Foreign Tourists Arrival Forecasting at Major Airports in Indonesia: A Comparison of Holt-Winters and Exponential Smoothing Maximum Likelihood

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ABSTRACT

Purpose: This research purports to forecast the number of foreign tourists arriving at major airport in Indonesia. The airports chosen are Soekarno Hatta, Juanda, I Gusti Ngurah Rai, and Kualanamu international airports.

Design/methodology/approach: The data used were foreign tourists arrival at major airports located in Jakarta, Surabaya, Medan, and Denpasar. The data extended from January 2014 until December 2018. Two time-series methods were employed, namely Holt-Winter Seasonality and Exponential Smoothing with maximum likelihood. The forecasts would reveal the fitted numbers of foreign tourists arriving from January 2019 until December 2019. The fitted numbers would then be compared to the actual numbers of January 2019 to December 2019.

Findings: The results showed that, overall, Holt-Winters seasonality excel at forecasting foreign tourists arrival at Soekarno Hatta and Juanda international airports. While Exponential Smoothing perform better for prediction at I Gusti Ngurah Rai and Kualanamu international airports. The MAPE for Holt-Winters at Soekarno Hatta and Juanda international airports were 26.1585% and 14.538%. The MAPE for Exponential Smoothing at at I Gusti Ngurah Rai and Kualanamu international airports were 7.76% and 15.6791%.

Research limitations/implications: Forecasting for foreign tourist arrival at Soekarno Hatta and Juanda international airports should employ Holt-Winters approach. Forecasting for foreign tourists arrival at I Gusti Ngurah Rai and Kualanamu international airports should employ Exponential Smoothing with maximum likelihood.

Practical implications: Certain forecasting methods work better than the others at certain international airports. Many forecasting methods are available. Two methods are specifically prominent for detecting seasonality and trend, i.e Holt-Winters and Exponential Smoothing with maximum likelihood.

Originality/value: Most research focus on one method at a time. This research compares two methods so that we can know better which method is suitable for certain airports. Four international airports are sampled in this study. Not many research focus on several places at a time.

Paper type: Research paper

Keyword: Exponential Smoothing, Holt-Winters, Seasonality, Trend

I. INTRODUCTION

Tourism has always been a source of income for countries. The tourism industry generated approximately USD 1.5 trillion in 2015. The main tourist attractions are mainly located in the European continent. This
explains why Europe is the most earner from tourism industry. Asian continent ranked second right below European continent. The income generated by tourism was approaching USD 400 billion in 2015, while Europe gained more than USD 500 billion (Ardra, U., & Martawardaya, 2017). Another impact of tourism industry lies on the human development of the visited countries. Employment in a certain country is also affected by tourism industry. Many institutions and parties participate in laying the foundations and developing tourism. Therefore, it requires many manpower. A developed tourism industry will open jobs to the economy. Growing tourism will spur economic and trade development. Hence the term tourism-led economic growth hypothesis (Anggraeni, 2017; Holik, 2016; Amaluddin, 2019). Anggraeni, (2017) also further proved that the relationship between tourism and economic growth is of two-way causality. Besides affecting economic growth, tourism is also being affected by economic growth. It appears that foreign tourists feel more comfortable when the destination countries have a slightly developed infrastructure to guarantee their enjoyment and comfort during the vacation. Consequently, any efforts to drive economic development further will have direct impact on tourism industry. In order to take full advantage of tourism, countries must prepare the basic infrastructure and accommodation to welcome tourists. Foreign tourists will be attracted to arrive and thus tourism industry will commence contributing to the economy. Tourism also participates in the human development of the destination countries. Positive impact of tourism on human development index has been observed. The more developed a tourism industry in a country, the better the human development index. One of the aspect of human development that is directly affected by tourism is the literacy of the population (Biagi, Ladu, & Royuela, 2017). However, after certain threshold, tourism starts to impose certain externalities. Negative effect starts to be imminent when it extends beyond certain limit. Nevertheless, it appears that the positive effect of tourism transcends the purely economic effect. Indonesia also relies on tourism industry to generate national income. Although the share of tourism contribution to Indonesian GDP is less than 10%, it opens many job opportunities for the population. Tourism also has spurred growth through its multiplier effects in other industry such as transportation, accommodation, and small and medium enterprises (Mudrikah, Sartika, Yuniarti, Ismanto, & Satia, 2014). The total workforce absorbed by tourism sector is around 9% (Sujai, 2016). Therefore, advancement in tourism industry will also lead to growth in other sectors that support tourism industry. The purpose of this research is to compare two time-series forecasting methods, i.e Holt-Winters seasonality and Exponential Smoothing with maximum likelihood. These two methods have been proven exceptional at detecting trend and seasonality (Fauzi, N. F., Ahmad, N. S., Shafii, N. H., & Halim, 2020). By applying Holt-Winters and Exponential Smoothing with maximum likelihood, we can find out which method is better at detecting trend and seasonality at certain airports. Therefore, the regulators can apply such method for forecasting purposes. The result of forecasting will provide feedback to the government about whether the current policy has been on the right track to attract foreign visitors to Indonesia.

Holt-Winters seasonality has been employed in forecasting research. A modification of Holt-Winters called Holt-Winters damped model was used by Primandari, (2017). Holt-Winters damped model is usually applied for increasing trend. The prediction will lower future forecast because it is very common that the increasing trend is not sustainable, so a damping parameter will be added to lower future expectations (Primandari, 2017). The forecasting object is passengers arriving at Soekarno-Hatta airport. She found that Holt-Winters with damped trend outperformed the ordinary Holt-Winters. The resulting alpha was 0.9093, Beta 0.4888, and gamma 0.1180. Dewi, N. P., & Listiowarni, (2020) forecast staple food price in a regency in Madura. They compared the results generated by additive and multiplicative Holt-Winters. They found that additive Holt-Winters performed better with MAPE score of 1.02%, compared to 1.2% of multiplicative. This is indicative of food price that is better explained by additive Holt-Winters (Dewi, N. P., & Listiowarni, 2020). Nurhamidah, Nusyirwan, & Faisal, (2020) used Holt-Winters to forecast the number of passengers arriving at Hasanudin airport for the period of 2009-2019. The type of seasonality is additive. However, they did not use train data and test data in the research. Therefore it is hard to validate whether the forecast is accurate or not (Nurhamidah, Nusyirwan, & Faisal, 2020). Pertwi, (2020) used Holt-Winters to predict rainfall in Mataram city. The data were secondary data from Mataram Central Bureau of Statistics from 2014 to 2018. They found an alpha value of 0.2, beta 0.1, and gamma 0.1. However, the MAPE value is pretty large (142.3). Suggesting another model could be superior for predicting rain fall other than Holt-Winters (Pertwi, 2020). Holt-Winters is also instrumental in predicting pollution (Muna, S., & Kuntoro, 2021). Muna, S., & Kuntoro, (2021) tried to predict the air quality in Surabaya city. Constructing model using 2014 to 2019 data, they found that the value of alpha was 0.8, beta 0.5, and gamma 0.6. This model has a very low mean average percentage error (MAPE) of 10.3455%. Aryati, A., Purnamasari, I., & Nasution, (2021) used Holt-Winters to predict foreign tourists visiting Indonesia. The data were taken from January 2014 until September 2018. They found that the pattern matched multiplicative Holt-Winters. The MAPE was very small, i.e. 0.938%, indicating the excellence of the model for
prediction. The resulting alpha was 0.9, beta 0.1, and gamma 0.9 (Aryati, A., Purnamasari, I., & Nasution, 2021).

II. METHODOLOGY

This research focuses on forecasting methodology. The data were taken from the website of Kementerian Pariwisata dan Ekonomi Kreatif (http://kemenparekraf.go.id). The data showed the number of foreign tourists arriving at major international airports in Indonesia from January 2014 up to December 2019. The major international airports chosen are Soekarno-Hatta, Juanda, Kualanamu, and I Gusti Ngurah Rai international Airports. The data were split into two categories namely training and test data. The train data were from January 2014 until December 2018. The test data were from January 2019 until December 2019. Two methods of forecasting will be employed. They are Holt-Winters Seasonality and Exponential Smoothing with Maximum Likelihood. Both method will be applied against training data. The parameters will be estimated. Subsequently, both method will predict the numbers of foreign tourists for January 2019 until December 2019. The forecasts will then be compared to the test data to derive the accuracy of the forecasts. The parameter for forecast accuracy is MAPE.

The first forecasting method employed is Holt-Winters Seasonality. The type used is additive. The component form is as follows (Hyndman, R. J., & Athanasopoulos, 2018):

\[
\hat{y}_{t+h} = \ell_t + h \beta_t + s_t + h\cdot m(k+1)
\]

\[
\ell_t = \alpha(y_t - s_{t-m}) + (1-\alpha)(\ell_{t-1} + \beta_{t-1})
\]

\[
\beta_t = \beta(\ell_t - \ell_{t-1}) + (1-\beta)\beta_{t-1}
\]

\[
s_t = \gamma(y_t - \ell_{t-1} - \beta_{t-1}) + (1-\gamma)s_{t-m}
\]

\(\ell_t\) denotes the level equation. It is seasonally adjusted as can be seen from the equation, \(y_t - s_{t-m}\). It derives from the weighted average of seasonal adjustment and nonseasonal forecast \(\ell_{t-1} + \beta_{t-1}\). The seasonal equation is represented by \(s_t\). From the equation we can see that current seasonal pattern is a weighted average from previous seasonal pattern \(s_{t-m}\). The parameters of \(\alpha, \beta, \gamma\) will be estimated. The Holt-Winters seasonality works by minimizing the sum of squared errors. This is in contrast to exponential smoothing with maximum likelihood. This method will try to fit the best distribution to the data and then estimate the parameters. It will be conducted automatically by the R Studio software to fit the best distribution that maximizes the likelihood. The measurement for MAPE is as follows:

\[
MAPE = \frac{1}{n} \sum_{t-1}^{n} \frac{|y_t - \hat{y}_t|}{y_t} \times 100\%
\]

The equation above shows the deviation of forecast from the actual data is denoted by \(y_t\). This is the data at time \(t\), The forecast is \(\hat{y}_t\), the forecast at time \(t\). It is a percentage form. Therefore, it will be divided by the actual data times 100%. The smaller the MAPE number, the better the forecast result. The bigger the data, the further the deviation of forecast results from the actual data. Hence the forecast method that yield smaller number is considered better in performance.

III. RESULTS AND DISCUSSION

The following figure displays the graphic for foreign tourists arrival at major international airports in Indonesia.
The first figure on the top left-most panel shows us the graph for Soekarno Hatta airport. The second figure on the middle is Juanda airport. The third figure is Kualanamu Airport. The fourth figure, located on the second row, is the I Gusti Ngurah Rai airport. The visual inspection on the Soekarno Hatta figure tells us that there is clearly a seasonal pattern for the tourist arrival. At certain times in a year, there is a sharp increase in the number of tourists arriving, followed by a sharp decrease. The cycle tends to repeat at a regular interval. The magnitude of seasonality tends to increase. The second figure also shows some seasonality. Although it is not as obvious as that of Soekarno Hatta, Kualanamu, and I Gusti Ngurah Rai. In I Gusti Ngurah Rai international airport seasonality can be seen with an increasing trend. Soekarno Hatta and Juanda international airports also show some increasing trend. Only Kualanamu that does not display a characteristic of increasing trend. The following table displays the result of parameter estimation using Holt-Winters seasonality and Exponential Smoothing Maximum Likelihood (ETS):

<table>
<thead>
<tr>
<th></th>
<th>Holt-Winters</th>
<th></th>
<th></th>
<th>ETS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\alpha)</td>
<td>(\beta)</td>
<td>(\gamma)</td>
<td>(\alpha)</td>
<td>(B)</td>
<td>(\gamma)</td>
</tr>
<tr>
<td>Soekarno Hatta</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0193</td>
</tr>
<tr>
<td>Juanda</td>
<td>0.5267</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.323</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kuala</td>
<td>0.4645</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.3778</td>
<td>0</td>
<td>0.0001</td>
</tr>
<tr>
<td>IG Ngurah Rai</td>
<td>0.9455</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.9988</td>
<td>0</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

*Figure 1 Foreign Tourists Arrival At Indonesian Major Airports*

Table 1 Parameter Estimation Results using Holt-Winters and Exponential Smoothing Maximum Likelihood (ETS)
We can see from the above table that Holt-Winters consistently produce identical results for the $\beta$ and $\gamma$. Both are the parameters for the weighted average calculation of trend and seasonality. According to Holt-Winters the trend and seasonality of foreign tourists arrival at Indonesia major international airports are roughly the same. The $\alpha$ value differs among airports. This is a seasonally adjusted level value. ETS method considers $\beta$ value of 0 for Juanda, Kualanamu, and I Gusti Ngurah Rai airports. This indicates that the trend for a certain time period is just a continuation of trend at prior period, $b_t = b_{t-1}$. Juanda also has $\gamma$ value of 0. Current seasonality is a perpetuation of prior period seasonality $s_t = s_{t-1}$, a representation of marked seasonality. Kualanamu and I Gusti Ngurah Rai airports have the same weighted average of seasonality, while Soekarno Hatta has a $\gamma$ value of 0.0193. As Holt-Winters approach, the $\alpha$ value differs among airports. There is a different level of foreign tourists arrival at different airports. After estimating the parameters, the next step is plotting the forecast interval in figures below:

![Forecasts from Holt-Winters' additive method](image1)

![Forecasts from Holt-Winters' additive method](image2)

![Forecasts from Holt-Winters' additive method](image3)

![Forecasts from Holt-Winters' additive method](image4)

Figure 2 Forecast Intervals Using Holt Winters

The first figure on the top left panel is of Soekarno-Hatta, followed by Juanda international airports. The second row contains Kualanamu (left) and I Gusti Ngurah Rai (right) international airports. Holt-Winters seasonality is very excellent in recognizing the trend and seasonality in the data. Consequently, it produces forecast intervals that mimic the trend and seasonality of the historical data. The dark blue shade is 80% confidence interval, while the light blue is 95% confidence interval. That is why the light blue interval is wider than the dark one. Soekarno-Hatta and I Gusti Ngurah Rai forecast intervals produce two seasonalities that are different from each other. The difference looms because of the trend. Juanda and Kualanamu forecast intervals generate two identical seasonality with no trend. This could result in not so good forecast number of foreign tourist arrivals. The following is the forecast intervals generated by ETS:
The above figures show the result for ETS estimation. The results are different from Hot Winters’. Soekarno-Hatta, Kualanamu, and I Gusti Ngurah Rai international airport displays forecast results with obvious trend and seasonality. There is a clear indication of forecast results of when there will be a peak and there will be a trough. A forecast result like this will make it easy for the related institutions to make some planning based on the forecasts. The dark blue region indicates confidence interval of 80% and the light blue 95%. The light blue is always wider than the dark blue. However, ETS seems to predict that there will be no trend and seasonality for Juanda. It resorts back to naïve random walk in which the last value is the best prediction for the
next period value. We can expect that the result is not so good for Juanda airport. The following table display the results of forecast and the related MAPE value:

<table>
<thead>
<tr>
<th>Date</th>
<th>SH</th>
<th>SHHW</th>
<th>SHETS</th>
<th>JU</th>
<th>JUHW</th>
<th>JUETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec-19</td>
<td>186723</td>
<td>253347</td>
<td>220893</td>
<td>20546</td>
<td>23449</td>
<td>24529</td>
</tr>
<tr>
<td>Nov-19</td>
<td>183759</td>
<td>264274</td>
<td>215670</td>
<td>20780</td>
<td>24930</td>
<td>24529</td>
</tr>
<tr>
<td>Oct-19</td>
<td>189231</td>
<td>264416</td>
<td>255122</td>
<td>20895</td>
<td>22154</td>
<td>24529</td>
</tr>
<tr>
<td>Sep-19</td>
<td>211775</td>
<td>263382</td>
<td>230215</td>
<td>20462</td>
<td>22666</td>
<td>24529</td>
</tr>
<tr>
<td>Aug-19</td>
<td>251596</td>
<td>310742</td>
<td>230116</td>
<td>29180</td>
<td>24529</td>
<td>24529</td>
</tr>
<tr>
<td>Jul-19</td>
<td>267143</td>
<td>273955</td>
<td>218967</td>
<td>24913</td>
<td>23673</td>
<td>24529</td>
</tr>
<tr>
<td>Jun-19</td>
<td>190031</td>
<td>212138</td>
<td>290528</td>
<td>22485</td>
<td>20430</td>
<td>24529</td>
</tr>
<tr>
<td>May-19</td>
<td>156654</td>
<td>235855</td>
<td>314377</td>
<td>14529</td>
<td>21443</td>
<td>24529</td>
</tr>
<tr>
<td>Apr-19</td>
<td>196977</td>
<td>238951</td>
<td>255928</td>
<td>18431</td>
<td>21860</td>
<td>24529</td>
</tr>
<tr>
<td>Mar-19</td>
<td>214161</td>
<td>259291</td>
<td>257388</td>
<td>20497</td>
<td>20651</td>
<td>24529</td>
</tr>
<tr>
<td>Feb-19</td>
<td>196183</td>
<td>223520</td>
<td>251603</td>
<td>17389</td>
<td>16820</td>
<td>24529</td>
</tr>
<tr>
<td>Jan-19</td>
<td>174963</td>
<td>219997</td>
<td>241226</td>
<td>13792</td>
<td>17086</td>
<td>24529</td>
</tr>
</tbody>
</table>

The above table the actual data from January 2019 until December 2019 for Soekarno-Hatta (SH) and Juanda international airports (JU). The column SHHW denotes the forecast result using Holt-Winters approach for Soekarno-Hatta and SHETS means the approach used is exponential smoothing with maximum likelihood for Soekarno Hatta. From the bottom of the table we can see that the MAPE value for SHHW is lower than SHETS (0.261585 < 0.312971). This means Holt-Winters is more superior in predicting the foreign tourists arrival at Soekarno-Hatta international airport. The column JU denotes the actual data for Juanda airport. The next column is the result of applying Holt-Winters approach to Juanda airport (JUHW). The last column displays the forecast results for Juanda by doing ETS approach. As we can see in the figures displaying forecast results for Juanda, the number is constant. This is a naïve forecast in which the last value is assumed to persist in the future. The MAPE number shows that Holt-Winters is again more able to predict with better result than ETS. The following table displays result for Kualanamu and I Gusti Ngurah Rai international airports.
IV. CONCLUSION

The purpose of this research is to compare two time-series forecasting methods, i.e Holt-Winters seasonality and Exponential Smoothing with maximum likelihood. These two methods have been proven exceptional at detecting trend and seasonality. The results show that Holt-Winters seasonality performs better for predicting foreign tourists arrival at Soekarno-Hatta and Juanda international airports. On the other hand,
Exponential Smoothing with maximum likelihood performs better at prediction of Kualanamu and I Gusti Ngurah Rai international airports. However, Exponential Smoothing with maximum likelihood fails to recognize patterns of trends and seasonality at Juanda international airports. The result only shows a single value for prediction period of 12 months. Therefore Holt-Winters is proven robust to identify seasonality and trend for forecasting purpose.

REFERENCES


