Modeling the effectiveness of the PSBB based on COVID-19 case in Greater Surabaya Area

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Abstract. East Java province with high mobility has a high case fatality rate of COVID-19. The core spread of COVID-19 is from the Greater Surabaya area following Surabaya, Sidoarjo, and Gresik districts. The East Java Government through Regulation No.18/2020 imposed a Large-Scale Social Restriction (PSBB) that is intended to support the effectiveness of the physical distancing strategy in addressing the emergency status of the COVID-19. But no official report has been found on the effectiveness of PSBB. Therefore, it is necessary to evaluate the effectiveness of PSBB, especially in Greater Surabaya. This research aims to know the model of PSBB policy to minimize the spread of COVID-19 in the greater Surabaya. The study focused on health facility (ventilator, ICU, non-ICU), population, case over a certain period, and positive case in care. This study analyzes the distribution pattern and models the effectiveness of PSBB against the spread of COVID-19 in Greater Surabaya. The data analysis used the COVID-19 Surge-CDC Model. The result of the research shows that the condition of COVID-19 cases increased significantly in the model without intervention. The sharp increase in cases is related to the anticipation of other policies related to the ability of regions to provide health facilities.

Keywords: COVID-19, SurgeCDC Model, disease transmission, Large-Scale Social Restrictions

1. Introduction
Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) otherwise known as COVID-19 is a global pandemic affecting the human respiratory tract [1]. Sausage restriction strategies are being implemented in various regions to reduce the activity and spread of COVID-19 [2]. The spread of COVID-19 in Indonesia has increased so that it requires serious efforts to break the chain of transmission [3]. Various policies have been implemented, starting from the provision of health facilities, physical distancing, to the enactment of PSBB. The implementation of PSBB has a wide impact on social, economic, environmental, infrastructure, and spatial aspects [4]. So it is necessary to analyze the various components of policies that have been carried out by the government, especially concerning the implementation of the PSBB and the provision of health facilities [5]. Currently, large-scale social barriers to areas of high potential are known as PSBB. The consideration of PSBB implementation is due to the mobility and ongoing activities in an area [6]. The negative impact that occurs when implementing restrictions on regional activities is the decline in economic growth. East Java as a province with high mobility also has some COVID-19 cases. The government through the Governor of East Java Regulation No. 18 of 2020 imposes Large-Scale Social Restrictions (PSBB). One of the areas...
in East Java that has a fairly high level of the spread of COVID-19 is Greater Surabaya. Surabaya as one of the business centers in East Java has direct regional interaction with Sidoarjo and Gresik Regencies. Although the PSBB goal to reduce the spread of COVID-19 is the main reason, reports regarding the effectiveness of the results have not been officially available. The increase in the number of cases in Greater Surabaya and the implementation of the PSBB made it necessary to measure the effectiveness of the PSBB policy in Greater Surabaya. In measuring the effectiveness of the PSBB policy, it is necessary to process data related to various case data, health facilities, and spatial, so that an analysis tool is needed that can accommodate the processing needs of these various data. One of the analytical tools that can be used to combine this data is the COVID-19Surge (CDC). In practice, the use of COVID-19Surge (CDC) can accommodate various types of data and is linked with other further research to make policy formulation [7]. So that this research can be an example of how the COVID-19 Surge (CDC) produces a model of the effectiveness of the PSBB policy which later can also be used as a consideration in policymaking to minimize the spread of COVID-19.

2. Methods
This research aims to model the effectiveness of the PSBB policy on the spread of COVID-19 in Greater Surabaya (Surabaya City, Sidoarjo Regency, and Gresik Regency). In combining and analyzing various data, the main analysis tool is used, namely the COVID-19Surge (CDC). Through the analysis process, the distribution patterns and models of the effectiveness of PSBB in Greater Surabaya will be identified.

2.1 COVID-19Surge (CDC)
The COVID-19Surge (CDC) analysis tool is an implementation of the Centers for Disease Control and Prevention’s COVID-19Surge Tool. COVID-19Surge (CDC) uses the basic components of Susceptible, Infected, Infectious, Convalescing, Recovered (or dead) (SIIRC).

| Table 1. COVID-19Surge (CDC) |
|-----------------------------|
| No | COVID-19Surge (CDC) |
|-----------------------------|
| 1 | Initiate SIIRC with the total number of COVID-19 cases on the model start date and 14 days earlier |
| 2 | The average % of cases received requiring ICU Care is the percentage of cases accepted |
| 3 | The average % of ICU cases requiring a ventilator is the percentage of ICU cases only |
| 4 | Average Downtime per Ventilator can take into account the duration of the ventilator when not serving (such as when decontaminated or transferred) |
| 5 | New Infections Per Case (R0) has an impact on the rate of spread of COVID-19 |
| 6 | This could involve multiple interventions, various social distancing start dates, end dates, and the effectiveness of the intervention parameters. It can also involve a variety of interventions (social distancing, shelter, locking, or reopening a site) with the duration and degree of effectiveness desired by the researcher. |
| 7 | Further parameters can be deepened on the COVID-19Surge |

The analysis was carried out quantitatively through mathematical calculations and analysis using the ArcGIS Pro software. The analysis used population data for each sub-district (Surabaya City, Sidoarjo Regency, Gresik Regency), administrative maps (Surabaya City, Sidoarjo Regency, Gresik Regency), COVID-19 case data (Surabaya City, Sidoarjo Regency, Gresik Regency) on March 25- August 3, and data on health facilities (Surabaya City, Sidoarjo Regency, Gresik Regency). The analysis aims to produce a map and graph of the spatial pattern of the distribution of COVID-19 from 3 August 2020 to 3 August 2021 and a COVID-19 intervention policy model in the next year.
Table 2. Details of Use of Case Data and Health Facilities

| Case Data for Each District in Surabaya City, Sidoarjo Regency, Gresik Regency March 25-August 3 | Data | Detail Data |
|---|---|---|
| | Positive in Care and Positive Cumulative March 25-August 3 | 1. R0 |
| | | 2. Doubling Time (3-4 days) |
| | | 3. Recovered (April 15) |
| | | 4. Contagious Days (14 Days) |
| | | 5. Case 14 days before (15 April) |

| Data on Health Facilities for Each COVID-19 Referral Hospital in Surabaya City, Sidoarjo Regency, Gresik Regency | Bed Ventilator (filled and available) | 1. Average % of Clinical Cases Admitted for Hospital Care |
|---|---|---|
| | Bed Without Ventilator (filled and available) | 2. Average % of Admitted Cases Requiring ICU Care |
| | Ordinary Bed (filled and available) | 3. Average % of Cases in ICU Requiring Ventilators |
| | Confirmation (independent, building, care for the ventilator, care without the ventilator, normal care) | 4. Average Length of Non-ICU Hospital Stay |
| | | 5. Average Duration in ICU Without Ventilator |
| | | 6. Average Duration in ICU with Ventilator |
| | | 7. Average Downtime per Ventilator (1 Day) |
| | | 8. Total Ventilator Available/district |
| | | 9. Total ICU Room/district |
| | | 10. Total Non-ICU Room/district |

\[ \text{R} = (\text{Rs}^*\text{Rs(yesterday)})^*\text{Rs(the day after tomorrow)})^{\frac{1}{3}} \]  
\[ \text{R(Low)} = \frac{n}{2} - \frac{1.96\sqrt{n}}{2} \]  
\[ \text{R(High)} = 1 + \frac{n}{2} + \frac{1.96\sqrt{n}}{2} \]

Information:
- Ro = highest R value
- Rs = total active today / total active 5 days before
- R1 = active case today / active case yesterday
- R2 = active case today / active case 2 days yesterday
- R3 = active case today / active case 3 days yesterday
- R4 = active cases today / yesterday's 4 active cases

\( a) \ R0 \)

The basic reproductive number which is usually denoted by R0 is a very important quantity in epidemiological models [13]. This magnitude provides a lot of meaning in the interpretation of mathematical models to explain how much the transmission of disease can occur.

\( b) \ Doubling \ Time \)

Doubling Time is the number of days it takes for an infected individual to double. An increase in doubling time indicates that the transmission is decreasing or the development of covid is slow and vice versa if the doubling time is decreasing, indicating that the development of Covid is getting faster.

\( c) \ Cases \ 14 \ day \ before \)

The number of COVID-19 cases, before the imposition of large-scale social restrictions (PSBB). The following is a formulation used to perform mathematical calculations:

\[ R = (\text{Rs}^*\text{Rs(yesterday)})^*\text{Rs(the day after tomorrow)})^{\frac{1}{3}} \]  
\[ \text{R(Low)} = \frac{n}{2} - \frac{1.96\sqrt{n}}{2} \]  
\[ \text{R(High)} = 1 + \frac{n}{2} + \frac{1.96\sqrt{n}}{2} \]
Value Ro > 1 then the case will increase
Value of Ro < 1 then the case will go down
The value of R0 = 1 for 14 days the case will decrease

e) Intervention Policy
Specify intervention strategies and timelines to determine the potential reduction in COVID-19 cases and the duration of the epidemic. Multiple non-overlapping interventions and durations can be specified. The Intervention Policy parameter allows specifying multiple non-overlapping interventions, with different Start Dates, End Dates, and Effectiveness of Intervention.

- Start Date – The start date of the new intervention. This Start Date does not have to match but cannot be earlier than the initial analysis Start Date specified.
- End Date – The end date of the new intervention.
- Effectiveness of Intervention (% Decrease in New Infections) – The anticipated decrease in infections of the new policy relative to the policy at the initial Start Date. The value can be negative which would mean the intervention is less effective than the intervention at the Start Date. This percentage is used to scale the New Infections Per Case (R0) parameter during the intervention period. If left empty 0 will be used.

3. Results and Discussion

3.1 The distribution pattern of COVID-19 before and after the Surabaya PSBB

The city of Surabaya has the highest number of infection cases compared to other districts in this study. Data processing is divided into three phases, namely before the PSBB from 16 April to 27 April 2020, during the PSBB 28 April to 8 June 2020, and after the PSBB 20 June to 5 October 2020. Validation analyzed using RSME (Root Mean Square Error). RMSE is an alternative method for evaluating forecasting techniques used to measure the accuracy of a model's forecast results. RMSE is the average value of the sum of squared errors, can also represent the size of the error generated by a forecast model. A low RMSE value indicates that the variation in value produced by a forecast model is close to its observation value variation. Validation of the pattern of the spread of COVID-19 in the City of Surabaya on 27 April shows RMSE before PSBB 1.58337, on June 8 showed RMSE during PSBB 2.073, and on August 3 showed RMSE after PSBB 1.76326. RMSE value approaching number 2 means which model is increasingly valid. In the phase before PSBB in Surabaya, there were 248 cases with an intervention rate of 72.5%, when PSBB was 2,197 cases with an intervention rate of 28.6%, and after PSBB was 2,596 cases with an intervention rate of 50.8%. The percentage decrease in new infection cases is greater than the percentage at the time of PSBB, this indicates significant effectiveness with the PSBB policy applied. Percentage when PSBB shows the impact of cases before PSBB is applied, while percentage after PSBB indicates an impact after the implementation of PSBB.

![Figure 1. Positive Cases in Surabaya City (Using Intervention)](image-url)
Figure 2. Positive Cases in Surabaya City (Without Intervention)

Figure 3. Surabaya City's COVID-19 Infection and Recovery (Using Interventions)

Figure 4. Surabaya City COVID-19 Infection and Recovery (Without Intervention)
In general, if there is an intervention, the cure rate for COVID-19 in the City of Surabaya will increase from phase to phase. Meanwhile, the number of cases of infection decreased after PSBB, although at the beginning of this phase there was a peak of the increase in infection, the increase was not too sharp. If there is no intervention in the pattern of the spread of COVID-19 in the City of Surabaya in the phase before PSBB 1,135 cases, during PSBB 151,157 cases, and after PSBB 108,285 cases. Meanwhile, the rate of recovery only increased after PSBB. The number of cases of infection tends to be larger and sharper without intervention than with intervention.

3.2 The distribution pattern of COVID-19 before and after PSBB in Sidoarjo Regency

Sidoarjo Regency as an area directly adjacent to the City of Surabaya also has a high number of cases of the spread of COVID-19, so the PSBB was enforced. Data processing is divided into three phases, namely before the PSBB 16 April to 27 April 2020, the PSBB 28 April to 8 June 2020, and after the PSBB 20 June to 5 October 2020. Validation of the pattern of the spread of COVID-19 in Sidoarjo Regency on 27 April shows RMSE before PSBB 0.93121, on June 8 it shows RMSE during PSBB 1.39971, and on August 3 shows RMSE after PSBB 1.62682. RMSE value approaching number 2 means which model is increasingly valid.

In the phase before PSBB in Sidoarjo Regency, there were 62 cases with an intervention level of 63.78%, when PSBB was 646 cases with an intervention level of 29.18%, and after PSBB was 946 cases with an intervention level of 49.30%. The percentage decrease in new infection cases is greater than the percentage at the time of PSBB, this indicates significant effectiveness with the PSBB policy applied. Percentage when PSBB shows the impact of cases before PSBB is applied, while percentage after PSBB indicates an impact after the implementation of PSBB.
In general, if there is an intervention, the cure rate for COVID-19 in Sidoarjo Regency will increase from phase to phase. Meanwhile, the number of cases of infection decreased after PSBB, although at the beginning of this phase there was a peak of the increase in infection, the increase was not too sharp.

If there is no intervention in the pattern of the spread of COVID-19 in Sidoarjo Regency in the phase before PSBB, 231 cases, during PSBB 31,668 cases, and after PSBB 262,195 cases. Meanwhile, the rate of recovery only increased after PSBB. The number of cases of infection tends to be larger and sharper without intervention than with intervention.

3.3 The distribution pattern of COVID-19 before and after PSBB in Gresik Regency
Gresik Regency also has a large case infection rate with data processing which is also divided into three phases, namely before the PSBB 16 April to 27 April 2020, the PSBB 28 April to 8 June 2020, and after the PSBB 20 June to 5 October 2020. Validate the pattern of the spread of COVID-19 on October 5, 2020, indicates the RSME after PSBB is 1.19293. RMSE value approaching number 2 means which model is increasingly valid. In the phase before PSBB in Gresik Regency, there were 248 cases with an intervention level of 75%, when PSBB was 33.03 cases with an intervention level of 28.6%, and after
PSBB was 2,596 cases with an intervention level of 43.75%. The percentage decrease in new infection cases is greater than the percentage at the time of PSBB, this indicates significant effectiveness with the PSBB policy applied. Percentage when PSBB shows the impact of cases before PSBB is applied, while percentage after PSBB indicates an impact after the implementation of PSBB.

**Figure 9.** Positive Cases in Gresik District (Using Intervention)

**Figure 10.** Positive Cases in Gresik District (Without Intervention)
In general, if there is an intervention, the cure rate for COVID-19 in Gresik Regency will increase from phase to phase. Meanwhile, the number of cases of infection did not decrease after PSBB even though the infection did increase, the increase was not sharp.

If there is no intervention in the pattern of the spread of COVID-19 in the Gresik Regency in the phase before PSBB, 136 cases, 19,526 cases during PSBB, and 129,267 cases after PSBB. Meanwhile, the rate of recovery only increased after PSBB and tended to take longer to achieve an increase in recovery. The number of cases of infection has indeed increased, but the cases are not sharp. Then the increase in cases of infection without intervention tends to be greater with a sharp increase compared to interventions that are not too sharp.

### 4. Conclusion and Recommendation

Based on the results of research on the effectiveness of the PSBB model for COVID-19 cases in each city or district, it shows a condition of increasing sharp cases in the model without intervention. The sharp increase in cases is related to the anticipation of other policies related to the ability of regions to provide health facilities. If the number of cases is too high and this happens in all cities/regencies, it will be difficult for the region to accommodate the needs of health facilities for its residents. This effectiveness measurement model can also know how effectively each city/regency lowers positive
cases of COVID-19. Be aware of the percentage of intervention does not decrease or tends to be still high then it is likely to have an impact on the surrounding area in real conditions. This is due to the transmission of the COVID-19 virus through social interaction between cities/districts. It is hoped that the modeling can help the local governments to assess the effectiveness of the policies that have been set and determine future policies. Anticipation is needed to meet the demand for health facilities such as room space, medicine, and medical personnel. The COVID-19 pandemic needs to be minimized collectively in each city/regencies so as not to exceed the regional capacity to carry out medical treatment.

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