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Predicting Number of Accumulative Cases Of Covid-19 Using the Iteration Method

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Abstract. *The COVID-19 pandemic, first identified in Wuhan, China in December 2019, has rapidly spread to various countries, including India and Indonesia. This study utilizes data from the cumulative cases in India and Indonesia, espand specific provinces within Indonesia, such as DKI Jakarta and Gorontalo, spanning a period of approximately two years. The proposed method incorporates factors such as expected recovery and mortality rates to determine the maximum daily growth, which deviates from exponential growth and tends towards stability or decline. RStudio software was employed to estimate future trends based on the current available data. The results indicate that Indonesia, Jakarta, and Gorontalo exhibit a sloping average growth rate over the past 30 days, while India demonstrates linear movement compared to the previous period. A 20% increase in growth rate in Jakarta leads to a significant rise in new cases compared to the other regions. Conversely, a 0% growth rate reduction in India and Gorontalo results in a notable deviation of cumulative case numbers from the actual data. This method can be applied to analyze similar problems if in the future there is another spread of pandemic diseases.*

Keywords: COVID-19, Iteration Method, Exponential Growth, Gorontalo and DKI Jakarta

Introduction

The world is currently alert to the spread of a virus called Coronavirus Disease (Covid-19) which is caused by the Severe Actuce Respiratory Syndrome Coronavirus-2 (SARS-Cov-2) virus on March 12 2020 Covid-19 and was declared a pandemic (WHO, 2020). This case was first reported in Wuhan, Hubei Province, China in 2019. The source of infection is still unknown, but the first case was linked to a fish market in Wuhan [1].

Since the first case in Wuhan, there has been an increase in Covid-19 cases in China every day and peaked between late January and early February 2020. Most of the first reports of Covid-19 came from Hubei and surrounding provinces, then added to other provinces and throughout China [2] On January 30 2020, there have been 7,736 confirmed cases of Covid-19 in China, and 86 other cases reported from various countries including India and Indonesia (World Health Organization [3].

India is one of the countries worst affected by Covid-19 after America. The first case was revealed on 30 January 2020. India experienced 2 spikes in cases in May 2021 and January 2022.

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The increase in the number of Covid-19 cases occurred in a short time and required immediate treatment. The government implemented several handling efforts to prevent the spread of Covid-19, namely by issuing 2 travel restrictions from the center of Covid-19 in China's Hubei Province, implementing physical distancing measures for the community, carrying out PSBB (Large-Scale Social Restrictions), and providing health protocol principles by oblige to wear a mask when leaving the house, wash hands, maintain distance, and finally the government's efforts are to carry out vaccinations which aim to reduce the transmission of Covid-19, reduce mortality and maintain immunity.

With the development of information and science, it is necessary to have numerical calculations to facilitate solutions that cannot be solved analytically. There are various kinds of numerical methods that can be used to solve a problem including the iteration method.

Iteration method or iteration process is one of the numerical methods used to find a solution or solution to a non-linear problem. The iteration process is carried out repeatedly using a one-point approach as a starting point. To get the value of the equation, only one initial x value is needed to start the iteration [4].

Various solutions and efforts have been made by the government but the confirmed cases and death rates can change rapidly depending on time. According to previous research, the accumulative number of confirmed cases can help to show estimates of Covid-19 cases for the next 14 days using a simple iteration method [1] [3]. Therefore, researchers use the accumulated value of Covid-19 cases over the past year to estimate recovery and death rates and compare them with existing data using the Iteration method by applying computational physics using R studio.

Theoretical Background

Coronavirus Diases 2019 (Covid-19) is a disease that is transmitted through droplets or splashes of saliva. The spread of droplets can occur when an infected person sneezes or coughs, where the virus in the droplets will be able to be pushed to a distance of approximately 1.8 meters [5]. Viruses that move via droplets will survive through the air and deposit on the mucous membranes of the mouth, nose or eyes of people who are nearby [2]. Another way of spreading the virus is by shaking hands with an infected person, touching infected objects/surfaces, frequently touching the nose or mouth or coming into contact with patient feces. Virus transmission can also occur through hidden transmission, where individuals who are infected but are asymptomatic unknowingly transmit the virus to others. These individuals are often referred to by medical terms as OTG (people without symptoms) [6].

Governments in various countries were faced with a confusing situation when the covid-19 outbreak emerged. The government was forced to take strategic steps to handle and respond to the pandemic situation. The Covid-19 pandemic has also shown the good and bad governance and policies of a country's government. At first, the Indonesian government showed stuttering and was caught up in denial of the urgency and impact of Covid-19 before finally taking the steps needed to deal with the pandemic more systematically [7].

According to [8] confirmed data on Covid-19 cases are growing exponentially in most countries in the world. Thus an estimate of the spread of Covid-19 is urgently needed to find out what actions

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must be implemented and the wider community's motivation to comply with the policies put in place to inhibit the spread of this pandemic [9].

Research on epidemic processes has a long and fruitful history in statistical physics. A simple mathematical model that describes the spread of an epidemic can be used to adjust data and the number of parameters that can be monitored, and the values obtained can be used to estimate Covid-19 cases [1]. In this study using the Iteration Method which only requires the daily accumulative value of Covid-19.

The iteration method is a numerical method that can be used to solve nonlinear equations by solving each x variable in an equation. This method can be used if the equation cannot be solved analytically. The iteration method requires an initial estimate of the value of the variable x to be searched for. By using the given equation, the x value will be updated according to the iteration rules that have been set. This process will be carried out repeatedly until a solution that meets the convergence requirements is obtained [4]. The iteration method is a method of solving non-linear equations by solving each x variable in an equation.

Materials and Methods

The main components of this research are accumulative data for Covid-19 in one of the countries that have experienced the 2nd wave, namely India, accumulative data for Indonesia as a whole, 1 area with the highest exposure to Covid-19, namely DKI Jakarta and accumulative data for Gorontalo. In addition, supporting tools and materials are needed, including Microsoft Excel and R-Studio.

Simulation Methods, Conditions and Parameters

The data used is data from the daily accumulative cases of covid-19 in India which is one of the countries with the most exposure to covid, data from India is taken from (https://ourworldindata.org/coronavirus). For Indonesia as a whole the data is taken from (https://covid19.who.int), the regions in Indonesia that have the highest number of cases are DKI Jakarta, and Gorontalo. For Jakarta and Gorontalo data taken from (https://covid19.go.id/peta-sebaran-covid19).

The accumulative data obtained will be calculated using the iteration method. This method only requires confirmed daily accumulative cases

1. Calculate the average growth rate using the following equation:

$$G_{\Delta} = \frac{1}{m} \sum_{i=n-m}^{n-1} \left(\frac{x_i}{x_{i-i}} - 1\right) \quad (1)$$

2. Calculate the minimum and maximum growth rates over the last m days as G↑ G↓ respectively using the following equation [10][11]:

$$x_{i+1} = x_i \, (1 + G_{\Delta}) \quad (2)$$

3. Calculating the estimated rate of recovery and death in cases of Covid-19 using the following equation:

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$$x^*_{i+1} = x_{i+1} - p_{x_{i-d}} - (1-p)x_{i-h} \quad (3)$$

where :

h = isolation period of 14 days

d = recovery period of 21 days

p = death rate after 21 days [6].

At this stage, implementation was carried out by applying the Iteration method to the R-Studio program to obtain a calculation model along with a graph of estimated Covid-19 cases in the four regions for the next 30 days. **Figure 1** explains the iteration process carried out in this research.

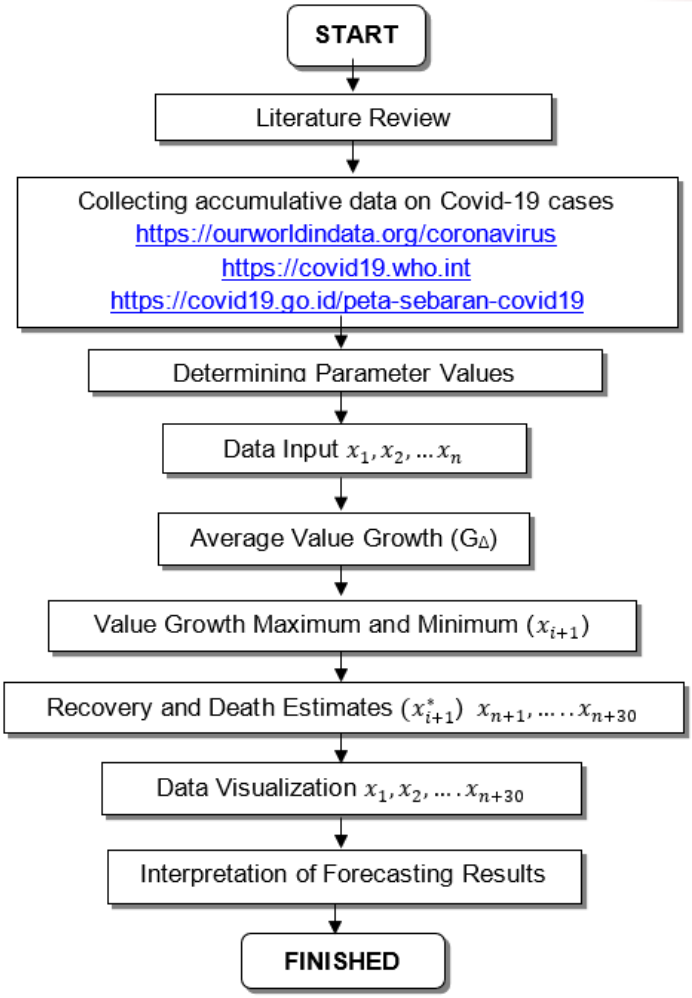

Figure 1. Research Flowchart

Results and Discussion

Cumulative Case Estimates

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1. Estimated Cumulative Cases in India

Taking into account the assumptions in this study, data shooting is carried out when the data moves exponentially over time to estimate the movement of cases in the October 2021 period. With the help of the R program, the following forecast results are obtained:

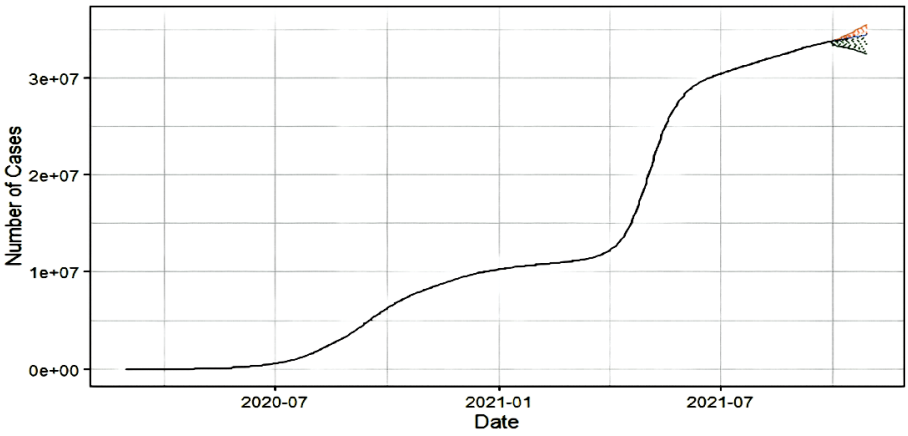

Figure 2. India Covid Accumulative Cases Projection Graph

To clarify the results of the estimated cumulative case graph, the enlargement is carried out as follows:

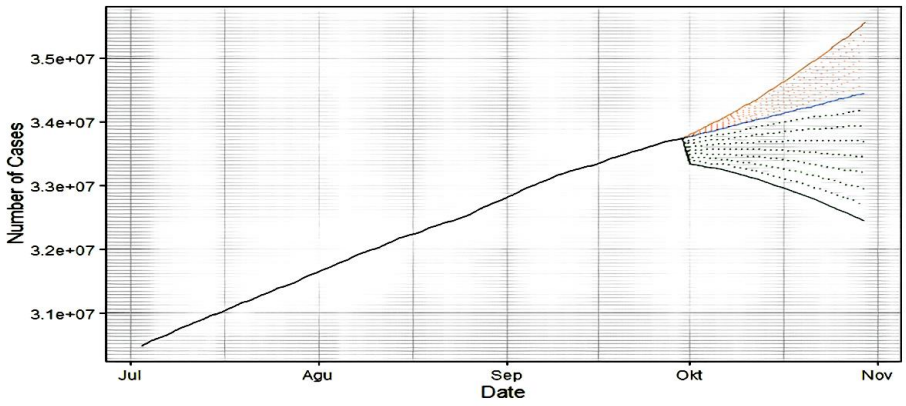

Figure 3. Zoom results for Indonesia's Accumulative Case Estimation.

The figure shows the case estimates for each scenario, the red shaded area is the cumulative case estimate if the growth rate in the previous 30 days was increased by 20%. The blue line is the actual movement. The green shaded area is the estimated number of cases if there are no additional cases in the previous 30 days.

2. Estimated Cumulative Cases in Indonesia

With the help of the R program, the following approximate results are obtained:

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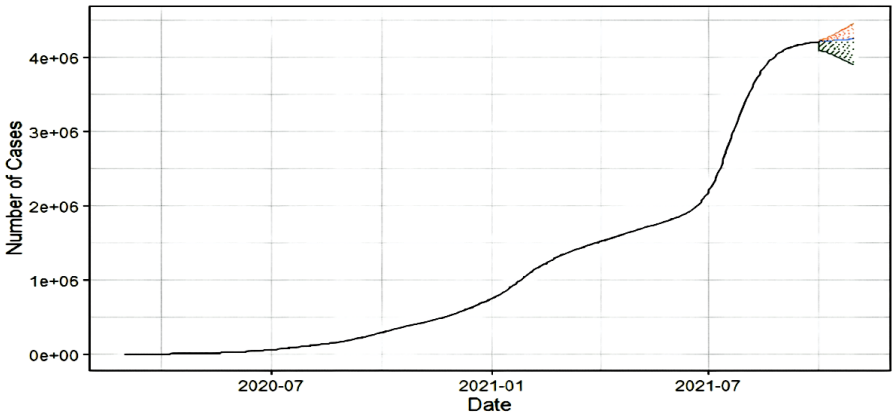

Figure 4. Graph of Indonesia's Covid Accumulation Case Projection

To clarify the results of the estimated cumulative case graph, the enlargement is carried out as follows:

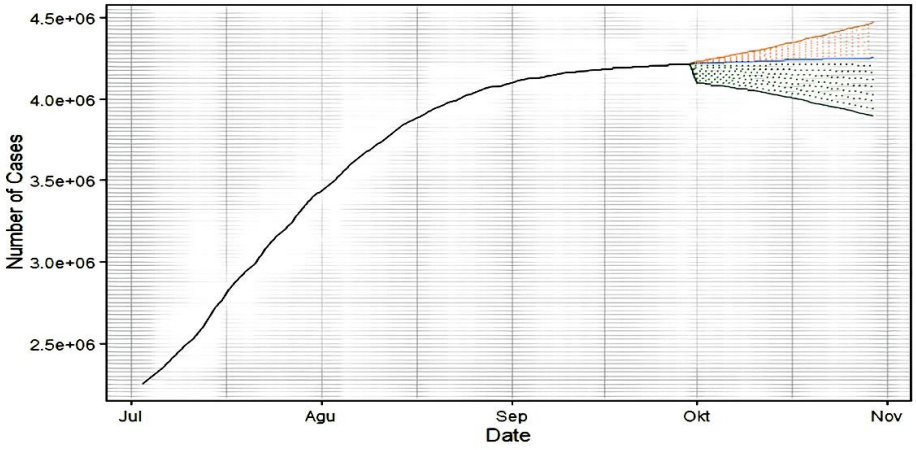

Figure 5. Zoom results for Indonesia's Accumulative Case Estimation

The figure shows the case estimates for each scenario, the red shaded area is the cumulative case estimate if the growth rate in the previous 30 days was increased by 20%. The blue line is the actual movement. The green shaded area is the estimated number of cases if there are no additional cases in the previous 30 days.

3. Estimated Cumulative Cases in Gorontalo

With the help of the R program, the following approximate results are obtained:

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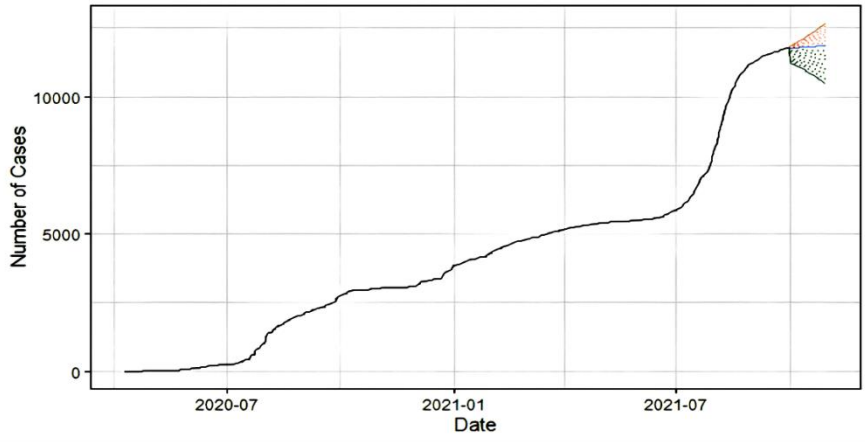

Figure 6. Gorontalo Covid Accumulative Case Projection Graph

To clarify the results of the estimated cumulative case graph, the enlargement is carried out as follows:

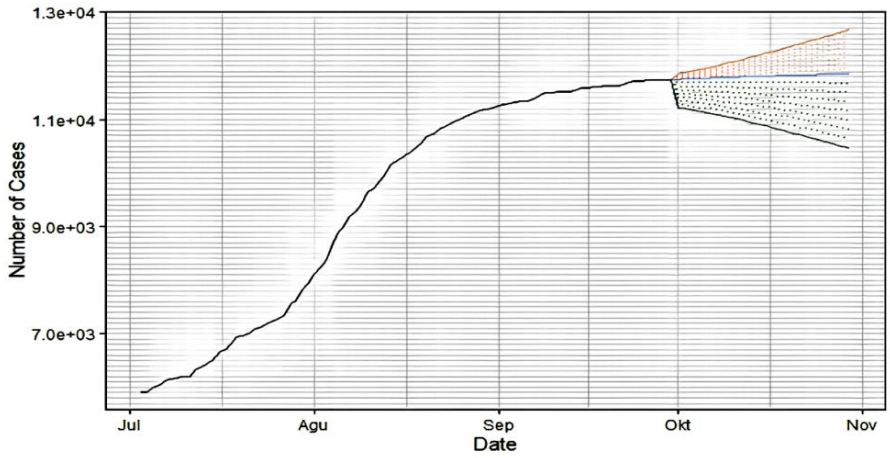

Figure 7. Zoom results for Gorontalo Accumulative Case Estimates

The figure shows the estimated cases with each scenario, the red shaded area is the cumulative case estimate if the growth rate in the previous 30 days is increased by 20%. The blue line is the actual movement. The green shaded area is the estimated number of cases if there are no additional cases in the previous 30 days.

4. Estimated Cumulative Cases in Jakarta

With the help of the R program, the following approximate results are obtained:

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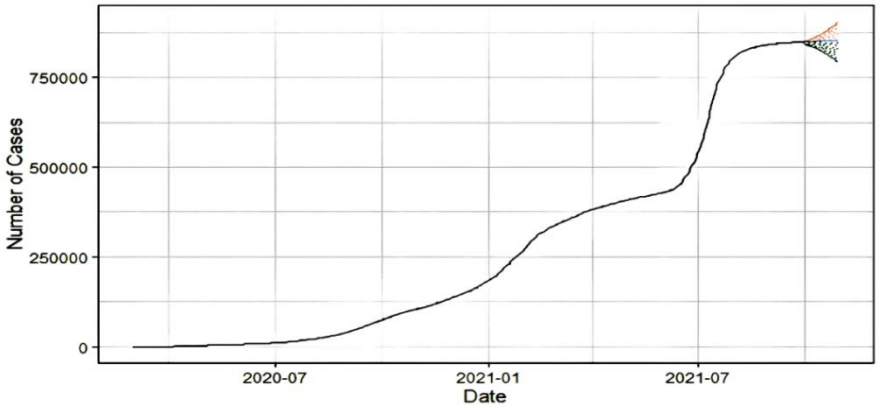

Figure 8. Jakarta Covid Accumulative Case Projection Graph

To clarify the results of the estimated cumulative case graph, the enlargement is carried out as follows:

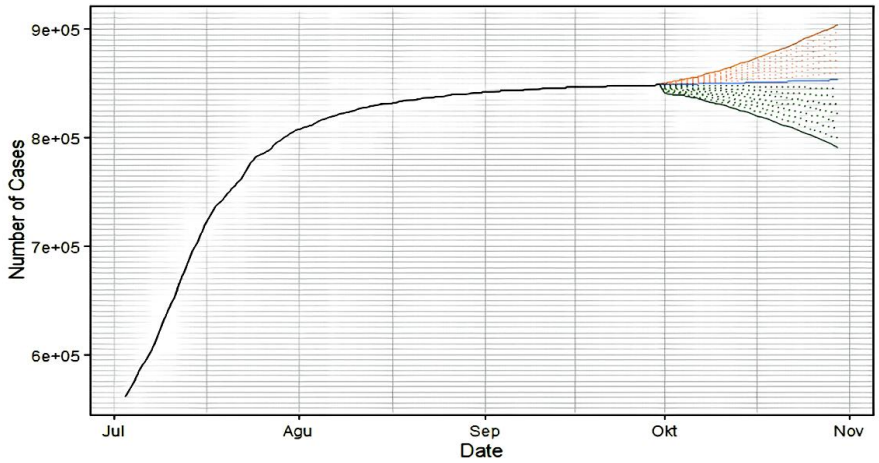

Figure 9. Jakarta Cumulative Case Estimation Zoom Results

The figure shows the case estimates for each scenario, the red shaded area is the cumulative case estimate if the growth rate in the previous 30 days was increased by 20%. The blue line is the actual movement. The green shaded area is the estimated number of cases if there are no additional cases in the previous 30 days.

From the estimated Covid-19 cases for India, Indonesia, Jakarta and Gorontalo, as seen in the forecast chart above, exponential growth will still persist in the four regions. The solid black line shows the actual data, which was last updated for this analysis in October 2021. From this date onwards, it has predictive value in that the solid blue line shows the trend for the last 30 days, i.e. if nothing has changed. The top solid orange line shows the prediction obtained if the maximum daily growth rate recorded for the last 30 days G↑ will increase by 20%, while the bottom green line shows the prediction if the daily growth rate will drop to zero from October onwards. The orange and green dotted lines show predictions for a decrease in the daily growth rate by an equal

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distance from top to bottom. By following the lines from the bottom up, starting with the solid green line, one can identify lines that are flat for a 30 day forecast. For India for example the 5th line corresponds to a daily growth rate of 4% from October onwards. This will be the target if you don't want to see a plateau in the next 30 days. For Indonesia, Jakarta and Gorontalo the same target is 2.8% (7th row from the bottom). Keeping the growth rate at least under 5% is an important target for promising prospects. can be identified a line which is flat for 30 days forecast. For India for example in 5th line corresponds to daily growth rate of 4% from October onwards. This will be the target if you don't want to see a plateau in the next 30 days. For Indonesia, Jakarta and Gorontalo the same target is 2.8% (7th row from the bottom). Keeping the growth rate at least under 5% is an important target for promising prospects. can be identified a line which is flat for 30 days forecast. For India for example in 5th line corresponds to daily growth rate of 4% from October onwards. This will be the target if you don't want to see a plateau in the next 30 days. For Indonesia, Jakarta and Gorontalo the same target is 2.8% (7th row from the bottom). Keeping the growth rate at least under 5% is an important target for promising prospects.

Conclusions

Based on the analysis process that has been carried out, it can be concluded that the Estimated Number in India, Indonesia, Gorontalo and Jakarta is described as follows: Based on the average growth rate in the previous 30 days, the actual data movement is sloping in three regions, namely Indonesia, Jakarta and Gorontalo. Meanwhile, India moved linearly compared to the previous period. Furthermore, based on the increased growth rate of 20%, it can be seen that for Indonesia, it does not look significant when compared to India, Gorontalo and Jakarta. In the case of Jakarta, the graph is moving away from the actual data, this indicates an increase in the previous period where there was a significant addition of new cases when compared to the other 3 regions. Last Based on a growth rate of 0 (zero) in the previous period.

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