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MODEL OF COVID-19 SPREAD CONTROL USING THE DYNAMIC SYSTEM APPROACH IN WEST NUSA TENGGARA PROVINCE, INDONESIA

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ABSTRACT: The objective of this research is to try to conduct an outbreak modeling of a Corona virus (COVID-19) pandemic in West Nusa Tenggara (NTB) Province. The modeling approach used in this study is through dynamic system approach with the SEIR technique (Susceptible - Exposed - Infectious - Recovered). In this model, the effectiveness of the policy is tested on three policy scenarios, namely: (1) Loose Scenario is the effectiveness of the intervention 0 - 30%; (2) Moderate Scenarios is the effectiveness of interventions 31 - 60%; and (3) Strict Scenarios is the effectiveness of interventions > 61%. The dynamic model with the Susceptible - Exposed - Infectious - Recovered (SIER) technique can reasonably project the spread of COVID-19. The scenarios of policy interventions that can be implemented to overcome the spread of COVID-19 in West Nusa Tenggara Province are moderate scenario and strict scenario.

Keywords: Model, Spread, COVID-19, Dynamic System

1. INTRODUCTION

A pandemic of disease outbreaks due to the Corona Virus (COVID-19) currently has shocked the world. This virus was first identified in China, precisely in Wuhan at the end of December 2019. The SARS-CoV-2 virus that causes Corona Virus (COVID-19) is something that frightening for every country in the world because its appearance has caused the lives of millions of people who have confirmed positive exposure and more than one hundred thousand people have died.

Based on Friday's update (01/05/2020) more than 200 countries have been infected with Corona virus cases (COVID-19) with 3,934,153 cases, of which 239,447 people have died (https://www.worldometers.info/coronavirus). In Indonesia, reported on the official website www.covid19.go.id Friday (01-05-2020) the number of cases of people exposed to positive COVID-19 has reached 10,551 cases in which 1,591 cases were declared cured and 800 cases were declared dead. A total of 34 provinces in Indonesia have been positively exposed to the Corona virus (COVID-19) including in West Nusa Tenggara Province (NTB). Press release on the official website of the NTB Provincial Government Task Force on May 6 2020 (https://corona.ntbprov.go.id) informed that there was an increase in the number of positive cases of COVID-19 by 11 people so that the total of 300 positive cases in which the previous day amounted to 289 positive people. The trend of increasing positive cases in NTB province continues happen so it requires to be anticipated seriously through control in the form of government policy interventions and active community participation in controlling the spread of this Corona virus (COVID-19).

One of the modeling methods to see future projections of the transmission rate and the infection rate of the Corona virus (COVID-19) in West Nusa Tenggara (NTB) is by modeling and simulating scenarios through a dynamic system approach. The dynamic system is a methodology for studying surrounding problems that observe the problem as a whole (holistic) and the study system changes over the time by taking into account the feedback factor [1] [8] [13] [14].

System dynamic is defined as fields for understanding how things change over the time [2] [3]. System dynamics software such as Stella, Powersim, Simile and Vensim help formulate models of stock and flow components. System dynamic is based on difference and differential equations [3]. The difference equation is an equation that states the future state depends on the current state and other factors.

Whereas Modeling can be interpreted as a representation of an object or actual situation or imitation of a real-world model created virtually [4] [15] [16]. Modeling is an inseparable part of human civilization. The origin of this modeling has existed since the days of ancient Egypt, Babylon, and the heyday of Greece and Rome. Modeling is a process of elaborating or representing an object or phenomenon, and the way of thinking through a logical sequence [5] [6] [17] [18].

This research trying to conduct an outbreak modeling of a Corona virus (COVID-19) pandemic in West Nusa Tenggara (NTB) Province. Modeling with dynamic system approach with the SEIR technique (Susceptible - Exposed - Infectious-Recovered) is a development of SIR (Susceptible - Infectious - Recovered) in which this technique is a dynamic model created by Sir Ronald Ross, MD, a medical doctor from England. The basic technique of SIR is the most basic transmission for infectious diseases that are transmitted directly by bacteria, viruses, or fungi. Direct transmission occurs through individual contact with individuals through sneezing or coughing, through skin contact, or through the exchange of body fluids such as H7N9 flu, tuberculosis, and MERS-CoV [7] [8]. The SEIR model is used mathematical modeling to estimate the growth rate of a pandemic such as Corona Virus (COVID-19) and very familiar for epidemiologists**.**

2. METHOD

The modeling approach used in this study is through dynamic system approach with the SEIR technique (Susceptible - Exposed - Infectious - Recovered). The SEIR technique used in this study becuase the uniqueness of the Corona virus (COVID-19) related to the incubation period which is quite long with the incubation period of 5.2 (4.1 - 7.0) days and an infection period of 2.3 (0.0 - 14.9) days (Li, Leung and Leung at. al, 2020). The SEIR model is used to predict and analyze the changing trends in epidemic situations, then estimate the parameters involved in the infection dynamics model [11].

The character of this disease has a latent phase in which the individual is infected but not yet contagious. The suspend between the acquisition of infection and the state of the infection can be included in the SIR model by adding latent / exposed populations, E, and allowing infected (but not yet transmitted) individuals to move from S to E and from E to I. According to [9] [10] [11] [12], formulation of the model These are:

$$
\begin{aligned}
dS/dt &= -\beta SI/N, & S(0) &= S_o > 0,\\
dE/dt &= \beta SI/N - \varepsilon E, & E(0) &= E_o \geq 0,\\
dI/dt &= \varepsilon E - \gamma I, & I(0) &= I_o > 0,\\
dR/dt &= \gamma I, & R(0) &= R_o \geq 0,
\end{aligned}
$$

Where S (t), E (t), I (t), and R (t) are numbers in the Vulnerable Group (S), Exposed Group (E), Infectious / Infected (I), and Recoverd (R) , so that S (t) + E (t) + I (t) + R (t) = N. Tools used for data analysis in this study using the dynamic system approach with the help of Vensim Software which is a data analysis tool used to see projections of the causal relations (causality) of the variables or parameters used.

The assumed parameters in this study are:

a) Vulnerable Population, namely: Travel Symptom Without Symptom (PPTG) of 54,452 and Symptomless Person (OTG) of 3,739 with a total number: 58,191 people (up to date on May 6, 2020)
b) The level of transmission that is influenced by the R0 (Basic Reproductive Number) value of 3 (Read at.al, 2020), decreases in the relative contact frequency of the vulnerable population fraction by 0,
c) The ability of public health, namely the ability to conduct tracing, monitoring, rapid/swab tests, and quarantine of 500 people/day
d) Infection from outside is the number of people infected from outside of 5 people
e) Incubation period of 5 days
f) The death rate that is affected by the ability of the hospital is related to the available bed capacity for positive patients who are in urgent need of hospitalization of 500 beds, the duration of infection is 5 days, the mortality rate with good care is 0.001 and minimum care is 0.01.

The assumptions parameters above is based on the data collection in the field and then simulating the effectiveness of the intervention policy scenarios, namely:

1. Community Education Policy, which is to improve the behavior of a healthy community lifestyle (wearing masks, washing hands frequently with soap, not crowding, social distancing or / physical distancing,)
2. Isolation public policy, namely concerning lockdown policy, PSBB / PSBL, partial isolation or independent isolation.

The policy interventions are tested for effectiveness by simulating 3 (three) policy scenarios with dynamic system approach, namely:

1. Loose Scenario that is the effectiveness of the intervention 0 - 30%
2. Moderate Scenarios that is effectiveness of interventions 31 - 60%
3. Strict Scenarios that is the effectiveness of interventions> 61%

3. RESULTS AND DISCUSSION

Loose scenario that is the effectiveness of policy interventions of 0-30%

Based on Figure 1 shows that if policy intervention is loose and the community is not cooperative, then at the peak of positive cases COVID-19 can reach 3,640 cases on the 81st day around the 2nd week of June 2020 with the number of dead cases totaling 46 cases.

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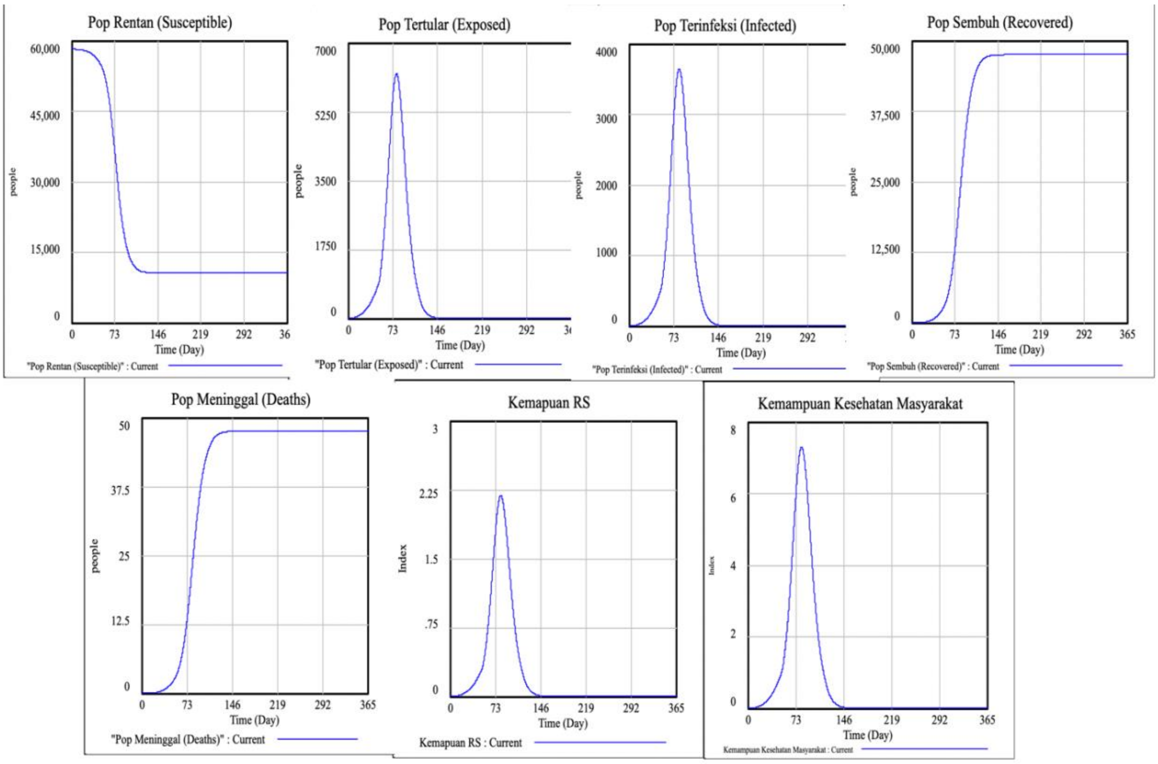

Fig 1. Loose Scenario Policy Interventions

The results of the simulation of loose scenario with dynamic system approach is policy interventions with the effectiveness of between 0-30%. The policy intervention is a combination of the relative effectiveness of community behavior factors that affect the level of transmission and the ability to isolate later will affect the rate of transmission from susceptible healthy people to infected people but have not shown symptoms (Exposed), then the group of people in this phase will increase their status become confirmed positive (infected) after going through rapid tests and swabs and then recover after the formation of immunity, but people who are disadvantaged with a weak immune condition will die. The high number of cases of impunity / positive COVID-19 in this loose policy intervention scenario is due to the fact that most people are not cooperative in complying with the COVID-19 protocol properly, for example not being obedient in wearing masks when outside the home, not keeping distance or physical distancing / social distancing, not staying at home during the incubation period, the healthy lifestyle that is still low such as awareness in maintaining personal hygiene for example always washing hands with soap, as well as maintaining the cleanliness of the neighborhood.

In addition, the effectiveness of ability for isolation or independent quarantine or isolation in hospitals or isolation areas are still low, this condition will accelerate the rate of transmission so that people who were vulnerable and healthy will have a big enough opportunity for contracting so that the positive confirmed cases (infected) of COVID-19 will be higher and will have an impact on the rate of recovery and the rate of mortality. Based on data from May 18, 2020 Cases of recovery in the NTB Province were quite good from a total of 365 positive confirmed cases, of which 219 cases with a cure rate of around 60% while of the number of dead as many as 7 cases with a mortality rate of 1.92%.

Moderate scenario that is the effectiveness of policy interventions of 31-60%

Based on Figure 2 shows that if moderate policy interventions and the community are sufficiently cooperative, then at the peak of positive cases COVID-19 could reach 85 cases on the 50th day around the 2nd week of May 2020 with the number of deaths are 3 cases.

In the moderate scenario with the effectiveness of policy interventions 31- 65% showed significant decrease in positive confirmed cases COVID-19 from 3640 cases dropped to 85 cases on the 50th day around the 2nd week of May 2020 with the number of deaths are 3 cases, not only the number of cases of infection and mortality rates are declining, but the moderate intervention is also accelerating the peak incidence of the 2nd week of June to the 2nd week in May 2020.

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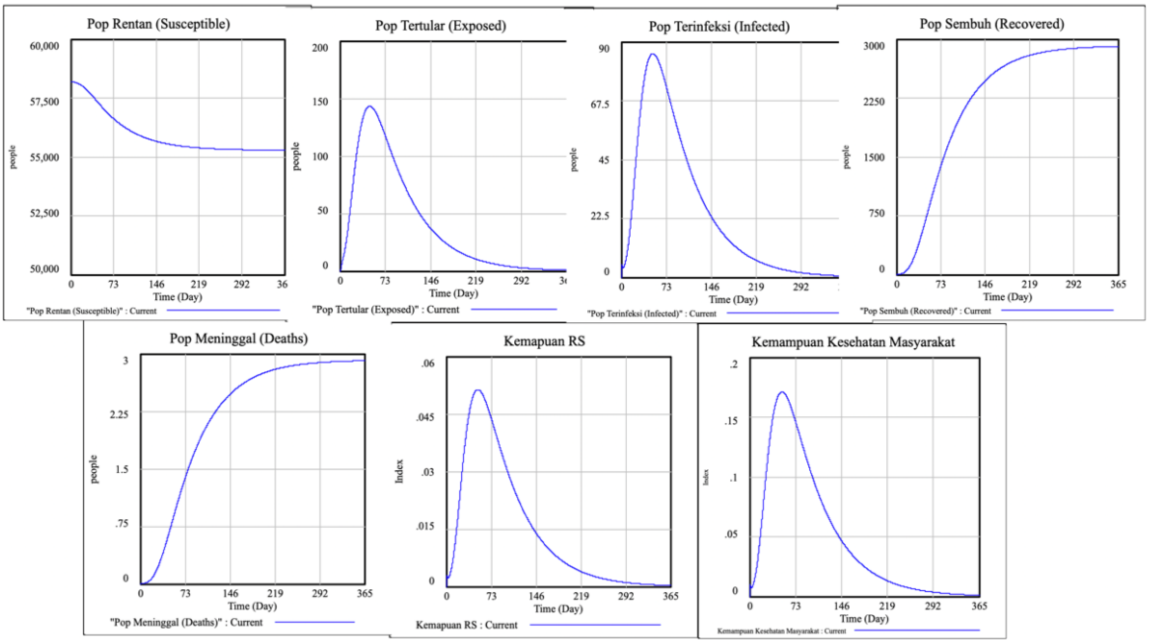

Fig 2. Moderate Scenario Policy Interventions

This condition is very good and quite significant in reducing or preventing the increase in the number of new cases confirmed positive COVID-19. In the conditions of this policy intervention it is assumed that the level of public awareness in- reducing the risk of exposure to COVID-19 is quite good, besides the increased ability to perform isolation actions both in positive confirmed patients, Oversight People (ODP), and Patients in Oversight (PDP).

Strict scenario that is effectiveness of policy intervention> 61%

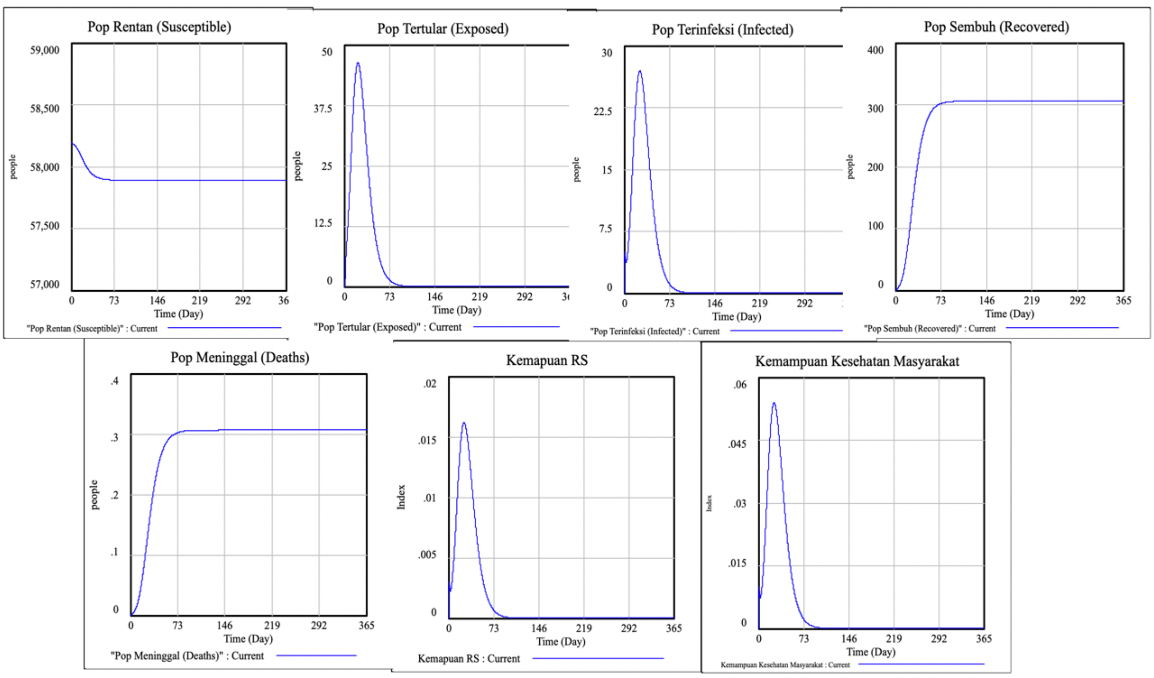

Fig 3. Strict Scenario Policy Interventions

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Based on Figure 3 shows that if the policy intervention is strict and the community is very cooperative, then the peak of positive cases of COVID-19 could reach 27 cases on the 27th day round the 3rd week of April 2020 with the number of deaths is 0 cases. In the strict scenario with the effectiveness of policy interventions > 61% showed significant decrease in positive confirmed cases of COVID-19, which in the loose intervention the number of cases of 3640 dropped dramatically to 27 cases on the 27th day around the 3rd week of April 2020 with the number of death is 0 case. Related to the same incident as the culmination of policy interventions on the moderate scenario that more beginning of 3 weeks, namely from the 2nd week of May 2020 to the 3rd week of April. This condition has a meaning that the faster the incidence peak of a pandemic it will be easier to detect the spread so that it will be easier in controlling and handling the spread in order the rate of transmission and the rate of infection can be reduced to minimum and will reduce the burden on hospitals from the curative aspect.

From these three scenarios, we can determine that the application of moderate and strict scenarios are the solution in reducing the rate of transmission and the rate of COVID-19 infection. Thus, the both scenarios can be recommended as effective policy interventions to control the spread of COVID-19 in Indonesia, especially in West Nusa Tenggara province (NTB). However, because the application of the two scenarios emphasizes on the preventive aspects rather than the curative aspects, it would require the humanist social engineering. In addition, because each scenario has consequences in the form of positive or negative impacts, both in terms of the social dimension, economic, cultural and political, then the policy to be implemented must really consider to the aspect of benefits or unfavorable comprehensively.

4. CONCLUSIONS

Modeling with the dynamic system approach using the Susceptible - Exposed - Infectious - Recovered (SIER) technique is sufficient to be able to project the spread of COVID-19 in West Nusa Tenggara Province. The scenario of policy interventions that can be implemented to overcome with the spread of COVID-19 in West Nusa Tenggara Province are moderate scenario and strict scenario.

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