การพยากรณ์จำนวนแรงงานต่างด้าวในประเทศไทย โดยใช้วิธีการปรับเรียบด้วยเส้นโค้งเลขชี้กำลัง

Forecasting the number of foreign workers in Thailand by exponential smoothing method

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Received: 6 April 2023; **Revised**: 30 May 2023; **Accepted**: 19 June 2023

บทคัดย่อ

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อศึกษาเทคนิคและเปรียบเทียบวิธีการพยากรณ์โดยใช้วิธีการปรับเรียบด้วยเส้นโค้งเลขชี้กำลัง (exponential smoothing method) โดยประกอบไปด้วย 3 เทคนิค ได้แก่เทคนิค Simple Exponential Smoothing, เทคนิค Trend Method และเทคนิค Holt-Winters' Seasonal Method โดยใช้ข้อมูลจากข้อมูลจำนวนคนต่างด้าวที่ได้รับอนุญาตทำงานทั่วราชอาณาจักรจากฐานข้อมูลสถิติของสำนักบริหารแรงงานต่างด้าว กรมการจัดหางาน ซึ่งแบ่งข้อมูลออกเป็น 2 ชุด โดยชุดที่ 1 ตั้งแต่เดือนมกราคม ปี 2007 ถึงเดือนธันวาคม ปี 2020 สำหรับการสร้างตัวแบบพยากรณ์ (training data) ส่วนชุดที่ 2 ตั้งแต่เดือนมกราคม ปี 2021 ถึงเดือนธันวาคม ปี 2021 ใช้สำหรับการตรวจสอบความแม่นของการพยากรณ์ (testing data) จากผลการศึกษาพบว่า วิธี Damped Holt-Winters' Multiplicative Method เป็นวิธีที่มีความแม่นในการพยากรณ์มากที่สุด เนื่องจากให้ค่าเกณฑ์รากที่สองของความคลาดเคลื่อนกำลังสองเฉลี่ย (RMSE) และค่าเกณฑ์ร้อยละความคลาดเคลื่อนสัมบูรณ์เฉลี่ย (MAPE) น้อยที่สุด โดยมีค่า RMSE เท่ากับ 196.760 และ MAPE เท่ากับ 7.769% รองลงมาได้แก่วิธี Damped Holt-Winter's Additive Method โดยมีค่า RMSE เท่ากับ 213.832 และ MAPE เท่ากับ 8.596% ซึ่งทั้งสองวิธีให้ผลการพยากรณ์ที่ค่อนข้างแม่นยำ (MAPE < 10%)

คำสำคัญ: การพยากรณ์, แรงงานต่างด้าว, วิธีการปรับเรียบด้วยเส้นโค้งเลขชี้กำลัง, อนุกรมเวลา

Abstract

The objective of this research was to study the technique and compare forecasting methods using the three techniques of the exponential smoothing method. - simple exponential smoothing, the trend method, and Holt-Winter's seasonal method. This study collected data on the number of foreigners permitted to work throughout the Kingdom of Thailand from the statistical database of the Bureau of Foreign Workers Administration, Department of Employment. The data were divided into two sets; the first set, from January 2007 to December 2020, was used for the predictive model (Training Data). The second set of data from January 2021 to December 2021 was used for checking the accuracy of the forecast (Testing Data). The results showed that the Damped Holt-Winters' Multiplicative Method was the most accurate method for forecasting because it gives the smallest RMSE and MAPE values, with RMSE of 196.760 and MAPE of 7.769%, followed by the Damped Holt-Winter's Additive Method, with RMSE of 213.832 and MAPE of 8.596%. Both methods yielded quite accurate forecasting results.

Keywords: Forecasting, foreign workers, exponential smoothing method, time series

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Introduction

Nowadays, foreign workers and laborers play an important role in the Thai economy. This is due to the past economic conditions in Thailand that have grown quite high. According to the data on the number of foreigners allowed to work in Thailand (August 2022), there are a total of 2,408,716 people divided into general types of workers, 2,167,937 people, representing 90 percent, skilled workers, and others of 240,779 people, representing 10 percent. (Office of Foreign Workers Administration, 2022)

Based on the past and present data, it is found that the number of aliens tends to increase in the future. Especially general types of workers that consist of 1) workers permitted to work under the MOU, who are migrants of Myanmar, Laos, and Cambodian nationality under the agreement between the Thai government and their origin governments, 2) foreign workers according to cabinet resolutions, and 3) foreign workers who do not stay in the country and work occasionally. Employing these foreign workers to replace positions that Thai workers do not usually do or must pay high wages with more working conditions, specifically, the 3D tasks are those that are difficult, dangerous, and dirty. Although the entry of foreign workers will be useful in replacing the shortage of domestic workers. But it cannot be denied that this migration of foreign workers also has a negative impact on the economy and society such as crime, public health, the environment, illegal immigration, etc. (Thailand Development Research Institute, 2011) These problems affect the management of foreign workers by the relevant authorities. In this study, the researcher wants to study the number of foreign workers in the past to create a suitable predictive model for forecasting the number of foreign workers in Thailand. Although there is a tendency to increase, there are still seasonal variations together with the factors of the spread of COVID-19 and disease control policies since 2020 that affect the number of foreign workers (Tarat, 2021). Being aware of the number of foreign workers in Thailand will have a positive effect on the foreign worker management plan of relevant sectors.

Therefore, the researcher is interested in studying techniques for forecasting the number of foreign workers in Thailand. The purpose of this study was to study the technique and to compare forecasting methods using the exponential smoothing method which is an easy, convenient, and fast way to see patterns of seasonal trends. The three techniques used were Simple Exponential Smoothing (SES), Trend Method, which consisted of two subtypes, Holt's Linear Trend Method and Damped Trend Methods, and the last technique was Holt-Winters' Seasonal Method, which consists of fore sub-modules: Holt-Winters' Additive Method, Holt-Winters' Multiplicative Method, Damped Holt-Winters' Additive Method, and Damped Holt-Winters' Multiplicative Method.

Research Methodology

This study collected data on the number of foreigners permitted to work throughout the Kingdom from January 2007 to December 2021 from the statistical database of the Bureau of Foreign Workers Administration, Department of Employment, Ministry of Labor, or website www.doe.go.th and created a forecast model by using the R program which has the operation process as follows.

1. Data management

The researcher divided the data into two sets, the first set from January 2007 to December 2020 was 168 values for predictive model construction using the exponential smoothing method (Training Data). As for the second set of data from January 2021 to December 2021, 12 values are used for checking the accuracy of the forecast (testing data).

2. Statistical tests to check stationarity

The researcher used Augmented Dickey-Fuller (ADF) test to test whether a given time series data is stationary or not. If p-value less than significant level, the time series data will be stationary.

3. Creating a forecast model

The researcher constructed a predictive model using the exponential smoothing method which consists of 3 techniques, namely Simple Exponential Smoothing (SES), Trend Method, and Holt-Winter's Seasonal Method (Hyndman & Athanasopoulos, 2018). The variables are defined as follows:

$\hat{Y}_{t+1}$ = Predicted value to forecast at the time $t + 1$

Y_t = Time series data values at the time t

α = A coefficient of exponential smoothing, $0 < \alpha < 1$

β = A coefficient of smoothing parameter for the trend, $0 < \beta < 1$

γ = A coefficient of smoothing parameter for the seasonality, $0 < \gamma < 1$

The forecasting model for each technique is detailed below.

3.1 Simple Exponential Smoothing (SES)

Simple Exponential Smoothing (SES) is one of the simplest and most popular smoothing methods suitable for forecasting data without obvious trends or seasonal patterns with the following equation:

Forecasting Equation:

$$\hat{Y}_{t+1} = \ell_t$$

Smoothing Equation:

$$\ell_t = \alpha\hat{Y}_t + (1 - \alpha)\ell_{t-1}$$

where ℓ_t = Estimated smoothing of data at the time t

3.2 Trend Method

1) Holt's Linear Trend Method

Holt's Linear Trend Method is a smoothing method that considers linear trends without seasonal components, using Exponential Smoothing techniques, computed with mean and trend values with the following equations:

Forecasting Equation:

$$\hat{Y}_{t+1} = \ell_t + hb_t$$

Level Equation:

$$\ell_t = \alpha\hat{Y}_t + (1 - \alpha)(\ell_{t-1} + b_{t-1})$$

Trend Equation:

$$b_t = \beta(\ell_t - \ell_{t-1}) + (1 - \beta)\, b_{t-1}$$

where h = Period of forecasting

2) Damped Trend Methods

Damped Trend Methods are smoothing methods that consider a linear trend and do not have seasonal components, but have a slower rate of change, either rising or falling, with an equation component as follows:

Forecasting Equation:

$$\hat{Y}_{t+1} = \ell_t + (\phi + \phi^2 + ... + \phi^h)b_t$$

Level Equation:

$$\ell_t = \alpha Y_t + (1 - \alpha)(\ell_{t-1} + b_{t-1})$$

Trend Equation:

$$b_t = \beta(\ell_t - \ell_{t-1}) + (1 - \beta)\phi b_{t-1}$$

where ϕ = Coefficient of damped smoothing $(0 < \phi < 1)$

b_t = Estimated slope of data at the time t

h = Period of forecasting

3.3 Holt-Winters' Seasonal Method

1) Holt-Winters' Additive Method

The Holt-Winters' Additive Method is used when seasonal variation is relatively constant throughout the time series with the following components:

Forecasting Equation:

$$\hat{Y}_{t+1} = \ell_t + hb_t + S_{t+h-m(k+1)}$$

Level Equation:

$$\ell_t = \alpha(Y_t - S_{t-m}) + (1 - \alpha)(\ell_{t-1} + b_{t-1})$$

Trend Equation:

$$b_t = \beta(\ell_t - \ell_{t-1}) + (1 - \beta)b_{t-1}$$

Seasonal Equation:

$$s_t = \gamma(Y_t - \ell_{t-1} - b_{t-1}) + (1 - \gamma)S_{t-m}$$

2) Holt-Winters' Multiplicative Method

The Holt-Winters' Multiplicative Method is used when seasonal variations change proportionally at the time series level with the following components:

Forecasting Equation:

$$\hat{Y}_{t+1} = (\ell_t + hb_t)S_{t+h-m(k+1)}$$

Level Equation:

$$\ell_t = \alpha\frac{Y_t}{s_{t-m}} + (1-\alpha)(\ell_{t-1} + b_{t-1})$$

Trend Equation:

$$b_t = \beta(\ell_t - \ell_{t-1}) + (1 - \beta)b_{t-1}$$

Seasonal Equation:

$$s_t = \gamma\frac{Y_t}{(\ell_{t-1} + b_{t-1})} + (1-\gamma)s_{t-m}$$

3) Damped Holt-Winter's Additive Method

Damped Holt-Winters' Method is a Holt-Winter technique in which damping is added as an additive or multiplicative with the components according to the equation of the Additive form as follows:

Forecasting Equation:

$$\hat{Y}_{t+1} = \ell_t + (\phi + \phi^2 + ... + \phi^h)b_t + S_{t+h-m(k+1)}$$

Level Equation:

$$\ell_t = \alpha(Y_t + S_{t-m}) + (1 - \alpha)(\ell_{t-1} + \phi b_{t-1})$$

Trend Equation:

$$b_t = \beta(\ell_t - \ell_{t-1}) + (1 - \beta)\phi b_{t-1}$$

Seasonal Equation:

$$s_t = \gamma(Y_t - \ell_{t-1} - \phi b_{t-1}) + (1 - \gamma)S_{t-m}$$

4) Damped Holt-Winter's Multiplicative Method

Damped Holt-Winters' Method has components according to the equation of the model Multiplicative as follows:

Forecasting Equation:

$$\hat{Y}_{t+1} = (\ell_t + (\phi + \phi^2 + ... + \phi^h)b_t)S_{t+h-m(k+1)}$$

Level Equation:

$$\ell_t = \alpha\frac{Y_t}{s_{t-m}} + (1-\alpha)(\ell_{t-1} + \phi b_{t-1})$$

Trend Equation:

$$b_t = \beta(\ell_t - \ell_{t-1}) + (1 - \beta)\phi b_{t-1}$$

Seasonal Equation:

$$s_t = \gamma\frac{Y_t}{(\ell_{t-1} + \phi b_{t-1})} + (1-\gamma)s_{t-m}$$

Where s_t = Seasonal estimates of data at the time t

m = 12 for monthly data

k = Integer of $\frac{h-1}{m}$

4. Model selection

The researcher used Akaike's Information Criterion (AIC), The corrected Akaike criterion $(AICc)$ and Bayesian Information Criterion (BIC) for selection of time series models (Emiliano *et al*., 2014). The model with the least AIC, $AICc$, and BIC values will be selected.

5. Forecasting assessment

The researcher has examined the accuracy of forecasting by 2 criteria as follows.

1) Root Mean Square Error (RMSE)

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2}{n}}$$

2) Mean Absolute Percentage Error (MAPE)

$$MAPE = \frac{\sum_{i=1}^{n}\left|\frac{Y_i - \hat{Y}_i}{Y_i}\right|}{n} \times 100$$

where Y_t = Observed value or real value by $i = 1, 2, ..., n$

$\hat{Y}_t$ = Predicted value by $i = 1, 2, ..., n$

n = Total data

If the MAPE value is less than 10%, the forecast is quite accurate. If the MAPE value is between 10% and 20% then the forecast is good. If the MAPE value is between 20% and 50%, it is considered that the forecast is fair and if the MAPE value is more than 50%, it is considered that the forecast is inaccurate (Ungpansattawong, 2012).

Results

From the data on the number of foreigners permitted to work throughout Thailand from January 2007 to December 2021, it can be shown in the form of time series data, as shown in Figure 1. Considering the graph, it was found that the number of foreigners allowed to work in Thailand tended to increase, and there may be seasonal variation in the time series because the graph looks up and down repeatedly. The Augmented Dickey-Fuller (ADF) test was used to determine stationarity, it was found that the Dickey-Fuller statistic value is -3.328 (p-value = 0.0686). Therefore, at a 0.10 significant level, the time series data is stationary. The result of each modeling method as shown in Table 1.

Table 1 shows the results of the predictive modeling of each technique. The Simple Exponential Smoothing technique has only one initial value of the smoothing estimate, which is ℓ_0, and there is only one

coefficient from the smoothing equation is α, ignoring the influence of trends and seasons, where α values that make $AIC, AICc, BIC$ the lowest are α = 0.9999.

The results of predictive modeling by Trend Method that is interested in the influence of trends, there will be 2 starting values, namely the initial value of the smoothed estimate (ℓ_0) and the initial value of the slope estimate (b_0), and there are 2 main coefficients: α and β, where α is the coefficient from the level equation and β are the coefficients from the trend equation which Holt's Linear Trend Method gives the α and β values that make the lowest $AIC, AICc, BIC$ values are α = 0.9928 and α = 0.0001, while the Damped Trend Method will have the damped smoothing coefficient (ϕ) increased by α, β and ϕ, making the lowest $AIC, AICc, BIC$ values α = 0.9919, β = 0.0001 and ϕ = 0.9460.

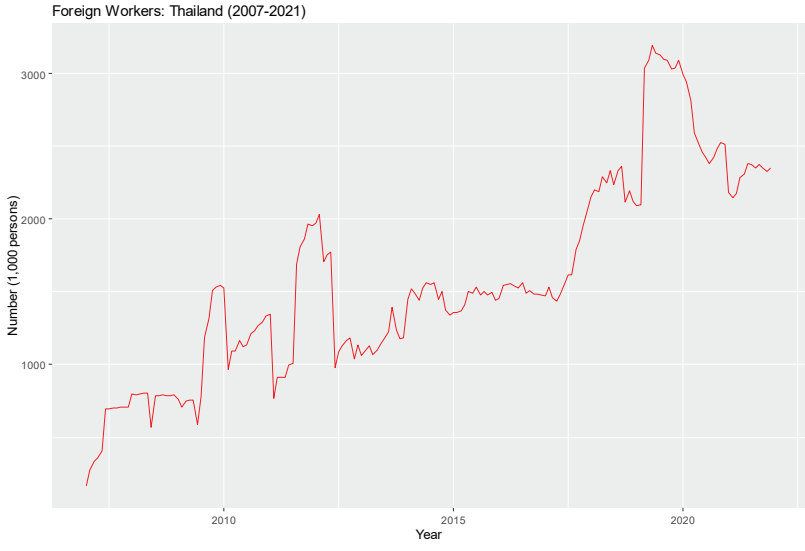

Figure 1 Data on the number of foreigners permitted to work throughout Thailand (unit: 1,000 people) from January 2007 to December 2021.

Table 1 Modeling results by exponential smoothing method.

Value	Simple Exponential Smoothing	Trend Method		Holt-Winters' Seasonal Method			
		Holt's Linear	Damped	Additive Method	Multiplicative Method	Damped Method	
						Additive	Multiplicative
Initial Value							
ℓ_0	168.277	154.761	154.571	443.525	442.405	438.805	423.420
b_0	-	14.036	65.986	18.748	20.652	28.289	29.994
$S_{0,1}$	-	-	-	23.875	1.004	24.041	1.020
$S_{0,2}$	-	-	-	25.143	1.038	25.801	1.015
$S_{0,3}$	-	-	-	39.347	1.010	37.767	1.017
$S_{0,4}$	-	-	-	59.781	1.027	60.237	1.024
$S_{0,5}$	-	-	-	28.014	1.039	30.079	0.995
$S_{0,6}$	-	-	-	-39.503	1.009	-46.203	0.974
$S_{0,7}$	-	-	-	-97.684	0.978	-97.271	0.966
$S_{0,8}$	-	-	-	-5.546	0.992	-4.193	1.005

Table 1 Modeling results by exponential smoothing method (cont.).

Value	Simple Exponential Smoothing	Trend Method		Holt-Winters' Seasonal Method			
		Holt's Linear	Damped	Additive Method	Multiplicative Method	Damped Method	
						Additive	Multiplicative
$S_{0,9}$	-	-	-	-18.304	0.973	-17.447	0.994
$S_{0,10}$	-	-	-	0.981	0.979	1.348	1.007
$S_{0,11}$	-	-	-	-42.198	0.948	-45.827	0.974
$S_{0,12}$	-	-	-	26.094	1.002	31.637	1.011
Coefficient Value							
α	0.9999	0.9928	0.9919	0.9891	0.7525	0.9878	0.9866
β	-	0.0001	0.0001	0.0002	0.0001	0.0001	0.0221
γ	-	-	-	0.0001	0.0001	0.0003	0.0002
ϕ	-	-	0.9460	-	-	0.9800	0.9800
Model selection							
AIC	2556.861	2559.456	2561.346	2577.528	2641.696	2579.408	2652.437
$AICc$	2557.008	2559.826	2561.868	2581.608	2645.776	2583.998	2657.028
BIC	2566.233	2575.075	2580.090	2630.636	2694.804	2635.639	2708.668

The result of predictive modeling by technique Holt-Winters' Seasonal Method is a technique that focuses on both trends and seasons. Therefore, in addition to the initial value of the smoothed estimate (ℓ_0) and the initial value of the slope estimate (b_0), there are also 12 default values of the season or seasonal indices ($S_{0,1}$, $S_{0,2}$, ..., $S_{0,12}$). According to the nature of the monthly time series data, there are 3main coefficients: α is the coefficient from the smoothed level equation, β is the coefficient from the smoothed equation of the trend (Trend Equation) and γ is the coefficient from the smoothed equation of the season (Seasonal Equations).

Holt-Winters' Additive Method provides the value for α, β and γ that make $AIC, AICc, BIC$ the lowest as follow; α = 0.9891, β = 0.0002 and γ = 0.0001. Holt-Winters' Multiplicative Method provides the value for α, β and γ that make $AIC, AICc, BIC$ the lowest as follow; α = 0.7525, β = 0.0001 and γ = 0.0001.

For the last method, the Damped Holt-Winters' Method, which is both an Additive Method and a Multiplicative Method, the Damped Smoothing Coefficient (ϕ) is added. Damped Holt-Winters' Additive Method has The values of α, β, γ and ϕ that result in the minimum values of $AIC, AICc, BIC$ are α = 0.9978, β = 0.0001, γ = 0.0003 and ϕ = 0.9800. The Damped Holt-Winters' Multiplicative Method has the values of α, β, γ and ϕ that result in the lowest values of $AIC, AICc, BIC$ have minimum values of α = 0.9866, β = 0.0221, γ = 0.0002 and ϕ = 0.9800.

Table 2 The result of forecasting assessment.

Exponential Smoothing Techniques	Training Data		Testing Data	
	RMSE	MAPE (%)	RMSE	MAPE (%)
Simple Exponential Smoothing	152.913	6.410	227.715	9.391
Holt's Linear Trend Method	152.274	6.322	308.644	13.311
Damped Trend Method	152.225	6.528	227.850	9.397
Holt-Winter's Additive Method	149.612	7.918	319.368	13.533
Holt-Winter's Multiplicative Method	159.429	7.988	337.302	14.185
Damped Holt-Winter's Additive Method	149.558	7.947	213.832	8.596
Damped Holt-Winter's Multiplicative Method	151.192	7.616	196.760	7.769

From Table 2, the researcher intends to evaluate the forecasting accuracy of the model for the period between 2007 and 2020 (training data). From the results, it was found that each method was quite accurate since all methods gave MAPE values less than 10% with Damped Holt-Winter's Additive Method giving the least value of RMSE. The method is close to all true values as shown in Figure 2.

Considering the forecasting assessment of each method to forecast in 2021 (Testing Data), Simple Exponential Smoothing, Damped Trend Method, Damped Holt-Winters' Additive Method, and Damped Holt-Winters' Multiplicative Method were found to produce quite accurate forecasting results, with MAPE values of less than 10%.

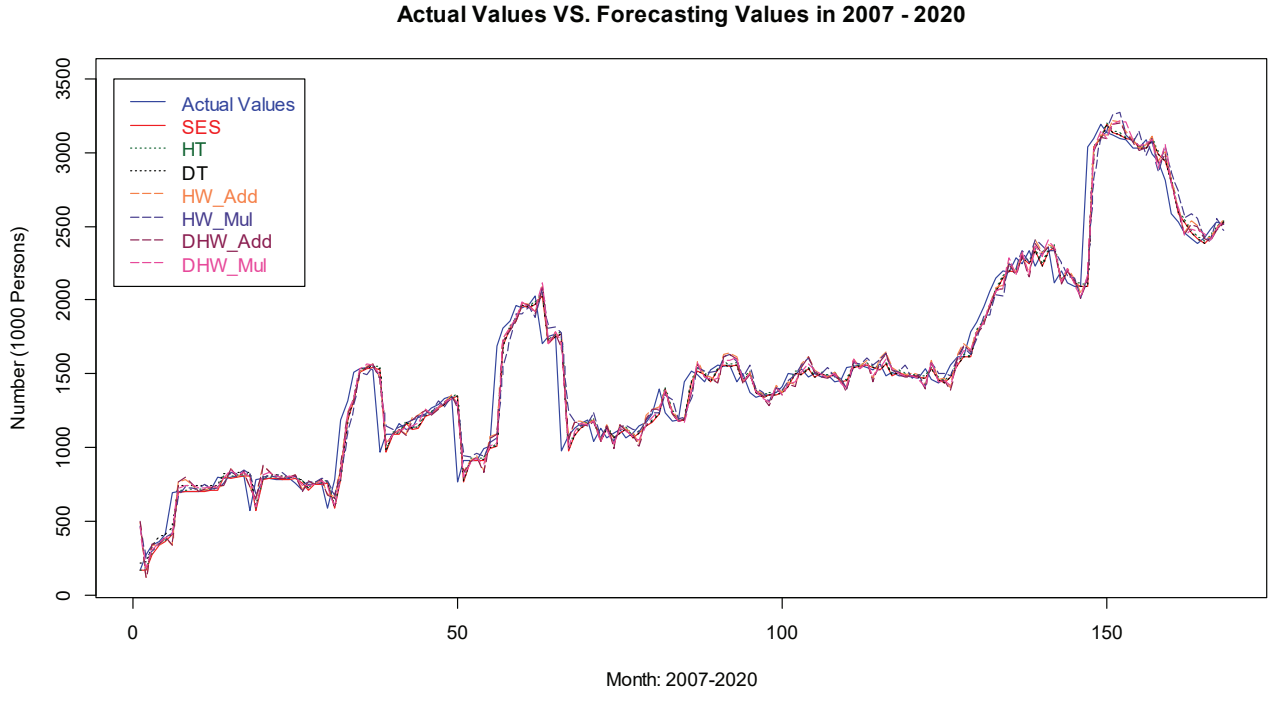

Figure 2 Forecasting by Exponential Smoothing with Various Techniques in 2007-2020.

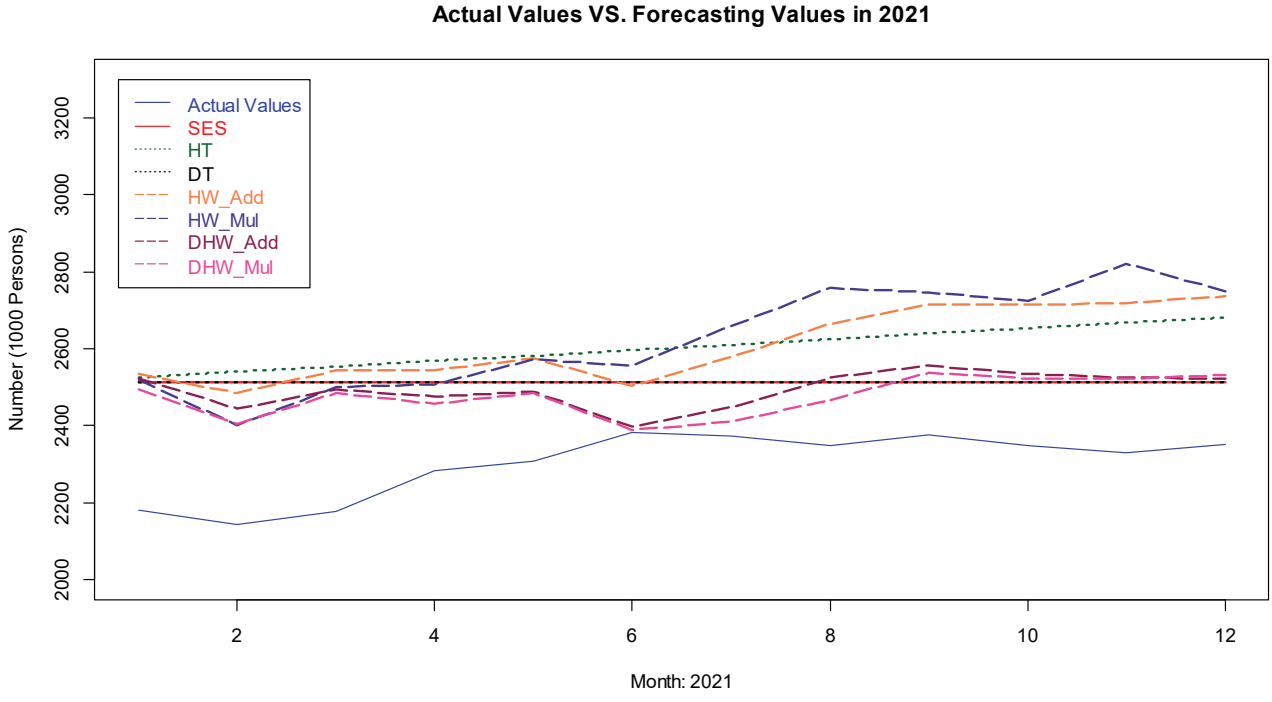

Figure 3 Forecasting by Exponential Smoothing with Various Techniques in 2021.

Holt's Linear Trend Method, Holt-Winters' Additive Method, and Holt-Winters' Multiplicative Method produced good predicting results because the MAPE value is between 10% and 20%. In addition, the Damped Holt-Multiplicative Winter's Method had a lower RMSE value than other approaches, indicating that it had a higher level of predicting accuracy.

From Figure 3, when the models of each method were compared with the actual data, it was found that the simple exponential smoothing method and the damped trend method overlapped and were found to be relatively stable. Holt's Linear Trend Method provides a forecast line that shows an increasing linear trend. Holt-Winters' Additive Method and Holt-Winters' Multiplicative Method have higher trend forecasts, but there are fluctuations from the influence of the seasons. Damped Holt-Winters' Additive Method and Damped Holt-Winters' Multiplicative Method are methods that add damping to slow down the rate of change in the number of foreign workers and are relatively stable but still influenced by the season. In comparison to other approaches, Damped Holt-Multiplicative Winter's method offers the prediction line that is most closely related to the true value and has the minimum RMSE value.

Conclusion and Discussion

This research presents a method for constructing a forecast model using exponential smoothing to time series data of the number of migrant workers throughout Thailand. This study collected data on the number of foreigners permitted to work throughout the Kingdom from January 2007 to December 2021 from the statistical database of the Bureau of Foreign Workers Administration, Department of Employment. The total of 180 values from the data collection were divided in to 2 sets: 1) 168 values for predictive modeling using 3 techniques: Simple Exponential Smoothing (SES), Trend Method, and Holt-Winters' Seasonal Method. Trend Methods can be divided into 2 types: Holt's Linear Trend Method and the Damped Trend Method. The Holt-Winters' Seasonal Method can be further subdivided into four methods: Holt-Winters' Additive Method, Holt-Winters' Multiplicative Method, Damped Holt-Winters' Additive Method, and Damped Holt-Winters' Multiplicative Method, for a total of seven methods. 2) 12 values were used to check the accuracy of forecasting using the lowest MAPE and RMSE criteria. The results showed that the Damped Holt-Winters' Multiplicative Method was the most accurate method for forecasting, indicating that the data tend to increase and the influence of the season is unstable, with the following forecasting model.

Forecasting Equation:

$$\hat{Y}_{t+1} = (\ell_t + b_t \sum_{i=1}^{h} 0.98^i) s_{t+h-m(k+1)}$$

Level Equation:

$$\ell_t = 0.9866 \frac{Y_t}{s_{t-m}} + 0.0134(\ell_{t-1} + 0.98 b_{t-1})$$

Trend Equation:

$$b_t = 0.0221(\ell_t - \ell_{t-1}) + 0.9779(0.98) b_{t-1}$$

Seasonal Equation:

$$s_t = 0.0002 \frac{Y_t}{(\ell_{t-1} + 0.98 b_{t-1})} + 0.9998 s_{t-m}$$

The initial value of the smoothed estimate (ℓ_0) was 423.420, the initial value of the slope estimate (b_0) was 29.994, and the initial value of the other 12 seasonality estimates or indices were 1.020, 1.015, 1.017, 1.024, 0.995, 0.974, 0.966, 1.005, 0.994, 1.007, 0.974, and 1.011 respectively from January to December. When using the forecasting model to plot a comparison graph between the actual data and the forecast for 2021, it was found that the Damped Holt-Winters' Multiplicative Method still had a clear distance between the actual data line and the forecast line despite the MAPE value and the lowest RMSE. But from the forecasting equations obtained, it is still enough to explain that adding damping has caused the rate of change in the number of foreign workers to slow down and be relatively stable, consistent with the situation of foreign workers in Thailand in 2021, which is still during the outbreak of COVID-19. Especially the third wave of the outbreak where the factory cluster was one of the sources causing the virus to spread across the country. As a result, migrant workers from neighboring countries who come to work in Thailand are seen as a risk group for both infection and transmission. Thailand has taken various measures to help control the outbreak of the disease among foreign workers, such as suspending the movement of workers along the border, delaying the approval of importing foreign workers, and providing flexibility for foreign workers whose permits will expire to be able to live in Thailand (Puey Ungphakorn Institute of Economic Research, 2020). This is the reason why the rate of change in the number of foreign workers slows down.

The forecasting model has shown that the number of foreign workers in Thailand fluctuates according to the trend caused by the increasing demand for labor in the industrial sector which corresponds to the research project on the needs of labor in the eastern region in the next 5 years (2018-2022). It was described that in the next 5 years there will be more demand for labor. This is because factories are constantly in demand for labor, especially in manufacturing industries with the highest demand for labor causing foreign workers to increase as well. Furthermore, there are also seasonal fluctuations caused by groups of migrant workers who use border passes under the border crossing agreement. which came to work in a round-trip season (Labor Economics Division, 2021) and irregular fluctuations caused by unusual events during the COVID-19 epidemic (Puey Ungphakorn Institute of Economic Research, 2020).

The forecasting using the exponential smoothing method prioritizes the most recent data and exponentially prioritizes the next data (Labor Market Research Division, 2007). This method does not take other factors into account at all, which are expected to affect the number of foreign workers in Thailand. In addition to the spread of COVID-19, there are other factors such as economic expansion (Labor Economics Division, 2021) or the expansion of industrial investment (Labor Market Information Administration Division, 2021). Therefore, in improving the model to forecast the number of migrant workers, a relationship model may be built by using other variables that correlate with the number of migrant workers, such as GDP, population, etc., to forecast as well to get more accurate forecasting results.

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