# MONTE CARLO SIMULATION IN PREDICTING THE SPREAD OF COVID-19 IN MEDAN CITY

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| Article Info | ABSTRACT |
|---|---|
| | Covid-19 or Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is a new type of virus that has given up on the human respiratory system and is currently spreading throughout the world. So, this research will discuss the prediction of the spread of Covid-19 in Medan City. The method used is the Monte Carlo simulation. This method is used to determine the number of patients both ODP patients (people under observation), positive, recovered and died. The Monte Carlo simulation is carried out with the help of Microsoft Excel and the simulation is carried out with 1 to 1,000,000 repetitions. From the simulation results, the smallest error data is 0% and the largest error data is 6%. |

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## 1. INTRODUCTION

Currently our country is experiencing a disaster due to a very dangerous virus that has claimed many lives In 2019, the whole world is being shaken and shocked by a mysterious virus that attacks the respiratory tract or a mysterious pneumonia called COVID-19 or Coronavirus Disease 2019. This virus first appeared at the end of December 2019 in Wuhan, China. Coronavirus Disease 2019 is a new virus (Sars – coV – 2). Currently, according to data from the World Health Organization, there are 220 countries that have been infected with Covid-19. (WHO data, 21 November 2020).

Initially, this virus was exposed to a seafood shopping center or shopping center in Wuhan, Hubei Province, China. On February 11, 2020, the World Health Organization announced a new virus which they named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS – coV – 2) and the name of this disease is Coronavirus Disease 2019 (COVID – 19). At first the transmission of this virus was not known for sure that it was transmitted between humans or between humans and animals. So that in the end it was found, this virus originated from bats, this is because bats have SARS – CoV - 2 sequences that are similar to coronavirus. Thus, it is concluded that Covid came from bats which then mutated and infects humans, mammals and birds are also predicted as intermediate reservoirs. The health team concluded that one of the universal indications for people infected with Covid is a cold, sore throat, cough, and fever.

Currently, starting at the end of December 2019 until November 2020, as many as 220 countries were infected with Covid-19. According to World Health Organization (WHO) data, on November 21, 2020, the number of sufferers was 57,274,018 infected with Covid-19 and the number of

deaths was 1,368,000. due to Covid-19. Until now, the United States is in first place with the most cases, namely 13,233,884 cases. This very large number is caused by the Covid-19 virus which spreads very quickly from human to human.

In Indonesia, initially on March 2, 2020, it was confirmed that 2 people were infected with the 2019 Coronavirus Disease. And at this time, as of November 21, 2020, the number of sufferers was 493,308 infected with Covid-19 with 15,774 deaths and 413,955 recovered. Now Indonesia is in the order of 22 of the whole world.

Then, Indonesia as we know, has 34 provinces. Of the 34 provinces, the most cases are occupied by Jakarta. Currently, as of November 23, 2020, there are 127,164 cases of corona infection. This is because, Jakarta is ranked 5th with the most population and has a dense activity. But not only in Jakarta, but 34 provinces of Indonesia that have spread the 2019 Coronavirus Disease. North Sumatra is in 9th place with a total of 15,235 cases.

Medan City is the capital city of North Sumatra Province. The city of Medan is the area with the most cases in North Sumatra. In the city of Medan, it has been confirmed that there are 7,566 positive cases of Covid-19. This is because the city of Medan is a place for people to gather who come from small areas in North Sumatra.

Based on the description above, the author wants to make a study to predict the spread that occurs in the city of Medan. This research is a Monte Carlo simulation. Monte Carlo simulation is a probabilistic simulation that provides a solution to a given problem based on a randomization process. This research process also uses the frequency distribution of a Covid-19 data variable that has been collected from the initial case to date.

In addition, this study also uses demand estimation which is an important component in a plan. In this study, demand is used as the number of positive Covid-19 patients. Then, using Simple Exponential Smoothing to predict the number of patients in Medan City. Not to forget, this research also requires a mathematical modeling that is used as a tool used to describe some parts related to the real world into the form of mathematical equations and inequalities. Mathematical modeling is also used to obtain analytical results, predict or provide real-world insights.

So, it is adjusted to the current conditions in the Medan City area. So the use of the demand estimation model for the Medan City area is needed in this study. In this research, a Monte Carlo Simulation method is also needed .

## 2. RESEARCH METHODE

In this study using the Monte Carlo simulation method. With this Monte Carlo simulation is one method of determining predictions or opportunities that occur. So with this method, researchers apply it to events that are happening now, namely the Covid-19 case that occurred in the city of Medan.

To predict the spread of Covid-19 cases, the steps taken are 1) the data collection stage, 2) determining the cumulative probability and probability , 3 ) simulating Monte Carlo.

### 2.1  Data collection stage

at this stage the researcher summarizes the data obtained from the Medan city government website page, namely  https://covid19.pemkomedan.go.id/ . the following is a summary of the data obtained from that page;

### 2.2  The stage of determining the probability and cumulative probability

In determining the probability and cumulative probability. Researchers use the help of Microsoft Excel to simplify the calculation process. In addition, before determining the probability and cumulative probability, the researcher first determined the range of data from each patient.

### 2.3  The Monte Carlo simulation stage

From several series carried out, then the results of the data obtained from probability, cumulative probability and random numbers, and there are several other ways. So, the data that has been obtained is inputted into the Monte Carlo simulation with repetitions of 1 to 1,000,000 times (M).

| Date | ODP | Positive | Recover | Died |
|------|-----|----------|---------|------|
| 27-Mar-20 | 53 | 5 | 0 | 1 |
| 28-Mar-20 | 56 | 5 | 1 | 1 |
| 29-Mar-20 | 58 | 5 | 1 | 1 |
| 30-Mar-20 | 62 | 5 | 1 | 1 |
| . | . | . | . | . |
| . | . | . | . | . |
| . | . | . | . | . |
| 24-Nov-20 | 299 | 1059 | 6136 | 315 |
| 25-Nov-20 | 291 | 1059 | 6171 | 315 |
| 26-Nov-20 | 285 | 1054 | 6197 | 315 |

## 3.   RESULT AND ANALYSIS
### 3.1  Determining Probability and Cumulative Probability

This study uses probability data for each population of Covid-19 sufferers. To determine the cumulative probability and probability data, the researcher uses the Microsoft Excel software. The following are the results of the calculation of the cumulative probability and probability from covid data from ODP, Positive, Recovered and Died patients;

**Table 1.**  Positive Patient

| Positive Range | | | Fi | Prob | Prob K |
|------|---|------|-----|------|--------|
| 0 | - | 449 | 90 | 0,367 | 0,367 |
| 450 | - | 899 | 23 | 0,093 | 0,461 |
| 900 | - | 1349 | 41 | 0,167 | 0,628 |
| 1350 | - | 1799 | 44 | 0,179 | 0,808 |
| 1800 | - | 2249 | 44 | 0,179 | 0,987 |
| 2250 | - | 2699 | 0 | 0 | 0,987 |
| 2700 | - | 3149 | 2 | 0,008 | 0,995 |
| 3150 | - | 3599 | 1 | 0,004 | 1 |
| Amount | | | 245 | 1 | |

**Table 2.** Recover Patient

| Range Recover | | | Fi | Probability | Prob K |
|---|---|---|---|---|---|
| 0 | - | 884 | 139 | 0,567 | 0,567 |
| 885 | - | 1769 | 25 | 0,102 | 0,669 |
| 1770 | - | 2654 | 17 | 0,069 | 0,738 |
| 2655 | - | 3539 | 12 | 0,048 | 0,787 |
| 3540 | - | 4424 | 13 | 0,053 | 0,840 |
| 4425 | - | 5309 | 17 | 0,069 | 0,910 |
| 5310 | - | 6194 | 21 | 0,085 | 0,995 |
| 6195 | - | 7079 | 1 | 0,004 | 1 |
| Amount | | | 245 | 1 | |

**Table 3.** ODP Patient

| ODP Range | | | Fi | Probability | Prob k |
|---|---|---|---|---|---|
| 0 | - | 72 | 20 | 0,081 | 0,081 |
| 73 | - | 145 | 80 | 0,326 | 0,408 |
| 146 | - | 218 | 26 | 0,106 | 0,514 |
| 219 | - | 291 | 24 | 0,097 | 0,612 |
| 292 | - | 364 | 44 | 0,179 | 0,791 |
| 365 | - | 437 | 29 | 0,118 | 0,910 |
| 438 | - | 510 | 21 | 0,085 | 0,995 |
| 511 | - | 583 | 1 | 0,004 | 1 |
| Jumlah | | | 245 | 1 | |

**Table 4.** Dies Patient

| ODP Range | | | Fi | Probability | Prob k |
|---|---|---|---|---|---|
| 0 | - | 44 | 93 | 0,379 | 0,379 |
| 45 | - | 89 | 28 | 0,114 | 0,493 |
| 90 | - | 134 | 17 | 0,069 | 0,563 |
| 135 | - | 179 | 13 | 0,053 | 0,616 |
| 180 | - | 224 | 30 | 0,122 | 0,738 |
| 225 | - | 269 | 20 | 0,081 | 0,820 |
| 270 | - | 314 | 41 | 0,167 | 0,987 |
| 315 | - | 359 | 3 | 0,012 | 1 |
| Amount | | | 245 | 1 | |

### 3.2 Determining Random Numbers In generating this random number

the researcher used excel software to shorten the time. To determine random numbers in excel, you can use the following function

"=RANDBETWEEN" ("BOTTOM;TOP" )

### 3.3 Simulate Monte Carlo Simulation

Based on several series of studies, namely the results of returns, return expectations, variations, and volatility. so from this monte carlo simulation, the smallest error is 0% and the largest error is 6%. Thus, it is hoped that these prediction figures can be used by researchers as a reference for future research.

**Table 1.** Simulation Result

| M | Day | ODP | | | Positive | | |
|---|---|---|---|---|---|---|---|
| | | Real | Expected Value | Gap | Real | Expected Value | Gap |
| 1 | 1 | 35 | 5,314 | 0% | 2457 | 6,236 | 5% |
| 10 | 2 | 35 | 5,232 | 0% | 2221 | 5,869 | 4% |
| 100 | 3 | 482 | 4,824 | 6% | 2063 | 5,408 | 4% |
| 1000 | 4 | 265 | 4,312 | 3% | 1758 | 4,779 | 3% |
| 10000 | 5 | 297 | 3,697 | 4% | 521 | 3,971 | 1% |
| 100000 | 6 | 297 | 2,906 | 4% | 2925 | 2,983 | 6% |
| 1000000 | 7 | 42 | 1,995 | 0% | 1002 | 1,995 | 2% |

**Table 2.** Simulation Result (Advanced)

| Recover | | | Died | | |
|---|---|---|---|---|---|
| Real | Expected Value | Gap | Real | Expected Value | Gap |
| 5942 | 6,51 | 6% | 19 | 5,61 | 0% |
| 2266 | 5,942 | 2% | 86 | 5,22 | 1% |
| 4724 | 5,273 | 5% | 51 | 4,726 | 1% |
| 3931 | 4,534 | 4% | 54 | 4,163 | 1% |
| 4176 | 3,746 | 4% | 2 | 3,546 | 0% |
| 1691 | 2,906 | 1% | 137 | 2,808 | 3% |
| 1119 | 1,995 | 1% | 84 | 1,987 | 1% |

## 3. CONCLUSION

Based on the results of the discussion and research that has been done, it can be concluded that in predicting or predicting the spread of the number of Covid-19 in Medan City, we can use a Monte Carlo Simulation method. This monte carlo simulation uses probability, cumulative probability and random numbers as important variables in finding predictive results.

Thus, by using the Monte Carlo Simulation, an overview of the distribution of the number of Covid-19 patients in the city of Medan was obtained. In this simulation, it is found that the smallest error rate is at 0% while the largest error rate is at 6%. From the results of this prediction, it is hoped that it can be used as reference material for other studies that require predictions in determining the number of Covid-19 patients in the Medan City area. So that other researchers can dig deeper into the data that has been predicted.

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