Computing the auto regressive distributed lag (ARDL) method in forecasting COVID-19 data: A case study of NTB Province until the end of 2020

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Abstract. The purpose of this research is to conduct data forecasting on the spread of COVID-19 in West Nusa Tenggara Province, Indonesia at the end of 2020. The data used in this research is the COVID-19 data in NTB Province including the data of the number of positive patient, the number of patients recovered and the number of patient passed away. The forecasting process uses the Autoregressive Distributed Lag (ARDL) method of the GUI Multiple Forecasting System (G-MFS) based on MATLAB by determining the prediction on the next day of the graph equation generated after the data simulation. The forecasting of the COVID-19 spread in NTB at the end of the year of 2020 obtained that the number of confirmed patients amounting to 19,614 people with an average increase of 1.48%, the number of patients healed are 6,651 with an average increase of 1.10%, and the number of patients died amounting to 4,953 people with an average increase of 2.42%. The average increase in the number of patients who died showed that the provincial government of NTB needs to give more serious attention to handling COVID-19 patients.

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1. Introduction

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In the early of 2020, all countries, all regions, and communities were shocked by the arrival of a new covid-19 pneumonia outbreak originating in Wuhan, Hubei Province, and then spreading rapidly to more than 190 countries and territories. The covid-19 pandemic that is engulfing the world, including in Indonesia is a serious concern for the government. The virus, which basically only infects animals, has grown so rapidly that it can infect humans [1]. When viewed from the development of this virus, it is divided into 6 types of Covid that can infect humans, among them are alphacoronavirus 229E, alphacoronavirus NL63, betacoronavirus OC43, betacoronavirus HKU1, Severe Acute Respiratory

Illness Coronavirus (SARS-CoV), and the Middle East Respiratory Syndrome Coronavirus (MERS-Cov). [1]

Covid-19 attacks the respiratory system. The same viruses a few years ago that attacked the respiratory system were SARS-Cov and MERS-Cov. Both viruses have been classified as major public health threats. But what sets Covid-19 apart from other viruses is its rapid spread, so there is no careful preparation in anticipation of its spread. This covid-19 infection process, according to the results of media power studies through direct contact with each other and droplets from human to human itself and not by air. The results also revealed that the people most susceptible to covid-19 are those who make direct contact with patients, including nurses and doctors[2] [3].

Based on data as of February 12, 2020, the worldwide mortality rate is 2.1%, while cases in Wuhan city reach 4.9%, and 3.1% in Hubei, as well as in The Province of China reaching 0.16%. Based on research and supervision conducted by medical personnel on the first 41 patients affected by the Covid-19 outbreak in Wuhan, there were 6 deaths, including 5 patients in the ICU and 1 non-ICU patient. Many cases of death occur in some elderly people with congenital diseases. [4]

Furthermore, on March 2, 2020, Indonesia also contracted Covid-19, which continues to increase every day. In the process of handling this Covid-19 outbreak, Anthony de Mello warned that the outbreak of the disease will develop very quickly if faced with fear or panic. More than a thousand people were victimized by illness, while four thousand people were victimized by panic. [5] Learning to do so, communication is one of the most important parts of dealing with the current pandemic threat. Public trust needs to be built and maintained so that panic does not occur and excessive fear in the community for the handling of the outbreak to run smoothly. One of the instructions given by President Joko Widodo's father is the seriousness of the government. The government is ready and able to deal with this kind of problem. The perception of the readiness, determination, and seriousness of the government needs to be conveyed to the public through a comprehensive and periodic explanation, by explaining what has been and will be done by the government. [5]

Data update task force for accelerated handling of Covid-19 as of Wednesday 2 April 2020, covid-19 infection cases in Indonesia showed an increase in the number of patients above 100 people, this increase made the total number of positive cases of Covid-19 in Indonesia to 1,790 patients. The increase in the number of positive cases of Covid 19 comes from provinces in Indonesia, one of which is West Nusa Tenggara Province (NTB). NTB province, which was initially predicted not to be exposed to Covid-19, showed a rapid increase in spread. As of April 10, 2020, NTB Province ranks 14th with the number of Covid-19 positive patients well below Bali Province, which is one-third of the number of Covid-19 positive patients in Bali Province. [6] However, in the past 2 months, the increase in NTB Province cases has jumped up into the top 10, well above Bali Province which recorded 915 cases or 2.4% of all Covid-19 cases recorded in Indonesia [7] and NTB Province was the second largest number of covid-19 positive children. [8]

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Based on the results of NTB government monitoring through health officials, 7 clusters were identified as the source of the spread of the Covid-19 virus. The seven clusters that spread Covid-19 in NTB include Gowa clusters, Bogor clusters, Jakarta clusters, Sukabumi clusters, Bali clusters, overseas clusters (cruise ship crews), and local transmissions. The Covid 19 spread map in NTB is shown in Figure 1 below.

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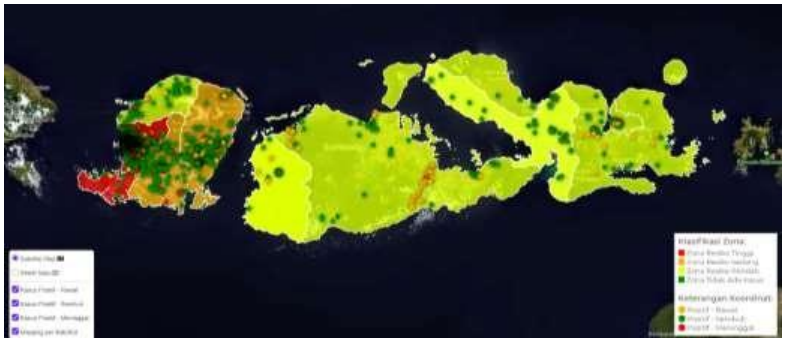

Figure 1. Distribution map COVID-19 in NTB.

Due to the increasing number of Covid-19 patients in Indonesia, especially in NTB Province, it is necessary to simulate or forecast Covid-19 data by the ARDL method. Forecasting is an action to predict what will happen in the future using data sets from the past [9]. Forecasting is also beneficial for effective planning. In calculating forecasting, the most important thing is how we understand the characteristics of a method that will be used in that forecasting to fit the decision-making situation [10]. The best method in a forecasting system is to construct several methods in a Graphical User Interface (GUI) MatLab form, i.e. by calculating all the indicators of accuracy to find the best mathematical model of time series data used at a certain period of time [11][12].

The ARDL method is a combination of the Autoregressive and Distributed Lag methods. Lag means a past value that will be used to see future values. The Autoregressive Distributed Lag (ARDL) method has two advantages, namely being unbiased and efficient because it can be used with a small sample [13]. The ARDL method has two advantages: it is unbiased and efficient because it can be used with a small sample. Using this method, we can find long-term relationships when the variables are mixed between 1:1 and 1:0. The estimator of this ARDL method will produce a consistent long-term coefficient created using normal asymptotic theory standards. The advantage of this ARDL method approach is to produce consistent estimates of long-term coefficients that deliver good results no matter how many variables the descriptor or its regressors are 1:0 or 1:1. In the case that there is a long-term coefficient that means trend stationarity, with ARDL method can be done by using a detrending against time-series data and modifying the detrended series by using a stationary distributed lag. ARDL is a regression model by entering its variable values that describe a present value or past value of its free variable into a descriptor variable[14].

ARDL serves to calculate the number of long-term coefficients and error correction model (ECM) - ARDL to calculate the number of short-term coefficients [13]. Especially for research with the ARDL approach, the Bounds Testing Cointegration co-integration test method is used to determine the co-integration of the model (Aziz Muslim). To find out the predicted value of covid-19 confirmed amount data in Indonesia, a model can be used forecasting if it has a smaller error rate, then the forecasting results will be closer to precise. How to find out the value of an increasingly smaller error can be known by calculating the value [15].

The purpose of conducting this research is to forecast data related to the spread of Covid-19 in NTB Province until the end of 2020. The first step is to simulate the number of confirmed patients, the data on the number of patients recovered, and the data on the number of patients who died to find mathematical models of each data. Furthermore, perform data analysis or mathematical calculations to see data patterns or trends until the end of 2020. Finally, review government policy on handling Covid-19 cases in the community.

2. Method

The data used in this research is the COVID-19 data in NTB Province including the number of positive patient data, the number of patients recovered and the number of patient data passed away. The forecasting process uses the Autoregressive Distributed Lag (ARDL) method of the GUI Multiple Forecasting System (G-MFS) based on MATLAB by determining the prediction on the next day of the graph equation generated after the data simulation. The following steps are performed in forecasting data of COVID-19 with the following ARDL method:

a. Identify the problem, which is the activity of finding and collecting references related to COVID-19 data in NTB Province, and how to complete the simulation and find mathematical models using the ARDL method.
b. Data retrieval and validation. From the search results of the reference made related to the data to be simulated, the data that researchers use in conducting this research is data daily time series of COVID-19 data in NTB Province from 24 March-14 July 2020 which includes the number of positive patients, the number of patients cured and the number of patients died
c. Predictions. In determining its predictions by using the ARDL method The research team performs three times the simulation to get results for daily predictions because the data used is daily data.
d. Interpretation of data. At this stage, the research team performs the interpretation of the data based on mathematical models and the mathematical results of a mathematically calculated result.

As for the algorithm is arranged as shown in Figure 2 below

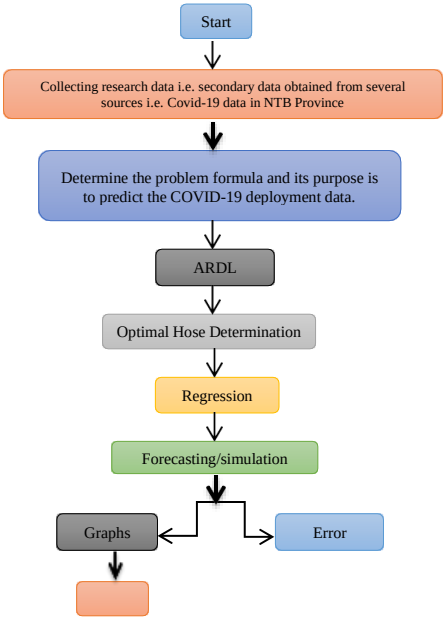

Figure 2. Research procedure.

3. Result and Discussion

The simulation was done 3 times the number of confirmed patient data, the number of patients recovered, and the number of patient data passed away. Data on the number of confirmed patients amounted to 113

data (daily), patient data recovered amounting to 98 data (daily) and deceased patient data amounted to 85 data (daily). The forecasting of these three data is as follows.

3.1. Mathematics Model of Forecasting and Confirmed Data

Based on simulated results using the assisted ARDL method G-MFS obtained forecasting results for confirmed patients with a total input of data of 113 obtained the following equation

$$(t) = 4.5 + 1.1564lag_1 - 0.094149lag_2 - 0.10041lag_3 + 0.29467lag_4 - 0.24847lag_5$$

From this equation, the forecasting data was obtained about the number of confirmed patients until the end of the year 2020. As for the forecasting result chart or actual data approach and forecast data are shown in Figure 3 below

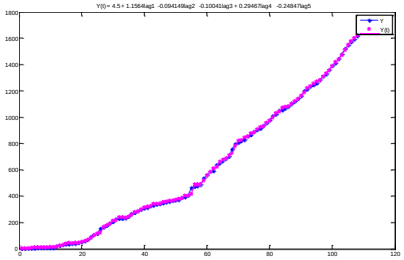

Figure 3. The actual Data approach and Forecast Data for confirmed patients.

In purple figure is a spread of data from forecasting, the graph shows that the data is forecasting well because its spread is located and follows the actual data. If viewed from MAPE obtained a value of 11.25% This figure indicates that the forecasting result is good, it is based on the interval of MAPE value is said to be good if it is at 10% to 20% intervals. Based on the equations obtained in figure 3 above, the number of patients confirmed until the end of the year amounted to 19,614 people with an average increase of 1.48%.

3.2. Mathematics Model of Forecasting and Confirmed Data for Cured Patients

Forecasting results for patients cured by the number of input 98 daily data, obtained the following equation

$$(t) = 2.6673 + 1.287lag_1 - 0.089523lag_2 - 0.11956lag_3 + 0.062794lag_4 - 0.13831lag_5$$

This equation was obtained forecasting data about the number of patients healed until the end of the year 2020. As for the forecasting result chart or actual data approach and forecast data are shown in Figure 4 below.

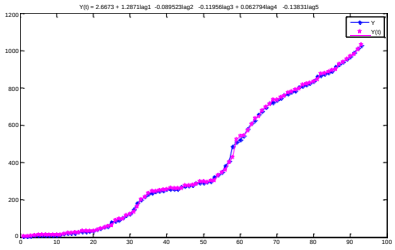

Figure 4. The actual Data approach and Forecast Data for recovered patients.

Purple-colored graphics are a spread of data from forecasting results if viewed from the value of MAPE at 6.46%. These results indicate that the forecasting skills are very good, this is based on the value of the MAPE is at intervals below 10% [16]. The number of patients cured based on the above equation until the end of the year 2020 amounted to 6,651 people with an average increase of 1.10%.

3.3. Mathematics Model of Forecasting and Confirmed Data for Died Patients

Forecasting results for patients passed away by the number of input 85 daily data obtained equation as follows

$$(t) = 0.27691 + 0.97648lag_1 + 0.2945lag_2 - 0.36382lag_3 + 0.050293lag_4 + 0.065294lag_5$$

This equation was obtained forecasting data about the number of patients healed until the end of the year 2020. As for the forecasting result chart or actual data approach and forecast data are shown in Figure 5 below.

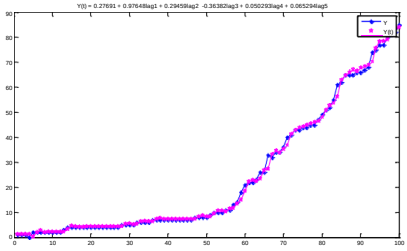

Figure 5. The actual Data approach and Forecast Data for deceased patients.

Purple-colored graphs are a spread of data from forecasting, indifferent with forecasting on confirmed patient data and patients heal, data for died patients has a fairly high increase on average which is an average increase of 2.42%. These results need to be the concern of the Government to be more serious in crying, COVID-19 patients. The number of patients who died based on the equation above until the end of the year amounted to 4,953 people.

3.4. Percentage Decrease Per Data Category

A declining percentage is a general overview of how the COVID-19 spread in NTB Province until the end of the year 2020. The graphics are presented in Figure 6 below.

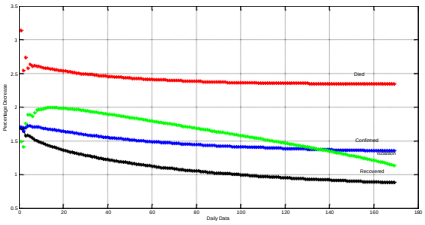

Figure 6. Percentage of patient reduction chart.

In Figure 6 above, it is divided into 4 different colors. The blue color shows a percentage of the patient's confirmed decline and black color shows a decrease in the patient's decline. The percentage of the reduction for the patient to be confirmed and the movement healed is slow but has a significant decline, the red color indicates a decrease in the patient's death. A decrease in the patient's decline is still very slow and this needs to be a constant concern from the Government in addressing the spread of COVID-19 in NTB province. Green color indicates a reduction in the number of isolation patients.

Patient data isolation obtained from the result of the calculation of confirmed patient data minus the patient healed and reduced patients died.

Furthermore, some policies that have been applied by the Government as an effort to handle this COVID-19 case such as (1) the provincial government of West Nusa Tenggara (NTB) Set the emergency response status of non-natural disaster COVID-19, this is performed as an acceleration attempt to handle the COVID-19 outbreak in NTB. (2) Expansion and addition of the rapid response complaint centers, (3) The NTB government will divide the personal protective equipment (PPE) for the Regency/city, (4) Provide places that can be used to conduct quarantine so that the focus of the confirmed patients can be maximal. (5) Share the COVID-19 social safety net (JPS) help package. The purpose of sharing this package, as a form of support in a moral and material in the affected community.

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4. Conclusion

The forecasting of the COVID-19 spread in NTB until the end of the year 2020 was obtained the number of confirmed patients amounted to 19,614 people with an average increase of 1.48%, the number of patients healed 6,651 with an average increase of 1.10%, and the number of patients died amounting to 4,953 people with an average increase of 2.42%. The average increase in the number of patients who died showed that the provincial government of NTB needs to give more serious attention in handling COVID-19 patients. Also, it is encouraged to all walks of life to keep an eye on regulations or policies of the government in the handling period of COVID-19 so that the calamity is quickly ended. XXX

Commented [U5]: Please include recommendations based on your research findings.

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