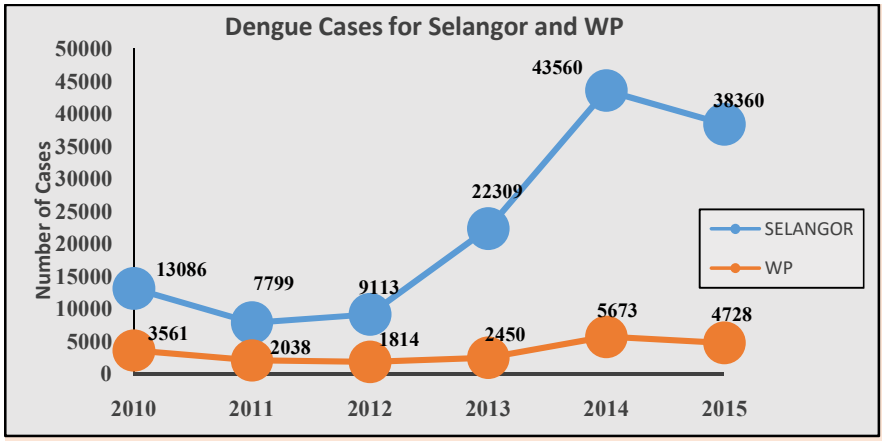
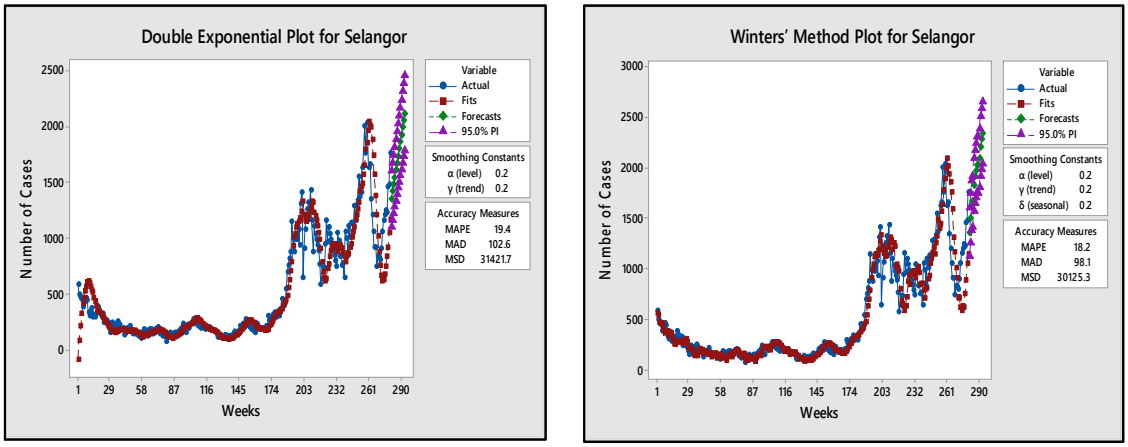
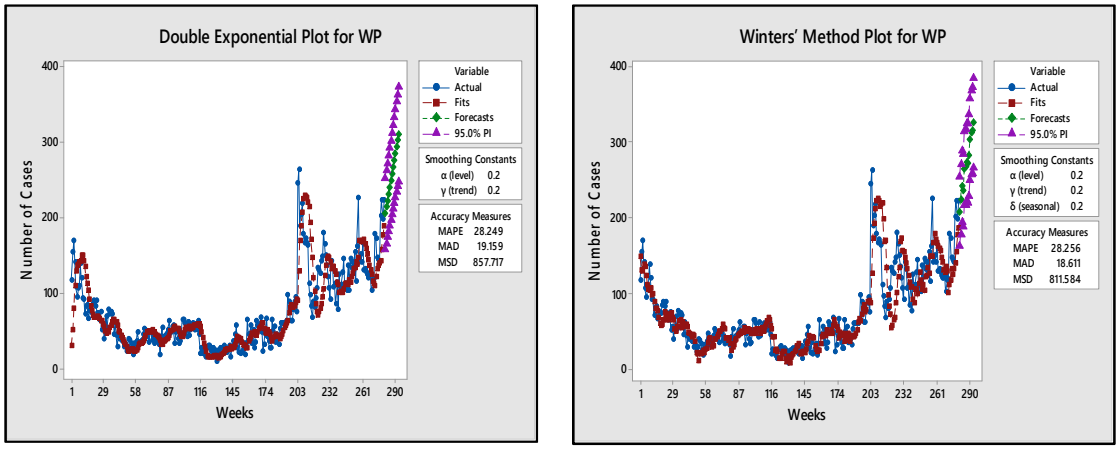


Fig.1. Dengue Cases (2010-2015) for Selangor and WP



(a) (b)

Fig.2. Graphs for Selangor for Double exponential and Holt-Winters methods



(a) (b)

Fig.3. Graphs for Wilayah Persekutuan for Double exponential and Holt-Winters methods

Table 1. Numerical comparisons for Double exponential and Holt-Winters methods

Region	Accuracy Measures	Double Exponential Method	Holt-Winters Method (Additive)
Selangor	MAPE	19.4	**18.2**
	MAD	102.6	**98.1**
	MSD	31421.7	**30125.3**
WP	MAPE	**28.25**	28.26
	MAD	19.2	**18.6**
	MSD	857.7	**811.6**

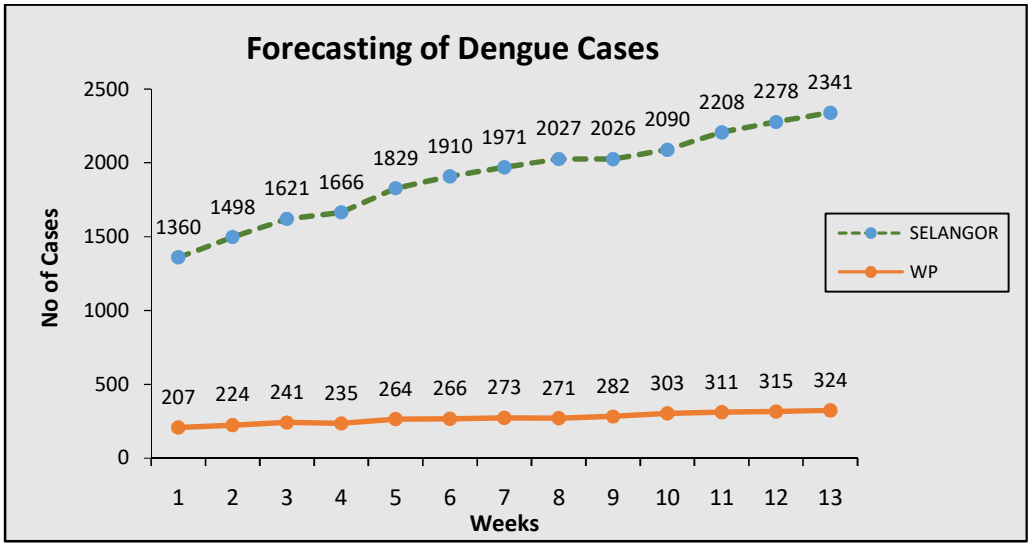


Fig.4. Weekly forecasting results using Holt-Winters method for Selangor and WP

4 . CONCLUSION

This paper presents the comparison of two different exponential smoothing techniques that could be implemented to analyze and forecast dengue fever cases in Selangor and Wilayah Persekutuan. Results show both models are able to capture the pattern of the dengue cases, however more stringent comparisons identified that Holt-Winters as the better model for both regions. Forecast results of 13 weeks show that dengue cases have the tendency to rise at both regions although the rise for Selangor would be more distinctly. The outcome of this research could be beneficial to public health officers and relevant authorities to better manage the anticipated dengue fever epidemic. Additionally it is hoped that effective planning has the

potential to reverse the growing pattern of dengue by elevating the readiness to identify, characterize, and contain the epidemic.

5. ACKNOWLEDGMENT

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REFERENCES

[1] W. K. Cheah, K.S. Ng, Marzilawati Abd-Rahman, Lucy C. S.Lum, A Review of Dengue Research in Malaysia, The Medical Journal of Malaysia 69 Suppl A :59-67(2014).

[2] C. C. Ho, C.Y.Ting, Time Series Analysis and Forecasting of Dengue Using Open Data, Advances in Visual Informatics, Lecture Notes in Computer Science, vol 9429 (2015).

[3] E.Z. Martinez, EA. Sd. Silva, Predicting the number of cases of dengue infection in Ribeirao Preto, Sao Paulo State, Brazil, using a SARIMA model. Cadernos De Saude Publica, 27(9):1809–18(2011).

[4] Ministry of Health Malaysia, Statement on dengue by Director General of Health. (2015).

[5] S. Promprou, M. Jaroensutasinee, and K. Jaroensutasinee, Forecasting dengue haemorrhagic fever cases in Southern Thailand using ARIMA models, Dengue Bulletin, vol. 30,p. 99. (2006)

[6] V. Wiwanitkit Lessons learned from previous dengue outbreaks. Asian Pacific Journal of Tropical Disease, 4(1), 67–70.(2014).

[7] S. Wongkoon, M. Pollar, M. Jaroensutasinee, K. Jaroensutasinee, Predicting DHF incidence in Northern Thailand using time series analysis technique. Proc World Acad Sci EngTechnol ; 26:216-220, (2007).

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