Comparison of Forecasting the Number of Outpatients Visitors Based on Naïve Method and Exponential Smoothing

I Basri K¹, I D Sumitra²
Departemen Pascasarjana, Universitas Komputer Indonesia, Indonesia

E-mail: *ilhambasrik@gmail.com

Abstract. This paper aimed to predict outpatient visits from both general and BPJS category based on the Naïve and the Exponential Smoothing method, these two methods are compared to obtain the best method in predicting outpatient visits at XYZ hospitals. The data that were processed in this paper is based solely on the annual data collection over a period of 5 years from 2014-2018 which consists of 2 categories, namely general visit data and BPJS visit data. The annual general category data has the following data amounts: 2014 = 11028, 2015 = 12950, 2016 = 17587, 2017 = 21951, and 2018 = 19049. As for the BPJS visit data, the data as follows 2014 = 16869, 2015 = 14059, 2016 = 14217, 2017 = 13019, and 2018 = 9641. Results of predictions number of outpatient visits from Naïve method on the visit data which is categorized as general has MSE 5191788 and MAPE values of 16.335%, the categorized BPJS has a value of MSE 13165490 and MAPE 19.081%. While the Exponential Smoothing method on the visit data that is categorized as general has MSE 7790587 and MAPE values of 21.808%, BPJS category only having MSE 13165490 and MAPE values of 20.718%. Of the two methods, the method considered better is the Naïve method which has a percentage of MAPE values <20%. It can be concluded that the Naïve method is more suitable for forecasting the number of visits from the general category and BPJS compared to the Exponential Smoothing method because the forecast value and the std err are smaller.

1. Introduction
Forecasting is a science practice used to predict a thing or value that have not been happened and has a purpose to predict something that will happen in the future [1]. Forecasting is a vital part of every business organization and to every management decision which is very significant, [2, 3, 4, 5]. To do a forecasting, we need data that can be used as a reference in forecasting. The data is periodic data (time series) [6]. A time series is a sequence of observations indexed by time, usually ordered in equally spaced intervals and correlated. In our days, it is well known the importance of time series studies. These studies provide indicators about a country economy, the unemployment rate, the export and import product rates, etc. The most interesting and ambitious task in time series analysis is to forecast future values. Models are commonly fitted in order to predict future values of a time series [7, 8, 9]. The examples of this time series model include Moving Average, Exponential Smoothing and trend projections.

In 2016, Dwi Aprilia [10] conducted a study entitled The Application of the Forecast Exponential Smoothing Method to the Number of Puskesmas Patients in Surabaya. The results of this study indicate the number of visits at Mulyorejo Community Health Center patients that fluctuate every month. Comparison of previous research with this study has been done, but the previous research using only one method, while this study is to compare 2 methods consisting of naïve and Exponential Smoothing which aims to find the best method so that it can be used to see patterns of data on the number of visitors in will come.

This research is expected to be able to anticipate if there is a shortage of visitors by adding less fulfilled facilities. Another difference from the previous study was that the number of outpatient visits predicted had 2 categories: general visit category and BPJS visit category.

2. Methods
This study uses the Naïve and Exponential Smoothing method in predicting the number of outpatient visits both from the general category and the BPJS category.
2.1. Naive Method
Naïve method is a forecasting method that only uses last year’s actual value data as a forecast for this year, and so on. The next year’s forecast is only (t + 1) will be the same as this year’s data. The assumption that demand in the future period will be the same as the demand in the last period. The formula of the Naïve Method is:

\[ F_t = Y_{t-1} \] (1)

2.2. Exponential Smoothing Method
Exponential smoothing is a method of forecasting a moving average with a sophisticated weight but still easy to use. This method uses very little recording of past data. The basic exponential smoothing formula can be shown as follows:

\[ F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1}) \] (2)

Where:
- \( F_t \): New forecast
- \( F_{t-1} \): Previous Forecasting
- \( A \): smoothing constants (weighting) \( 0 \leq \alpha \leq 1 \)
- \( A_{t-1} \): last period actual demand

Smoothing constants for applications in the business field usually range from 0.05 to 0.5.

2.3. Evaluation of forecasting results
Evaluation of forecasting results is used to determine the accuracy of the forecasting results that have been made on the actual data. Some of the methods used are:

2.3.1 Mean Squared Error (MSE)
The Mean Squared Error (MSE) is a method for evaluating each error or remainder squared. Then added up and added to the number of observations. This approach regulates large forecasting errors because they are squared

\[ \text{MSE} = \frac{1}{N} \sum_{t=h}^{n} (Y_t - \hat{Y}_t)^2 \] (3)

Where:
- \( \text{MSE} \): Mean Square Error
- \( N \): Number of Samples
- \( t, y \): Actual Value Index
- \( t, \hat{y} \): Index Prediction Value

2.3.2 Mean Absolute Percentage Error (MAPE)
This method calculates the difference between the original data and forecasting data. The difference is validated, then calculated into the percentage of the original data. The percentage yield then obtained a mean value of Percentage Error (Percentage Error)

\[ \text{MAPE} = \frac{\sum_{i=1}^{n} |PE_i|}{n} \] (4)

Where:
- \( \text{MAPE} \): Mean Absolute Percentage Error
- \( N \): amount of data used
- \( t \): the \(-t\) period
3. Results and Discussion

3.1. Model identification.
In the process of identifying this data, we have to look at actual plot data from patient visits from the General category and BPJS, such as Figure 1:

![Graph of Annual Data Chart of Visitor’s Number](image1.png)

**Figure 1.** Annual data chart of visitor’s number

3.1.1 Forecast graph

3.1.1.1 The forecast graph of the naïve method.
Test results from actual data on patient visits in the general category and BPJS are predicted using the Naïve method to get the results of its predictions, such as Figure 2:

![Graph Plot of Actual and Forecast Methods Naïve](image2.png)

**Figure 2.** Graph plot of actual and forecast of methods Naïve

3.1.1.2 The forecast graph of the Exponential Smoothing method.
Test results from actual data of patient visits in the general category and BPJS are predicted using the *Exponential Smoothing* method to get the results of its predictions, such as Figure 3:
3.1.2. Forecast Naïve and Exponential Smoothing methods [11]
Determining the results of the actual data of patient visits from the general as well as the BPJS produces the forecast value as shown in the following table, such as Table 1:

| Method                  | General          | BPJS             |
|-------------------------|------------------|------------------|
| Naïve                   | -2.043650        | -1.954967        |
| Exponential Smoothing   | -1.682676        | -1.593350        |

4. Conclusions
Test results showed that the Naïve method on the visit data categorized as GENERAL have the next period Forecast 9641 which produces MSE 5191788 and MAPE 16.335% values with the std err reaches 3222,356. Then, the categorized BPJS has next period Forecast 19049 which produces MSE 13165490 and MAPE 19.081% with std err reaching 5131,372. Whereas for the Exponential Smoothing method on the visit data with GENERAL categorized has next period Forecast 11785.38 which produces MSE 7790587 and MAPE values 21.808% with std err reaching 3947.3. Next, the categorized BPJS has next period Forecast 18709.25 which produces MSE 13165490 and MAPE 20.718% with std err reaches 6587,942. It can be concluded that the Naïve method is more suitable for forecasting the number of visits from the general category and BPJS compared to the Exponential Smoothing method because the forecast value and the std err are smaller. Besides, the Naïve method on the MAPE value is <20% while Exponential Smoothing has > 20%

Acknowledgements
All praises we thank to Universitas Komputer Indonesia as our beloved University, to Universitas Komputer Indonesia lecturers and classmates of MSI 17 who gave a lot of input in making this journal.

References
[1] M A Maricar, P Widiadnyana and W A Wijaya, “Analysis of Data Mining for Forecasting Total Goods Delivery with Moving Average Method”. International Journal of Engineering and Emerging Technology, 2(1), January—June 2017.
[2] Rabby Q. Lavilles and Mary Jane B. Arcilla, “Enrollment Forecasting for School Management System”. International Journal of Modeling and Optimization, 5, October 2012
[3] Gene Rowe, George Wright “The Delphi technique as a forecasting tool: issues and analysis” International Journal of Forecasting 15 (1999) 353–375 www.elsevier.com/locate/ijforecast.

[4] Vinicius Alencar Siqueira, Walter Collischonn, Fernando Mainardi Fan and Sin Chan Chou,” Ensemble flood forecasting based on operational forecasts of the regional Eta EPS in the Taquari-Antas basin” Versão On-line ISSN 2318-0331 RBRH, Porto Alegre, v. 21, n. 3, p. 587-602, jul./set. 2016 Scientific/Technical Article.

[5] Eva Ostertagová1, Oskar Ostertag2 “The Simple Exponential Smoothing Model” Modelling of Mechanical and Mechatronic systems 2011, September 20 – 22, 2011 Herľany, Slovak Republic vol 380

[6] Time Series Analysis. In J. Schinka & W. F. Velicer (Eds.), Research Methods in Psychology(581-606). Volume 2, Handbook of Psychology (I. B. Weiner, Editor-in-Chief.). New York: John Wiley & Sons

[7] Eva OSTERTAGOVA, Oskar OSTERTAG “Forecasting Using Simple Exponential Smoothing Method” Acta Electrotechnica et Informatica, 12(3), 2012, 62–66, DOI: 10.2478/v10198-012-0034-2

[8] Baki Billah, Maxwell L. King, Ralph D. Snyder, Anne B. Koehler “Exponential smoothing model selection for forecasting” B. Billah et al. / International Journal of Forecasting 22 (2006) 239–247.

[9] Maria Elena Nenni, Luca Giustiniano and Luca Pirolo” Demand Forecasting in the Fashion Industry: A Review” Int. j. eng. bus. manag., 2013, 5, Special Issue Innovations in Fashion Industry, 37:2013.

[10] Dwi Aprilia, “Penerapan Metode Forecast Exponential Smoothing pada Jumlah Pasien Puskesmas” Jurnal Biometrika dan Kependudukan, 5(2) Desember 2016: 146–156.

[11] Arroyo, J., San Roque, A. M., Maté, C., & Sarabia, A. (2007). Exponential smoothing methods for interval time series. In Proceedings of the 1st European Symposium on Time Series Prediction (pp. 231-240).