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Analysis of the Increase in Covid-19 Patients in Maluku Province Using Markov Chain Method

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ABSTRACT

Since the beginning of 2020, most of the world has been hit by the covid-19 pandemic, patients who are confirmed to be covid-19 are increasing day by day until the end of 2020, this increase in covid-19 patients has also occurred in the province of Maluku. In this study using the Markov chain method to analyze the increase in COVID-19 patients in the Maluku province, the results of the study were obtained that there were 5 ranges of adding positive COVID-19 patients with the opportunity value of increasing in each range as follows In the range of 0-20 people, the opportunity value is 0.103, the range of 21-40 people, is the opportunity value 0.098, the range 41-60 people is the opportunity value is 0.093, the range 61-80 people is the opportunity value is 0.1, the range of more than 81 people the opportunity value is 0.74.

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1. Introduction

COVID-19 is a new type of disease from the corona virus that first occurred in Wuhan, China, in December 2019. COVID-19 can spread from person to person through droplets from the nose or mouth that come out when a person infected with COVID-19 coughs. or exhale [1]. Indonesia is one of the countries affected by COVID-19 with the first case occurring on March 2, 2020 until the latest data on April 22, 2020, as many as 7,418 were confirmed positive for COVID-19 [2]. Indonesia The fourth most populous and developing country in the world, it is therefore expected to suffer greatly and over a longer period of time. One of the regions in Indonesia that has not escaped the terror of COVID-19 is the Maluku province. The first positive case in Maluku was confirmed on March 23, 2020 and continued to experience a significant increase until November 4, 2020. This can be observed from the daily updates of COVID-19 case data on the Health Office website. Prov. Maluku (health office@malukuprov.go. Sid, 2020) which consists of the number of ODP (People Under Monitoring), PDP (Patients Under Supervision) and positive cases.

The Markov chain was first discovered by a Russian physicist named Andrei Andreevich Markov (June 2, 1856 – July 20, 1922). Markov chain is a method that studies the properties of a variable in the present which is based on the properties of the past in an effort to estimate the properties of these variables in the future [3]. This analysis is not an optimization technique but a descriptive technique. In the Markov analysis, the resulting probabilistic information can be used to assist decision making. This analysis is more commonly known as the Stochastic process (Stochastic process) is a special form of probabilistic model [4]. Several studies have been carried out using Markov Chains, including Suarni Putri Dwi in her thesis explaining the Markov Chain application. Ranati Markov is a method that can be used to stochastically model changes in the value of a random variable or state from time to time [5]. The application of the Markov Chain is very broad, one of which is in modeling the spread of the virus. In a previous study, namely Kinley Aritonang in his journal explaining the analysis of the increase in COVID-19 patients in Indonesia using the Markov Chain method in the calculation results showed that the possibility of adding patients between the range of 1 to 91 people was 0.21197, while the results of research from Maluku Province obtained a range of 1 to 20 people is equal to 0.406.

2. Research Methods

The data used in this study is secondary data of patients infected with COVID-19 in Maluku Province. The data is then processed and analyzed using the Markov chain method to see the increase in COVID-19 patients in Maluku Province. The stages in this research are as follows:

1. Determine the research topic.
2. Collecting data on patients infected with COVID-19 from the Maluku Regional Police office.
3. Processing patient data using Markov Process.
4. Create a range for adding Covid-19 patients
5. Determine the transition frequency
6. Create a transition probability matrix
7. Calculate the probability of increasing the number of patients who are confirmed positive for COVID-19.

3. Results And Discussion.

3.1. Research Data

This study uses data on COVID-19 patients in Maluku Province sourced from the Maluku Regional Police. The data used is from August 1, 2020 to November 4, 2020. The data taken includes data on patients who are confirmed positive (ill), recovered and died. These data can be described in Table 1 as follows:

Table 1. Data on COVID-19 Patients in Maluku Province

Month	Positive	Healed	die
August	740	459	10
September	447	681	8
October	1027	1393	6
November	20	54	0

Source: POLDA Maluku 2020

3.2. Range Addition of COVID-19 Patients

The range of COVID-19 patient data is needed to determine how many states or circumstances will be used. In this study, the range is divided into five states by considering the conditions used to cover all existing data. The distribution of the data can be seen in Table 2, as follows:

Table 2. Range of Addition of COVID-19 Patients

Added Range Patient	*state*
0-20	1
21-40	2
41-60	3
61 – 80	4
81	5

From Table 2, it can be described as follows in the range 0-20 classified as state 1, in the range 21-40 classified as state 2, in the range 41-60 classified as state 3, in the range 61-80 classified as state 4, and in the range 61-80 80 is classified as state 5

3.3. Transition Frequency

After dividing the data into several states, a transition frequency table can be created. The transition frequency table contains the number of transitions that occur in each state, as follows:

Table 3. Transition Frequency

	***state* 1**	***state*2**	***state*3**	***state*4**	***state*5**	**Total**
***state*1**	21	13	9	2	0	45
***state*2**	10	1	5	2	0	18
***state*3**	9	5	3	2	1	20
***state*4**	5	0	1	0	0	6
***state*5**	1	0	2	0	1	4
Total	46	19	20	6	2	93

Based on Table 3, the transition frequency from 1 to state 1 occurs 21 times, from state 1 to state 2 occurs 13 times, from state 1 to state 3 occurs 9 times, from state1 to state 4 occurs 2 times, and from state 1 to state 5 does not exist. Then the transition frequency from state 2 to state 1 occurs 10 times, state 2 to state 2 occurs once, state 2 to state 3 occurs 5 times, state 2 to state 4 occurs 2 times, and state 2 to state 5 does not exist. . Furthermore, the transition frequency from state 3 to state 1 occurs 9 times, from state 3 to state 2 occurs 5 times, from state 3 to state 3 occurs 3 times, from state 3 to state 4 occurs 2 times, and from state 3 to state 5 occurs once. After that the frequency of the transition from state 4 to state 1 occurs 5 times, from state 4 to state 2 does not exist, from state 4 to state 3 occurs once, from state 4 to state 4 does not exist, and from state and state 4 to 5 there isn't any. then the frequency of the transition from state 5 to state 1 occurs once, from state 5 to state 2 does not exist, from state 5 to state 3 occurs 2 times, from state 5 to state 4 does not exist, and from state 5 to state 5 occurs once.

3.4. Transition Opportunity Matrix

The transition frequency table which is located in Table 3 is then formed a transition probability matrix. The transition probability matrix itself is a matrix that contains information that regulates the movement of the system from one state to another. The probability of moving each state is calculated by dividing the number of times the transition occurs in each state by the total state of change in each state. The table that presents the transition frequency opportunities is presented in Table 4 as follows:

Table 4. Probability of Transition Frequency

	state 1	**state 2**	**state 3**	**state 4**	**state 5**	**Total**
state 1	$\frac{21}{45}$	$\frac{13}{45}$	$\frac{9}{45}$	$\frac{2}{45}$	0	45
state 2	$\frac{10}{18}$	$\frac{1}{18}$	$\frac{5}{18}$	$\frac{2}{18}$	0	18
state 3	$\frac{9}{20}$	$\frac{5}{20}$	$\frac{3}{20}$	$\frac{2}{20}$	$\frac{1}{20}$	20
state 4	$\frac{5}{6}$	0	$\frac{1}{6}$	0	0	6
state 5	$\frac{1}{4}$	0	$\frac{2}{4}$	0	$\frac{1}{4}$	4

From Table 4, it can be made a transition probability matrix which is symbolized by as follows:

$$P = \begin{bmatrix} 0,467 & 0,289 & 0,2 & 0,044 & 0 \\ 0,556 & 0,056 & 0,278 & 0,111 & 0 \\ 0,450 & 0,25 & 0,15 & 0,1 & 0,05 \\ 0,823 & 0 & 0,167 & 0 & 0 \\ 0,250 & 0 & 0,5 & 0 & 0,25 \end{bmatrix}$$

Based on the matrix, it can be explained that the probability of moving from state 1 to state 1 (P11) is 0.467, the probability of moving from state 1 to state 2 (P12) is 0.289, the probability of moving from state 1 to state 3 (P13) is 0.2, the probability of moving from state 1 to state 3 (P13) is 0.2. the movement from state 1 to state 4 (P14) is 0.044, the probability of moving from state 1 to state 5 (P15) is 0, the probability of moving from state 2 to state 1 (P21) is 0.556, the probability of moving from state 2 to state 2 (P22) is 0.056 the probability of moving from state 2 to state 3 (P23) is 0.278, the probability of moving from state 2 to state 4 (P24) is 0.111, the probability of moving from state 2 to state 5 (P25) is 0, and so on. Based on the transition probability matrix (P), the transition probability graph between states can be described as follows.

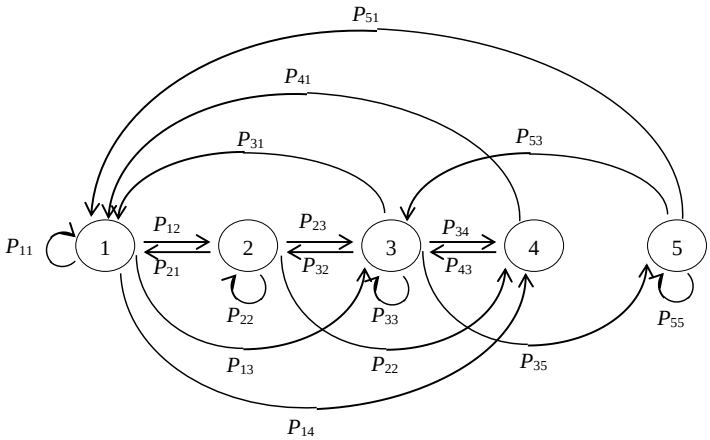

Figure 1. Graph of Transition Opportunities Between States

By using Equation = 1, several equations can be obtained to obtain the probability value of a certain state occurring in a steady state as follows:$m_1 + m_2 + \cdots + m_s$

1 = 0.467m1 + 0.289m2 + 0.2m3 + 0.044m4
2 = 0.556m1 + 0.056m2 + 0.278m3 + 0.111m4
3 = 0.450m1 + 250m2 + 0.15m3 + 0.1m4 + 0.05m5
4 = 0.833m1 + 0.167m3
5 = 0.250m1 + 0.5m3 + 0.25m5

The above equations can be written into the following equations.

$0{,}533m_1 - 0{,}289m_2 - 0{,}2m_3 - 0{,}044m_4 = 0$ (1)
$0.944 = 0m_2 - 0{,}556m_1 - 0{,}278m_3 - 0{,}111m_4$ (2)
$0.85 = 0m_3 = 0{,}45m_1 - 0{,}25m_2 - 0{,}1m_4 - 0{,}05m_5$ (3)
$m_4 - 0{,}833m_1 - 0{,}167m_3 = 0$ (4)
$0{,}75m_5 - 0{,}25m_1 - 0{,}5m_3 = 0$ (5)
$m_1 + m_2 + m_3 + m_4 + m_5 = 1$ (6)

Based on Equations 1 to Equations 6, it produces the following results:

1 = 0.103
2 = 0.098
3 = 0.093
4 = 0.1
5 = 0.74

Table 5. Probability of Increase in Patients Confirmed Positive for COVID-19 in Maluku Province in Stable Condition

Range of Patient Addition	Probability
0-20	0.103
21-40	0.098
41-60	0.093
61 – 80	0.1
81	0.74

Based on Table 5, it can be explained that the chance of increasing the number of confirmed COVID-19 patients 0-20 people (State 1) in Maluku Province every day is 0.103. Meanwhile, the opportunity to increase the number of confirmed COVID-19 patients from 21 to 40 people (State 2) in Maluku Province every day is 0.098. The same thing also happened for the opportunity to increase the number of confirmed COVID-19 patients from 41 to 60 people (State 3) in Maluku Province every day by 0.093. In State 4, the chance of increasing the number of confirmed COVID-19 patients from 61 to 80 people in Maluku Province every day is 0.1. As for the opportunity to increase the number of confirmed COVID-19 patients 85 people (State 5) in Maluku Province, there is the biggest chance of 0.74.

4. Conclusions

From this study it can be concluded that: the probability of increasing COVID-19 patients in Maluku Province using the Markov chain method is divided into five ranges with the following details: in the range between 0-20 people, the probability is 0.103, the range is between 21-40 people, the probability is 0.098, Range between 41 - 60 souls, the chance is 0.093, Range between 61 - 80 souls, the chance is 0.1, Range is more than equal to 81 souls the chance is 0.74. The probability value can change if there are several factors including, the latest data, changes in community social conditions and vaccinations have been activated.

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