# *Forecast of* COVID-19 *Cases in Indonesia with the Triple Exponential Smoothing Algorithm*

# Perkiraan Kasus COVID-19 di Indonesia dengan Algoritma Triple Exponential Smoothing

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***Abstract***. *The Coronavirus* (SARS-CoV-2)*, also known as* COVID-19*, has brought a worldwide threat to the living. The whole world is making extraordinary efforts to combat the spread of this deadly disease in terms of infrastructure, finances, data sources, protective equipment, life risk treatment, and several other resources. Artificial intelligence researchers focus their knowledge of expertise on developing mathematical models to analyze this epidemic situation using shared national data. To contribute to the welfare of the living community, this article proposes to utilize the Triple Exponential Smoothing algorithm to predict the development of* COVID-19 *throughout the country by utilizing real-time information from the Task Force for the Acceleration of Handling of Coronavirus Disease* 2019 *in Indonesia. Based on forecasting results, in Indonesia by the end of* 2020, COVID-19 *will continue to grow significantly, the number of confirmed* COVID-19 *people is* 386,571 *people with a death toll of* 15,622.

***Keywords:*** *forecast*, *algorithm*, *triple exponential smoothing*, COVID-19, *coronavirus*.

**Abstrak**. Virus Corona (SARS-CoV-2) yang juga dikenal sebagai COVID-19 telah membawa ancaman dunia bagi kehidupan. Seluruh dunia melakukan upaya luar biasa untuk memerangi penyebaran penyakit mematikan ini dalam hal infrastruktur, keuangan, sumber data, peralatan pelindung, penanganan risiko jiwa, dan beberapa sumber lainnya. Peneliti kecerdasan buatan memfokuskan pengetahuan keahlian mereka pada pengembangan model matematika untuk menganalisis situasi epidemi ini menggunakan data nasional bersama. Untuk berkontribusi bagi kesejahteraan masyarakat yang masih hidup, artikel ini mengusulkan untuk memanfaatkan algoritma Triple Exponential Smoothing untuk memprediksi perkembangan COVID-19 di seluruh tanah air dengan memanfaatkan informasi real-time dari Satgas Percepatan Penanganan Penyakit Coronavirus 2019 di Indonesia. Berdasarkan hasil peramalan, di Indonesia pada akhir tahun 2020 COVID-19 akan terus bertambah secara signifikan, jumlah penderita COVID-19 yang terkonfirmasi sebanyak 386.571 orang dengan korban meninggal sebanyak 15.622 orang.

**Kata kunci***: forecast*, algoritma, *triple exponential smoothing*, COVID-19, *coronavirus*.

## INTRODUCTION

COVID-19 or better known as the Novel Corona Virus is associated with respiratory disorders in humans which have been declared a global epidemic and pandemic in the first quarter of 2020 by the World Health Organization [1]. The COVID-19 virus infects people of all ages. However, evidence to date suggests that two groups of people are at a higher risk of developing severe disease COVID-19 [2]. They are older people and those with underlying medical conditions. WHO stresses that all must protect themselves from

COVID-19 to protect others. On March 10, the IFRC, UNICEF, and WHO released new guidelines to help protect children and schools from catching the COVID-19 virus. WHO briefly describes the possible modes of transmission of COVID-19, including contact, droplets, air, fomite, fecal-oral, blood, mother-to-child, and animal-to-human transmission. COVID-19 infection mainly causes respiratory illness ranging from minor illnesses to severe illness and death, and some people who are infected with the virus never experience symptoms. Transmission of COVID-19 can occur through direct, indirect, or close contact with an infected person through infected secretions such as saliva and respiratory secretions or respiratory droplets, which are released when an infected person coughs, sneezes, talks or sings [3]. Respiratory droplets less than 5-10 μm in diameter while droplets more than 5μm in diameter are referred to as droplet cores or aerosols [4]. Respiratory droplet transmission can occur when a person has close contact (within 1 meter) with an infected person who has respiratory symptoms (for example, coughing or sneezing) or is talking or singing. In this situation, respiratory droplets containing the virus can reach the mouth, nose or a susceptible person's eye, and this can lead to infection. Indirect contact transmission which involves contact with contaminated objects or surfaces (fomite transmission) also allows for virus transmission.

Air transmission from air transmission is defined as the spread of infectious agents caused by the dispersal of droplets (aerosols) which remain infectious when floating in the air for long distances and time [4]. It is suspected that airborne transmission of SARS-CoV-2 can occur even in aerosol-producing medical procedures [2, 5].

WHO, together with the scientific community researching Covid-19, has been actively discussing and evaluating whether SARS-CoV-2 can also spread through aerosols without aerosol-generating procedures, especially in the setting of indoor air conditioners with poor ventilation.

The vapor from inhalation together with the flow resulted in the hypothesis that it was a possible mechanism for the spread of SARS-CoV-2 via these aerosols [6]. This theory states that exhaled breath produces microscopic aerosols smaller than 5 μm and that evaporating and speaking also produces exhaled aerosols. Thus, susceptible people can inhale aerosols and can become infected if the aerosol contains enough virus to cause infection in the recipient.

In the early stages of the discovery of the COVID-19 pandemic, several countries implemented lockdown policies. However, this policy received a pro and contra response. Not all countries apply lockdown for various reasons. In Indonesia, the government does not issue a lockdown policy. The provisions issued are in the form of Large-Scale Social Restrictions or PSBB. With this PSBB policy, population mobility has indeed decreased [7].
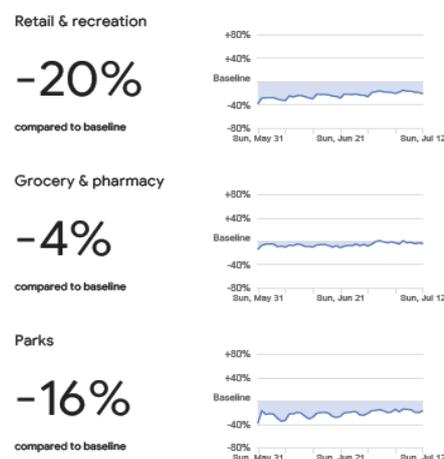


**FIGURE 1.** Graph of retail and recreational mobility, wholesale and pharmacy and parks.
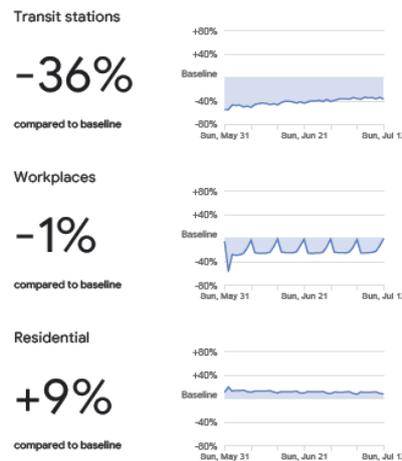
**FIGURE 2.** Transportation, workplace and residential mobility graphs.

Based on Figure 1, it can be seen that the trend of population mobility to mobility trends in places such as restaurants, cafes, shopping centers, amusement parks, museums, libraries, and cinemas has decreased by 20%. This data is generally collected throughout Indonesia and does not differentiate between location, rural or urban. So are trends in mobility for places such as wholesale markets, supermarkets, traditional markets, specialty food stores, drug stores, and pharmacies. Compared to the baseline, it has decreased by 4%. Mobility trends for places such as national parks, public beaches, marinas, plazas, and public parks have decreased by 16%. COVID-19, or better known as the Novel Corona Virus, is associated with respiratory disorders in humans which have been declared a global epidemic and pandemic in the first quarter of 2020 by the World Health Organization [1].

From Figure 2, it can be seen that there is an increase in mobility in residential areas. This PSBB policy has an impact on increasing housing mobility by up to 9%.

Measures to reduce the rate of increasing the spread of COVID have been taken, such as minimizing social contact through social distancing, closing various activities that involve large numbers of people, closing schools and colleges, and limiting public transport operations. However, COVID-19 in Indonesia continues to increase; therefore, it is necessary to make a quantitative estimate of this growth. Its main objective is to take the necessary steps to study the impact of the deployment which will assist in policy planning. Several researchers have predicted the spread of COVID 19 using different algorithms such as Machine Learning and Deep Learning, including neural networks for deep learning polynomial fitting, exponential smoothing, ARIMA and Backpropagation, and Fuzzy Tsukamoto [8-11]. In this study, the Triple Exponential Smoothing (TES) algorithm will be used to see the development of the spread of COVID-19.

## MATHEMATICAL MODEL

Forecasting is a process of predicting carried out with qualitative and quantitative approaches to predict future events by using reference to past data. There are two kinds of methods, namely qualitative methods and quantitative methods. Qualitative methods only use intuition without using mathematical or statistical approaches. Quantitative methods can be divided into two ways, namely the causal method and the time series method [11]. The causal method considers the value of a variable as the influence of many other variables. Meanwhile, the time series method only considers the value of a variable as a function of time. According to Makridakis, forecasting techniques are divided into two parts; the first is the subjective forecasting method and the objective forecasting method. The subjective forecasting model has a qualitative model, and the objective forecasting method has two models, namely the time series model and the causal model.

**Exponential Smoothing**

Calculates or estimates future value based on existing (historical) values using the AAA version of the Exponential Triple Smoothing (TES) algorithm. The estimated value is the continuation of the historical value within the specified target date, which should continue from the timeline. This function can be used to predict future sales, inventory needs, or consumer trends.

Exponential smoothing was first proposed in 1957 by C. C. Holt and is intended for a non-repeating time series (without seasonality), which does not show any trend. In 1958, he also proposed a modification of this method, which took into account the trend of Double Exponential smoothing. In 1965, Winters generalized this method to periodic adjustments.

**Triple Exponential Smoothing**

Therefore, the Triple Exponential Smoothing method is also called the Holt-Winters (Holt-Winters method). The main formula is as follows:

$$S_t = \alpha \frac{y_t}{I_{t-L}} + (1 - \alpha)(S_{t-1} + b_{t-1}) \tag{1}$$

Trend smoothing

$$b_t = \gamma(S_t - S_{t-1}) + (1 - \gamma)b_{t-1} \tag{2}$$

Seasonality smoothing

$$I_t = \beta \frac{y_t}{S_t} + (1 + \beta)I_{t-L} \tag{3}$$

Forecast

$$F_{t+m} = (S_t + mb_t)I_{t-L+m} \tag{4}$$

where,

    *a, b* and *g* from [0;1]
    *y* - observation
    *S* - smoothed observation value
    *b* - trend rate
    *I* - seasonality index
    *F* - forecast for *m* periods ahead
    *t* - current observation index

As for another exponential smoothing, $\alpha$, $\beta$ and $\gamma$ are selected on trial to minimize the mean squared error. Parameters that need to be considered in this method are the existence of the value *L*, and the number determines, where the more the number of L, the more accurate the estimate.

## DATA COLLECTIONS

In Indonesia, from March 2 to August 1, 2020, there were 108,376 confirmed cases of COVID-19 with a total number of 5,131 deaths [12].
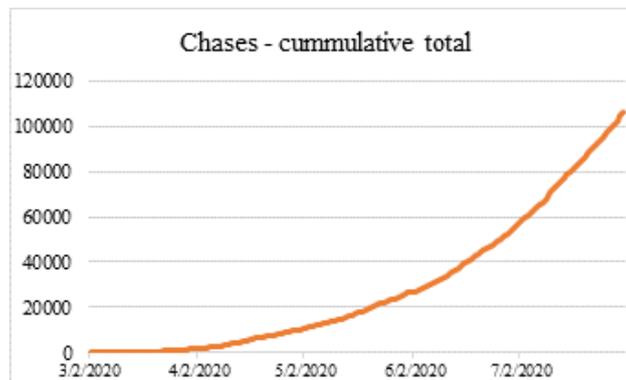


**FIGURE 3.** Graph of the total number of confirmed COVID-19 cases.

Figure 3 is the total number of confirmed COVID-19 patients as of July 31, 2020. While Figure 4 provides profile data for the number of COVID-19 sufferers on a daily basis.

In addition to data on COVID-19 sufferers, WHO also released data on victims who died. Figure 5 shows the total deaths due to COVID-19 in Indonesia, which were recorded as of July 31, 2020. Figure 6 provides a profile of deaths recorded on a daily basis. Due to the time issue, the data only has some differences since there is a difference between Indonesian local time and world time.
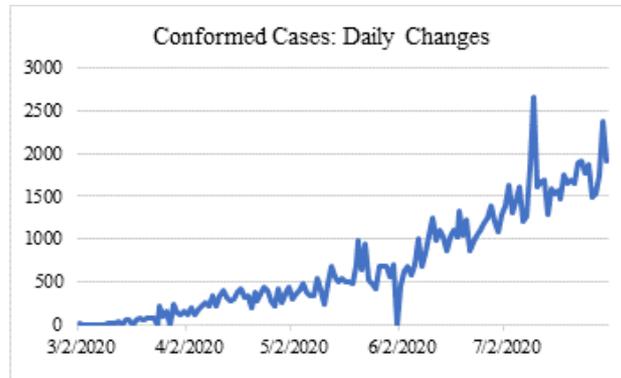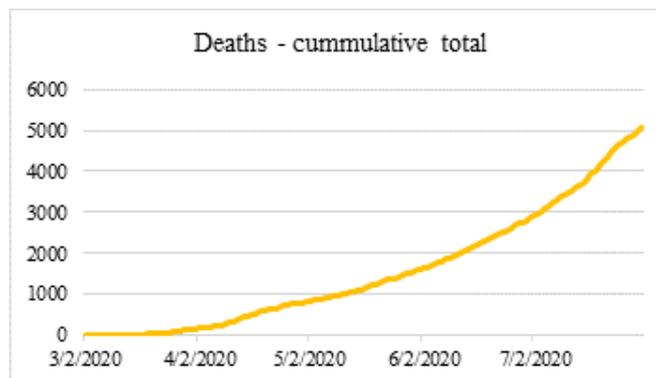


**FIGURE 4.** Profile of confirmed COVID-19 cases.



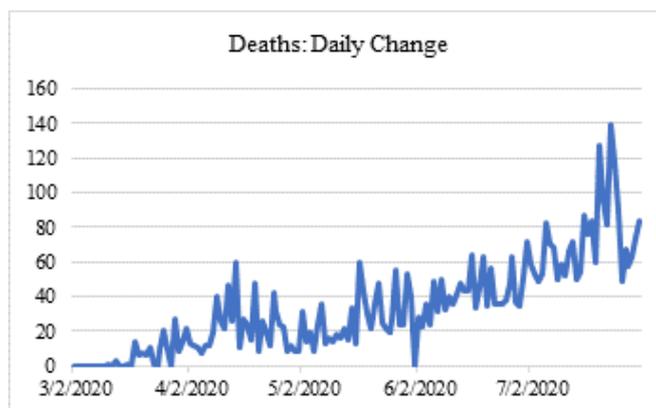**FIGURE 5.** Graph of total deaths due to COVID-19.



**FIGURE 6.** Profile of COVID-19 deaths in Indonesia.

## FORECASTING

Based on Figure 3, with the Triple Exponential Smoothing Algorithm (TES), the estimated number of people confirmed with COVID-19 as of December 31, 2020, in Indonesia is

65

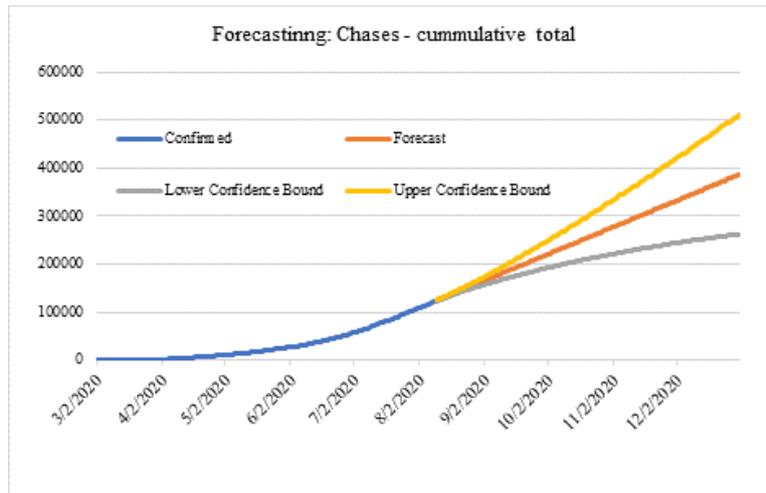forecasting to be 386,571 people with a lower limit between 261,986 and an upper limit of 511,157 people as in Figure 7.



**FIGURE 7.** Forecast of the total number of confirmed COVID-19 cases.
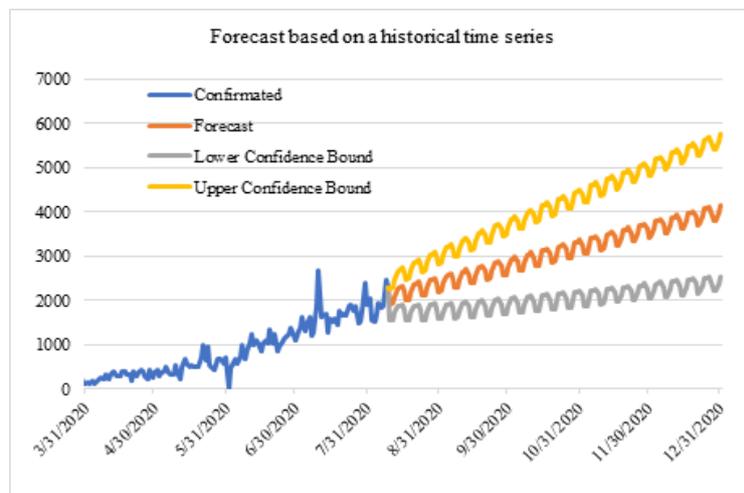


**FIGURE 8.** Forecast profile of confirmed COVID-19 cases

The number of daily confirmed COVID-19 cases in Indonesia can also be predicted, throughout August 2019 to December 31, 2020 it will continue to reach the highest until it reaches 4,159 cases with a maximum limit of 5,777 people and a lower limit of 2,541. Estimated data is given in Figure 8.
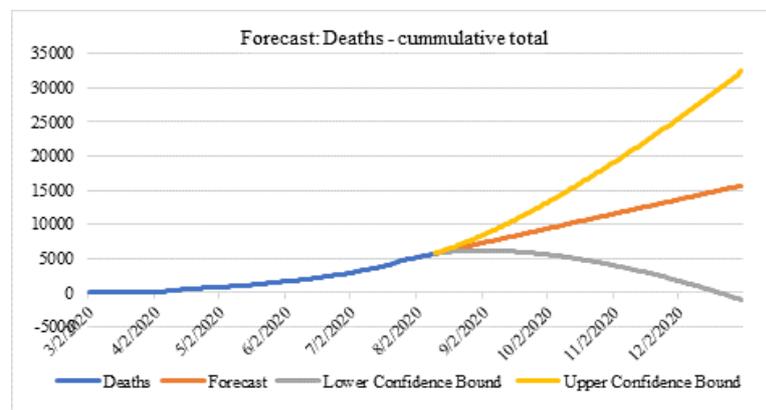


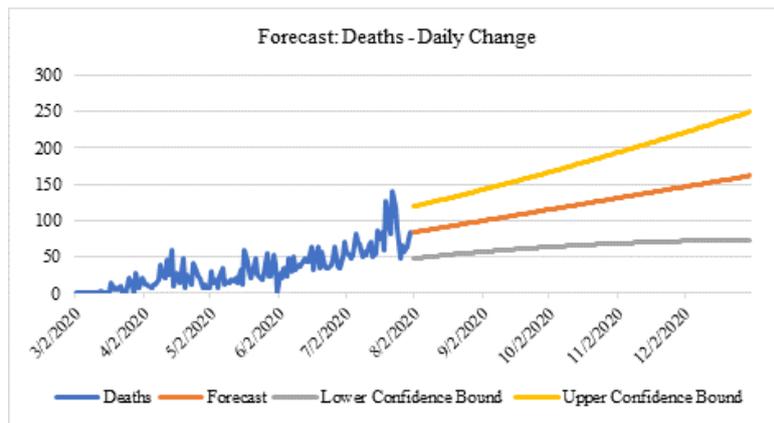**FIGURE 9.** Forecast of deaths cumulative total.

**FIGURE 10.** Forecast of deaths-daily change.

As for death cases, Figure 9 provides an estimate of the total death toll as of 31 December 2020 of 15,662 people. In the upper limit, it can be seen that the number who died could reach 32,346 people and the lower limit that is estimated to have died is -1,033 people mean no one died. The lower value reaches minus because the data on death cases is very volatile. There are days when the mortality rate is high, but there are days when there are no reported deaths due to COVID-19, these data have an impact on large forecast deviations.

Based on Figure 10, According to the daily mortality profile, it is predicted that by the end of 2020, the total daily mortality is estimated to be 161 per day.

From the World Health Organization data processed using the Triple Exponential Smoothing algorithm, in this study the estimates can be concluded as given in Table 1.

**TABLE 1.** Forecasting COVID-19 in Indonesia on December 31, 2020

|  | Daily | | | Total | | |
|---|---|---|---|---|---|---|
|  | Forecast | LCB | UCB | Forecast | LCB | UCB |
| Confirmed | 4,159 | 2,541 | 5,777 | 386,571 | 261,986 | 511,157 |
| Deaths | 161 | 74 | 249 | 15,662 | -1,033 | 32,356 |

From this data, preventive steps can be taken to overcome this serious problem of the COVID-19 pandemic. The layers of society must support the smooth program that has been implemented by the Government of Indonesia. If necessary, the government might need to carry out a lockdown to treat the increasing pandemic.

## CONCLUSION

With the development of current forecast estimates, the ETS algorithm is one of the options for estimating. In accordance with the prediction results of ETS, where the growth of COVID-19 in Indonesia is still experiencing a significant increase, it is necessary to take more concrete steps to reduce the growth rate of COVID-19. With the ETS algorithm, it is estimated that the number of confirmed COVID-19 will be 386,571 with the number of deaths of 15622 people by the end of 2020 in Indonesia. Meanwhile, the daily population rate confirmed by COVID will reach 4159 with the number of deaths of 161 people per day.

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