Forecasting The Number of Death Due To Traffic Accidents in Medan City Using Exponential Smoothing Method

Muhammad Suhadi[1], Susiana[2]

[1,2]Department of Mathematics-Faculty of Mathematics and Science Naturals, Medan State University

Article Info	ABSTRACT
Article history:	This study aims to determine the prediction of the number of deaths due to traffic accidents in the city of Medan in 2009 - 2018. This study was conducted with quantitative forecasting, namely forecasting based on quantitative data in the past. The data of this study is data on the number of deaths due to traffic accidents in the city of Medan in 2009 - 2018 with a total of 10 years. Data were analyzed using Microsoft Excel with Exponential Smoothing method. The number of deaths due to traffic accidents in Medan City in 2019 was 244 people, in 2020 it was 219 people, and in 2021 it was 197 people with a MAPE of 0.1536659 or 15.36% with an alpha constant (α = 0.1). This shows that the level of accuracy at MAPE <20, meaning that the forecasting ability is good using the Exponential Smoothing method while the MAD value is 41.02 and the MSE value is 2677.54.
Keywords:	
Forecasting, Exponential Smoothing, Mortality, Traffic Accident	

Corresponding Author:

Muhammad Suhadi
Department of Mathematics-Faculty of Mathematics and Natural Sciences, Medan State University
Email: muhammadsuhadi999@gmail.com

1.   INTRODUCTION

Roads are a very important requirement in the traffic transportation system, both land, sea and air transportation. Lack of attention to safety issues will cause traffic accidents to increase. Transportation services are very closely related to the safety aspects of both people and goods, a city that is developing, all sectors are racing to move forward. Traffic accidents that occur in Indonesia can still be prevented by paying more attention to infrastructure planning and completeness of road transportation facilities based on road categories. Traffic accidents are a problem that requires serious handling because of the large impact of losses caused. Based on the Global Status Survey on Road Safety published by WHO in 2013 states that the number of deaths due to traffic accidents in Indonesia has increased sharply, namely 20,000 in 2009 and increased to 31,234 in 2010. According to data from the Indonesian Police Traffic Corps in 2010 , out of 31,234 victims died due to traffic accidents in Indonesia.

Medan City is the capital of North Sumatra Province and one of the big cities in Indonesia. In the city of Medan itself, the data on deaths due to traffic accidents is still quite high. Where, in the last five years, the average death due to traffic accidents has reached 1749 people every year. This data does not include losses due to traffic accidents such as material losses, serious injuries, and minor injuries BPS (2017). A process of systematically estimating what is most likely to happen in the future based on past and present information so that the error (difference between what happened and the forecast result) can be minimized. One method for predicting what will happen in the future is forecasting.

Forecasting is a tool in one of the appropriate management functions used so that planning can be carried out effectively. Decisions that will be made in the future are more considered because of forecasting that uses data in the past. Ginting (2019) suggests that forecasting is a scientific guess (educated guess) because in every decision making involves conditions that will occur in the future, which underlies the forecast decision making.

2. RESEARCH METHODE
Traffic Accident

A traffic accident is an incident where a motorized vehicle collides with another object and causes damage. Sometimes these accidents can result in injury or death to humans or animals. Traffic accidents are events that are difficult to predict when and where they will occur. There are several divisions regarding accidents, namely:

a. Accidents based on accident victims
   Accidents based on accident victims emphasize humans themselves, these accidents include minor injuries, serious injuries or death.
b. Accidents based on the location of the incident
   Accidents can be found anywhere along the road, both on roads, road bends, climbs and derivatives, on the plains or in the mountains, inside the city or outside the city.
c. Accidents based on the time of the accident
   Accidents based on the time of the accident can be classified into two, namely the type of day (weekdays, holidays, and weekends) and time (morning, afternoon/evening, evening).
d. Accidents based on the position of the accident
   Accidents can occur in various collision positions, namely collisions while sneaking (side swipe), front and side collisions (right angle), face-to-back collisions (rear end), face-to-face collisions (head on), collisions with pedestrians (pedestrian). , hit and run (Hit & Run), and collision out of control (Out of Control).
e. Accidents based on the number of vehicles involved
   Accidents can also be based on the number of vehicles involved, whether it is a single accident carried out by one vehicle, multiple accidents carried out by two vehicles or a series of accidents carried out by more than two vehicles.

Mortality

Ismail (2009) suggests that medically death can be detected, which is marked by the cessation of a person's heartbeat. However, knowledge about death until this modern age is still very limited, no one knows when he will die, therefore not a few also feel anxious and stressed due to this mysterious thing. Everyone who lives believes that he will experience death. Even so, it turns out that many are trying to avoid death and optimize all their potential to live longer. Some people, so afraid of death, are not afraid of death itself, but of the process of dying which is described as an excruciating pain, while others are afraid of what will happen to them after death.

Defenition of Forecasting

According to Noh (2015), forecasting is also defined as the art and science of predicting future events. This can be done by involving taking data from the past and placing it into the future with a mathematical model. Some of the uses of forecasting have an important role, namely for scheduling available resources, as providing additional resources, lead time for obtaining raw materials, accepting new workers, or purchasing machinery and equipment can range from a few days to several years, and as a determining the resources desired by each institution must determine the resources it wishes to have in the long term. (Makridakis, 2018)

Based on the forecast period, the forecasting can be divided into three types, namely:

a. Short-term forecasting, namely forecasting carried out for the preparation of forecast results with a period of one year or less. This forecasting serves to determine the quantity and time of production capacity. This forecast is used to make decisions in terms of whether or not overtime is needed, work scheduling, and other short-term control decisions;
b. Medium-term forecasting, namely forecasting carried out for the preparation of forecast results for the next one to five years. This forecasting serves to plan the quantity and time of production capacity. This forecasting is more specialized than long-term forecasting which is used to determine cash flow, production planning, and budgeting.

c. Long-term forecasting, namely forecasting carried out for the preparation of forecast results for a period of more than five years to come. This forecasting serves to plan the quantity and time of production facilities. Long-term forecasting is used to make decisions regarding product and market planning, company expenses, factory feasibility studies, budgets, purchase orders, workforce planning and work capacity planning.

Time Series

The time series method is a series of values of a variable or observation result that are recorded in successive periods of time. The time series method is a forecasting method that uses an analysis of the relationship pattern between the variables to be estimated with the time variable (Rusdiana, 2014). An important step in choosing an appropriate time series method is to consider the type of data pattern, so that the most appropriate method with that pattern can be tested. Data patterns can be divided into four types, namely horizontal patterns (H), trend patterns (T), seasonal patterns. and cyclical pattern (S).

Exponential Smoothing Method

The Smoothing Method is a forecasting method for smoothing or smoothing past data by taking the average of the values in several periods to estimate the value in a period (Novica, 2018). The Smoothing method consists of moving average (Moving Average), trend projection (Trend Projection), and Exponential Smoothing.

The Exponential Smoothing method is a procedure that repeats calculations continuously using the latest data. This method is one of the time series analysis which is a forecasting method that shows the weighting decreases exponentially in a series of previous observations. The basic exponential smoothing formula can be written mathematically as follows:

$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$

where:

F_t : new forecasting
F_{t-1} : previous forecast period
α: smoothing, constant ($0 \leq \alpha \leq 1$)
A_{t-1} : previous actual demand period
The working principle of this method is based on the calculation of the average past data with exponential weighting. Each data is given a weight, where the more recent data is given the greater weight. The weight used is (Constant Smoothing or smoothing constant) for the most recent data, (1) is used for data from the previous period.

Error Size Value

Forecasting accuracy is a fundamental thing in forecasting, namely how to measure the suitability of a certain forecasting method for a given data set. Accuracy is seen as a refusal criterion to choose a forecasting method. In time series modeling from past data, it is possible to predict situations that will occur in the future, to test the correctness of this forecast, the accuracy of the forecast is used. Several criteria are used to test the accuracy of the forecast between the following methods:
MSD (Mean Absolute Deviation)

$$MSD = \frac{A_t - F_t}{n}$$

MSE (Mean Square Error)

$$MSE = \frac{e_i^2}{n}$$

MAPE (Mean Absolute Percentage Error)

$$MAPE = \sum_{i=1}^{N} \frac{PE_i}{n}$$

Methods

This research was conducted at BPS North Sumatra Province for 2 months. The type of data obtained is quantitative data (data on the number of deaths due to traffic accidents in 2009-2018)
The steps taken to conduct this research are as follows:
a. Literature Study, namely reviewing library sources related to the problem.

b. Data Collection, namely obtaining or retrieving data from the Central Statistics Agency (BPS) of North Sumatra. The data taken are deaths due to traffic accidents from 2009 to 2019.
c. Forecasting with Exponential Smoothing Method.
d. calculate the value of forecasting accuracy with MAPE (Mean Absolute Percentage Error) and MSE (Mean Square Error).
e. Draw conclusions.

3. RESULT AND ANALYSIS

Table 4.1: Data on the Number of Deaths Due to Traffic Accidents in Medan City

Year	Number of Deaths Due to Traffic Accidents
2009	227
2010	181
2011	331
2012	309
2013	257
2014	292
2015	251
2016	221
2017	217
2018	257

In the process of plotting the data shows that the number of deaths due to past accidents in Medan City within 10 years sometimes decreases then sometimes increases but the changes only occur at some time. The stationary data pattern occurs when the values of the data fluctuate around the average constant value. After looking at the resulting graph, it can be seen that the pattern of data on deaths due to traffic accidents in Medan City is stationary or has no trend. This shows that the data pattern is horizontal, where this type of data occurs when the data fluctuates around a constant average value.

The data for calculating the single exponential smoothing model uses data on the number of deaths due to traffic accidents in the city of Medan. The calculation of single exponential smoothing is done by determining the value of the smoothing constant (α). In determining the value of can use the formula:

$$\alpha = \frac{2}{n+1}$$, so:

$$\alpha = \frac{2}{10+1} = \frac{2}{11} = 0{,}18$$

Table 4.2: Comparison of Error Value with alpha 0.1

alpha = 0,1

YEAR	NUMBER OF DEATH	FORECAST	MAD	MSE	MAPE
2009	227	227	0	0	0
2010	181	227	46	2116	0,25414
2011	331	222,4	108,6	11793,9	0,32809
2012	309	233,26	75,74	5736,54	0,24511
2013	257	240,834	16,166	261,339	0,06290
2014	292	242,4506	49,5494	2455,14	0,16969
2015	251	247,40554	3,59446	12,9201	0,01432
2016	221	247,76499	26,7649	716,364	0,12110
2017	217	245,08849	28,0884	788,963	0,12944

2018	257		242,27964	14,7203	216,689	0,05727
2019			243,75167			
2020			219,37651			
2021	197,43886					
Error				41,0248	2677,54	0,15356
						15,3565

Based on the results of calculations using Microsoft excel, it can be seen in the table that the forecast for the number of deaths due to traffic accidents in Medan City in 2019 is 243.75167, in 2020 it is 219.37651, and in 2021 it is 197.43886, the value of **MAD** is 41.02485. the value of **MSE** is 2677,547, and the value of **MAPE** is 0.1535659.

Based on the calculation results above, the constant alpha ($\alpha = 0.1$) has the smallest error rate on **MAPE** when compared to other constant alphas. This shows that the number of deaths due to traffic accidents in the city of Medan in 2019 was 243,75167 rounded up to 244 people, in 2020 it was 219.37 rounded up to 219 people and in 2021 it was 197,43886 rounded up to 197 people.

4. CONCLUSION

Based on the research results that have been described in the discussion section, the following conclusions can be drawn: Forecasting the number of deaths due to traffic accidents in the city of Medan in 2019 using the exponential smoothing method is 244 people in 2019, 219 people in 2020 and 197 people in 2021. The calculation results obtained **MAPE** values of 15, 35659 or 15.36%, this indicates that the level of accuracy at **MAPE** < 20 means the value of forecasting ability is good, while the **MAD** value is 41.02 and the value of **MSE** is 2677.54 with a constant alpha ($\alpha = 0, 1$). **MAPE** indicates how much error in forecasting is compared to the real value, the lower the **MAPE** value the more accurate the forecasting technique and the greater the **MAPE** value the less accurate the forecasting technique. Forecasting ability is very good if it has a **MAPE** value of less than 10 and has good forecasting ability if it is less than 20. The results obtained by **MAPE** = 15.36 less than 20 means that the forecasting ability is good using the single exponential smoothing method.

REFERENCE

[1] Berlian, R., (2019): Model Peramalan Laka Lantas Polres Kolaka MenggunakanMetode Autoregressive Integrated Moving Average (ARIMA), Skripsi. 21 -22.

[2] BPS (2017): Perkembangan Inflasi Kota Medan Tahun 2017, Badan Pusat Statistika, Medan.

[3] Desi, Y., (2016): Peramalan Jumlah Penduduk Kota Samarinda Dengan Menggu- nakan Metode Pemulusan Eksponensial Ganda dan Tripel Dari Brown, Jurnal Eksponensial, 07(01).

[4] Fani, E. d., (2015): Perbandingan Metode Winter Eksponensual Smoothing dan Metode Event Based untuk Menentukan Jumlah Produk Terbaik di Perusahaan X, Jurnal Teknologi dan Ilmu Komputer, 04(16), 393 – 401.

[5] Fatimah (2015): Perbandingan Keefektifan Metode Exponential Smoothing dan Metode Dekomposisi untuk Peramalan Tingkat Hunian Hotel AL Salam II Sengkang, Skripsi, .

[6] Ginting, R., (2019): Sistem Produksi, Graha Ilmu, Yogyakarta.

[7] Hasanah (2019): Penerapan Metode Exponential Smoothing dalam memprediksi

[8] Jumlah Peserta Didik Baru di MAN 2 Kota Jambi, Skripsi, . Heizer, J., (2017): Manajemen Operasi, Salemba Empat, Jakarta.

[9] Hotima, d. D., (202): Penggunaan Metode Exponential Smoothing untuk Peramalan Penjualan Galvalum (Studi kasus pada Toko Istana Galvalum Jember), Majalah Ilmiah "Dian Ilmu", 19(02).

[10] Ismail, R., (2009): Menuju Hidup Islami, Insan Madani, Yogyakarta. Makridakis. (2018): Metode dan Aplikasi Peramalan, Erlangga, Jakarta.

[11] Noh, J., W. d. Y., (2015): Model Average Based FTS Markov Chain untuk

[12] Peramalan Penggunaan Bandwidh Jaringan Komputer, EECCIS, 9(1).

[13] Novica, I., (2018): Perbandingan Double Moving Average Dengan Double Exponential Smoothing Pada Peramalan Bahan Medis Habis Pakai, Jurnal Teknologi dan Sistem Informasi, 02(197 - 204).

[14] Rukhansah, N., M. M. d. A. R., (2015): Fuzzy Time Series Markov Chain dalam

[15] Meramalkan Harga Saham, Seminar Nasional Ilmu Komputer, .

[16] Rusdiana (2014): Manajemen Operasi, CV. Pustaka Setia, Bandung.