



Forecasting Number of Covid-19 Positive Patients in Sorong City Using the Moving Average and Exponential Smoothing Methods

Matheus Supriyanto Rumetna*, Tirsia Ninia Lina

Faculty of Computer Science, Victory University of Sorong, Papua Barat, Indonesia

Email: ¹*matheus.rumetna@gmail.com, ²tirsawp@gmail.com

Corresponding Author: matheus.rumetna@gmail.com

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Abstract—Sorong City is a part of West Papua Province, Indonesia. This city is one of the cities which have been affected by the Covid-19. This research attempts to provide a solution for the Sorong City Covid-19 Task Force's need for forecasting number of potential Covid-19 positive patients in the coming months so that faster treatment could be made. Such need has emerged due to the absence of laboratories and the increasing number of positive Covid-19 patients in the city. The absence of laboratories in the city has made the task force to send samples of presumed Covid-19 patients to the laboratories in Makassar City in order to be examined and tested. This process has been time consuming and further reducing the task force's already reduced performance effectiveness because of the social distancing policy applied in cities in Indonesia. The forecasting methods utilized in the research were the Moving Average and Exponential Smoothing. The methods were applied using POM-QM Software for Windows Version 5. The results of the Exponential Smoothing method are better than the results of the Moving Average method in forecasting the number of possible Covid-19 patients in July. For August and September forecasts, the results of the Moving Average method are better than the results of the Exponential Smoothing method. The results from both methods could be used as reference by the Sorong City Covid-19 Task Force in making decision and establishing policy.

Keywords: Forecasting; Moving Average; Exponential Smoothing; Covid-19; Sorong City Covid-19 Task Force

1. INTRODUCTION

The Coronavirus Disease, popularized as the Covid-19, was first identified in Wuhan City, Hubei Province, China, in December 2019 [1],[2],[3],[4],[5],[6],[7],[8],[9],[10],[11],[12],[13],[14],[15],[16],[17],[18]. During its first appearance, there were not many health experts who could have predicted that the disease could have risen to the pandemic level since the disease was considered a type of pneumonia with typical symptoms such as coughs, breathing problems, etc [19],[20],[21],[22],[23],[24],[25],[26]. The Covid-19 has managed to spread worldwide in rapid rate, driving the World Health Organization (WHO) to declare it as a pandemic. The Covid-19 has attacked many countries in the world, including Indonesia [2],[27],[28].

The first two cases of the Covid-19 spread in Indonesia were found in Depok City, West Java Province, in February 2020. Having seen his two citizens become the Covid-19 positive patients, the president of the Republic of Indonesia has taken several strategic measures. One of them is to establish Covid-19 Task Forces. Its goal was to establish a systematic treatment for the pandemic and prevent its wider spread [2],[27]. All areas in the Republic of Indonesia have their own Covid-19 Task Forces (headed by each own District Head), including Sorong City [29],[30],[31] which has a density of population [32],[33].

According to an official announcement from the spokesman of the Sorong City Covid-19 Task Force, Rudy R. Laku, on March 27th 2020, one Covid-19 positive patient and one patient under observation were identified. It was the first Covid-19 case in the city. At the end of March 2020, the total number of Covid-19 positive patients reached two, and has been increasing dramatically ever since: 8 patients in April 2020, 54 patients in May 29th 2020 and 92 patients in June 26th 2020. The absence of laboratories in the city has been hindering the task force to handle and treat the increasing number of the positive patients. Since there is no laboratory in the city, the samples of the patients would be sent to the laboratories in Makassar City by plane. This process depends on available flight schedules. In the laboratories, the samples would be examined and tested. After the test results were generated, they would be sent back to Sorong City by plane. This process has been time consuming, reducing the task force's performance in handling the pandemic. Therefore, there is a need to create a system which can be used by the task force to predict number of the Covid-19 positive patients in the coming months so that treatment process could be accelerated and prepared better in advance.

Alfian Nurlifa and Sri Kusumadewi [34] conducted a research using the Moving Average method in applying a management information system in which a forecasting is performed to help a store manager in decision making. The method was used to forecast the sales number in the coming months. The research produced a forecasting system which was used by the Rumah Jilbab Zaky store. The system is able to forecast next sales numbers based on existing categories.

A research conducted by Matheus Supriyanto Rumetna, Elisabeth Esmeralda Renny and Tirsia Ninia Lina regarding a problem faced by Samsung Partner Plaza company where the company would run out of inventory to be sold in the coming months. A company's inability to provide inventory that customers demand may cause them to find the goods they want in other companies, therefore reducing the company's opportunity to acquire profit. The research aimed to create a forecasting media which could provide information regarding number of inventory adequate enough to meet the customers' demands. The methods used in the research were Waterfall and Exponential Smoothing. The research produced an information system for forecasting inventory which helps the company order adequate amounts of inventory for next sales [35].

Next, a research conducted by Kristien Margi S and Sofian Pendawa W [36] explains that the Exponential Smoothing method is good for forecasting mid and long terms. The method's strength lies in its relatively easy operation. The research processed the data from PT. Media Cemara in 2015 which were presented monthly and the results were information regarding sales prediction and its accuracy with data MAD, MSE and MAPE.

Arminas and F. T. Karanga [37] in their research analyzed the sales forecast for Comforta's Bed. Their research aim was to predict future demands for the products. The company would produce the end goods solely based on the number of inventory in the warehouse. This effort was deemed ineffective. The methods used in the research were data analysis and process using POM software for Windows. A weakness of their product research was that there is no way to predict future demands with 100% certainty.

Based on the previous researches above, our research attempted to forecast the number of potential Covid-19 positive patients in Sorong City for the coming months using the Time Series Analysis and the Moving Average and Exponential Smoothing methods. Both methods were able to analyze several factors accounting for the Covid-19 event by examining the data of the Covid-19 in the past. POM-QM software for Windows Version 5 was also used to perform the process. Hopefully, this would help the Sorong City Covid-19 Task Force by providing number of potential positive patients for incoming months to be used as a reference in making decision and establishing policy. This has been the aim of this research.

2. RESEARCH METHODOLOGY

The Moving Average and Exponential Smoothing methods were utilized for forecasting. Data were collected from an online interview with a member of the Sorong City Covid-19 Task Force.

2.1 The Moving Average Method

The Moving Average Method is used when the past data do not possess any trend pattern or seasonal factors. This method is widely used to determine a trend from certain timeline [34],[38],[39],[40],[41],[42]. The method's equation is as follows:

$$MA = \Sigma X - \text{number of periods} \quad (1)$$

where:

MA = Moving Average

ΣX = Total calculation of all data from the calculated time periods

Number of Periods = Number of Periods of Moving Average

Or it could be alternatively presented as follows:

$$MA = (n1 + n2 + n3 + \dots) / n \quad (2)$$

where:

MA = Moving Average

n1 = Data from the first period

n2 = Data from the second period

n3 = Data from the third period etc.

n = Number of Periods of Moving Average

2.2 Exponential Smoothing

The Exponential Smoothing method uses a very few recording of past data. The model assumes data to fluctuate around a fixed average value without following any pattern or trend [41],[42],[43]. The following is an equation to calculate an Exponential Smoothing:

$$F_t = F_{t-1} + \alpha (D_{t-1} - F_{t-1}) \quad (3)$$

where:

F_t = Forecast of Current Demand

F_{t-1} = Forecast of Past Demand

α = Eksponential Constant

D_{t-1} = Demand.

3. RESULT AND DISCUSSION

The research used the monthly period in forecasting. The data used were regarding the Covid-19 positive patients in Sorong City during the last four months (March-June 2020), starting from March 27th until June 26th 2020. More detailed information can be seen in Table 1.

Table 1. The data regarding the Covid-19 positive patients in Sorong city

Month	Number of the Covid-19 positive patients
March	2 people
April	8 people
May	54 people
June	92 people

The data in Table 1 would be processed using POM-QM software for Windows Version 5. The software was first introduced by Howard J. Weiss in 1996. It was developed to perform necessary calculation needed by a management party to make decision [44],[45],[46]. The first forecast would be conducted using the Moving Average method (see equations 1 and 2) with periods to average = 4. This was done to predict number of potential Covid-19 positive patients in Sorong City for next three months (July, August and September) based on the data from March, April, May and June.

The forecast results for July show that there would be increase in the number of Covid-19 positive patients to 39 people (see Figure 1). In August, there would be another increase to 48,25 (or 48 after being rounded) in the number of Covid-19 positive patients (see Figure 2). In September, the number would likely to increase to 58,25 (or 58 after being rounded) people (see Figure 3). The forecast results of the Moving Average method are listed in Table 2.

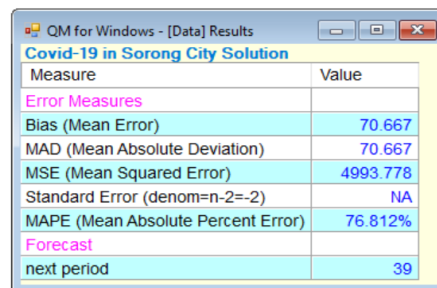


Figure 1. The forecast results for July using the Moving Average method and POM-QM Software

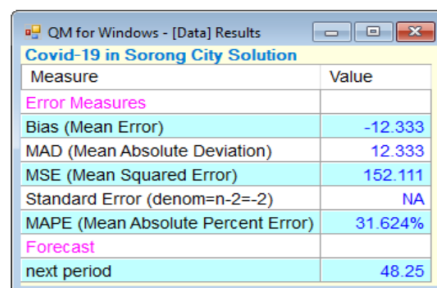


Figure 2. The forecast result for August using the Moving Average method and POM-QM Software

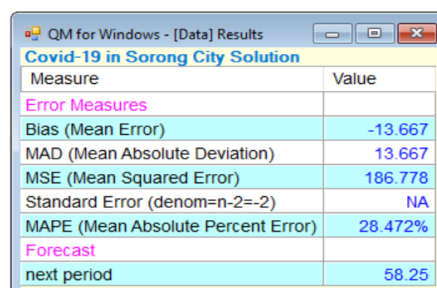


Figure 3. The forecast results for September using the Moving Average method and POM-QM Software

Table 2. The Details of The Forecast Results Using The Moving Average Method

Month	Number of Covid-19 positive patient(s)	Forecast
March	2 people	-
April	8 people	-
May	54 people	-
June	92 people	-
July	?	39 people
August	?	48 people
September	?	58 people

Next forecast was done using the Exponential Smoothing method (see equation 3). The data which were processed with this method were the ones in Table 1 with an alpha (α) = 0,6 to forecast the number of potential Covid-19 positive patients for the next three months (July, August and September) just like in the first forecasting method. Results show that for July, it was estimated that there would be an increase in the number of Covid-19 positive patients for 69,056 or 69 people after being rounded (see Figure 4). For August, new positive patients would be estimated to reach 69,176 or 69 people after being rounded (see Figure 5). For September, new positive patients were estimated to reach 70,248 or 70 people after being rounded (see Figure 6). The forecast results of the Exponential Smoothing method are listed in Table 3.

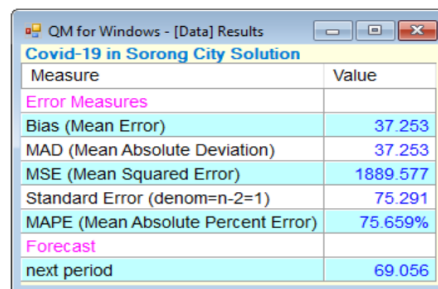


Figure 4. The forecast result for July using the Exponential Smoothing method and POM-QM Software

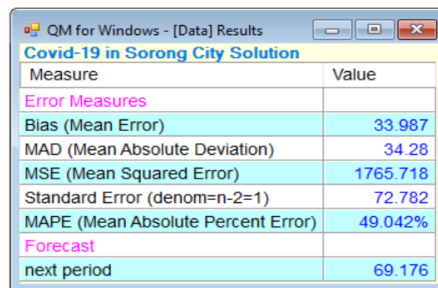


Figure 5. The forecast result for August using the Exponential Smoothing method and POM-QM Software

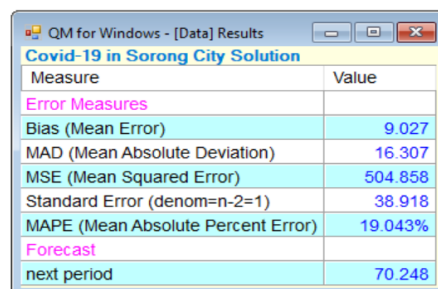


Figure 6. The forecast result for September using the Exponential Smoothing method and POM-QM Software

Table 3. The Details of The Forecast Results Using the Exponential Smoothing Method

Month	Number of Covid-19 positive patient(s)	Forecast
March	2 people	-
April	8 people	-
May	54 people	-
June	92 people	-

Month	Number of Covid-19 positive patient(s)	Forecast
July	?	69 people
August	?	69 people
September	?	70 people

The best forecast results from the best method can be determined by comparing the accuracy levels of both methods. The data comparison of the forecast levels of Covid-19 positive patients in Sorong City was performed based on Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE) in each method [47],[48],[49],[50],[51],[52],[53].

Table 4. The Comparison Between the Forecast Results of The Moving Average and Exponential Smoothing Methods for July

No	Method	Forecast results		Forecast Accuracy		
		Before rounding	After rounding	MAD	MSE	MAPE
1	Moving Average	39	39	70,667	499,778	76,821%
2	Exponential Smoothing	69,056	69	37,253	1889,557	75,695%

Based on Table 4, it can be concluded that the forecast result from the Exponential Smoothing method is better than the result of the Moving Average method. Therefore, it can be used as reference for the Sorong City Covid-19 Task Force because of its lower error level where MAD = 37,253, MSE = 1889,557 and MAPE = 75,695%.

Table 5. The Comparison Between the Forecast Results of The Moving Average and Exponential Smoothing Methods for August

No	Method	Forecast Result		Forecast Accuracy		
		Before Rounding	After Rounding	MAD	MSE	MAPE
1	Moving Average	58,25	58	13,667	186,778	28,472%
2	Exponential Smoothing	70,248	70	16,307	504,858	19,043%

Based on Table 5 it can be concluded that the forecast result of the Moving Average method is better than the result of the Exponential Smoothing method because of its lower error rate where MAD = 12,333, MSE = 152,111 and MAPE = 31,624%. Therefore, it can be used as reference for the Sorong City Covid-19 Task Force.

Table 6. The Comparison Between the Forecast Results of The Moving Average and Exponential Smoothing Methods for September

No	Method	Forecast Result		Forecast Accuracy		
		Before Rounding	After Rounding	MAD	MSE	MAPE
1	Moving Average	48,25	48	12,333	152,111	31,624%
2	Exponential Smoothing	69,176	69	34,28	1765,718	49,042%

Finally, the Table 6 shows that the forecast result of the Moving Average method is better than the result of the Exponential Smoothing method because of its lower error level where MAD = 13,667, MSE = 186,778 and MAPE = 28,472%. Therefore, it can be used as reference for the Sorong City Covid-19 Task Force.

4. CONCLUSION

Based on the results produced by the research, several conclusions below are drawn: 1) The forecast result of the Exponential Smoothing method is better than the result of the Moving Average Method for July whereas the forecast results of the Moving Average method are better than the results of the Exponential Smoothing method for August and September; 2) The forecast results from both methods can be used as reference for the Sorong City Covid-19 Task Force in making decision and establishing policy given the fact that Sorong City has not had adequate health facilities such as laboratories which allow testing and examination on samples of Covid-19 patients; 3) POM-QM Software for Windows (version 5) can be used to perform forecasting tasks quickly, easily and efficiently.

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