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Application of Markov Chain to Prediction Poverty in Banten Province

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ABSTRACT

The number of poor people in Banten Province is in the third lowest position in Java Island under the Special Region Province of the Capital Jakarta and Yogyakarta Special Region Province in 2018-2020 until finally it is in the second lowest position in 2021. However, this does not mean that the problem of poverty is no longer a top priority. This study aims to apply the Markov chain in predicting poverty in Banten Province. According to Marli et al. (2018) The Markov chain is a method that studies the properties of a variable in the present based on its past properties to estimate the properties of these variables in the future. In this research, the type of research used is applied research and used secondary data sourced from the Central Statistics Agency (BPS) Banten Province. The poverty prediction results for Pandeglang Regency in 2022, 2023 and 2024-2025 will increase by 2%, 0.46%, and 0.02%, respectively. Lebak Regency in 2022 will increase by 2%, in 2023 and in 2024-2025 it will decrease by 0.66% and 0.01%, respectively. Tangerang Regency in 2022 will decrease by 4%, in 2023 it will increase by 0.99%, and will fall back in 2024-2025 by 0.01%. Serang Regency in 2022 will increase by 1%, in 2023-2025 it will decrease by 0.83%. Tangerang City in 2022 remains, in 2023 and 2024-2025 it will increase by 0.53% and 0.01%, respectively. The city of Cilegon in 2022 remains, in 2023 it will increase by 0.18% and 2024-2025 will decrease by 0.01%. Serang City in 2022 remains, in 2023-2025 it will decrease by 0.71%. South Tangerang City in 2022 will decrease by 1%, in 2023-2025 it will increase by 0.04%. The steady state probability of Pandeglang Regency is 17.48%, Lebak Regency is 17.33%, Tangerang Regency is 27.98%, Serang Regency is 10.17%, Tangerang City is 15.54%, Cilegon City is 2.17%, Serang City is 5.29% and South Tangerang City is 4.04%.

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A. INTRODUCTION

Poverty is an endless theme to discuss (Kartika et al., 2021). Poverty is one of the major problems experienced by developing countries. Not only developing countries, but developed countries are also inseparable from the problem of poverty. The concept of poverty is a multidimensional concept, so the concept of poverty is not easy to understand (Hamid, 2018). According to Sukesi (2015) poverty is a multidimensional structural and cultural problem, including political, social, economic, natural assets and resources, psychology and others.

Poverty arises from differences in ability, differences in opportunity, and differences in resources (Maipita, 2013). According to Gopal *et al.* (2021) it is felt that the condition of the

poor is very difficult for them to get out of poverty if no assistance and support is given to them. The handling of the problem of poverty must be understood and understood as a world problem, so it must be addressed in a global contex (Yunus & Radjab, 2018). Allowing this problem to drag on makes things even more murky and will have a negative impact on the economy, social and politics of a country.

The problem of poverty has recently been widely discussed in various national and international forums. The reality proves that the efforts that have been made have not been able to reduce the number of poor people in the world, especially for developing countries. Income inequality and poverty rates are two big problems for many developing countries in the world, including one of the developing countries, namely Indonesia.

As one of the developing countries, Indonesia has an increasing population every year. Where the Central Statistics Agency stated that the number of Indonesian population has increased quite significantly in the last 10 years. It refers to the population census conducted once every 10 years. In the 2010 population census, the Central Statistics Agency stated that the current population of Indonesia is around 237.64 million people. Meanwhile, in the 2020 population census, the total population of Indonesia reached 270.2 million people. The above shows that the population growth rate is around 1.25% in the last 10 years (BPS, 2021).

Banten Province is the second lowest province in terms of the number of poor people in Java Island in 2021. The percentage of poor people in Banten Province in 2021 reached 7.72 percent. However, the percentage of poor people in Banten Province is still lower than the national average of 9.78 percent. With such a large figure, Banten Province is in ninth position as the province with the lowest percentage of poor people in Indonesia below Bali Province (4.53 percent), DKI Jakarta Province (4.67 percent), South Kalimantan Province (4.83 percent), Bangka Belitung Province (4.90 percent), Central Kalimantan Province (5.16 percent), Riau Islands Province (6.12 percent), East Kalimantan Province (6.54 percent), and West Sumatra Province (6.63 percent) (BPS Provinsi Banten, 2021).

Although Banten Province is in ninth place with the lowest percentage of poor people in Indonesia, it does not mean that the problem of poverty is no longer a top priority. Poverty alleviation is certainly a priority program, because a decent life is a right for everyone and this is what the Banten Provincial Government wants to realize. In this case, the Banten Provincial government through the Social Service Office under the Supervision of the Regional Poverty Reduction Coordination Team in March 2013, established and implemented a program to overcome the problem of poverty by creating a United Banten People's Social Security program aimed at the Very Poor Households in Banten Province (Hidayatiningtias, 2021).

Coordination of poverty reduction includes activities of synchronization, harmonization, and integration of policies for poverty reduction programs, as well as coordination of controlling the implementation of poverty reduction programs (Santoso, 2018). Quantitatively, the programs implemented by the government have succeeded in reducing the poverty rate. However, it must also be acknowledged that quantitative success based on statistical data has not fully recorded the realistic poverty comprehensively (Titioka et al., 2021). Not only the government must maximize efforts to deal with the problem, but the poor must also try their best to improve their situation. Because poverty in our society is

sometimes a paradigm and tradition, there is an expression that the parents are poor. Then his children and grandchildren will also become poor (Sriyana, 2021).

One of the statistical methods that can be used to predict the number of poor people is the Markov Chain. According to Marli *et al.* (2018) Markov chain is a method that studies the properties of a variable in the present based on its properties in the past to assess the properties of the variable in the future. Markov's model deals with a series of processes in which the events resulting from an action (experiment) depend only on the events that precede it and do not depend on the series of events that preceded it (Nasution, 2022). The process uses data (states) accompanied by the probability of each data for a different time (Prawirosentono, 2019).

The Markov chain is a stochastic model popularized by a Russian mathematician named Andrei Andreyevich Markov, in the early 20th century. By using the Markov process it is possible to model stochastic phenomena in the real world that evolve over time. The basic problem of stochastic modeling with the Markov process is to determine the appropriate state description, so that the corresponding stochastic process will actually have what is called the Markov property (Markovian Property), that is, knowledge of a current state is sufficient to predict the stochastic behavior of the process in question. next time. The theory of the Markov process can be applied in various fields of science, such as biology, economics, physics, operations research, computer science, and so on (Mangku, 2021). According to RL and Ross (1998) consider a process that has value in each time period. Where Xn denotes its value in time n, and suppose we want to create a probability model for a sequence of values X0, X1, X2,…. The simplest model will probably assume that Xn is an independent random variable, but often such an assumption is clearly unjustified.

Several previous studies have been conducted relating to the application of the Markov Chain. Among them are the research conducted by Allo, Hatidja and Paendong (2013) using Markov Chain analysis to determine the opportunity to change the brand of pre-paid mobile cards Global System for Mobile Communication (GSM) (Case Study of Students of the Faculty of Agriculture Unsrat Manado). Setyawan, Noeryanti dan Hadinegara (2019) using Markov Chain analysis to predict poverty in the Special Region of Yogyakarta Province. Novianti, Humairoh dan Harahap (2021) using the Markov Chain approach to analyze the chances of an increase in COVID-19 cases in the provinces on the island of Java. Based on the description above, researchers are interested in conducting research on the application of the markov chain method to predict poverty in Banten Province. Based on the description above, the researcher is interested in conducting research on the application of the Markov chain method to predict poverty in Banten Province.

B. METHODS

In this study, the type of research used is applied research. The type of data used is secondary data. In this study, researchers used data sourced from the Central Statistics Agency (BPS) of Banten Province. The data used by the researchers is data on the number of poor people in Banten Province in 2014-2021. Each observation is a regency/city in Banten Province. The analysis method used in this study is the Markov Chain. The steps of the data analysis technique that will be used in achieving the research objectives are to collect data on the number of poor people in 2014-2021, convert the data into the form of a transitional

probability matrix, conduct a Markov Chain analysis until it reaches a steady state, and determine poverty predictions from the probability matrix, as shown in Figure 1.

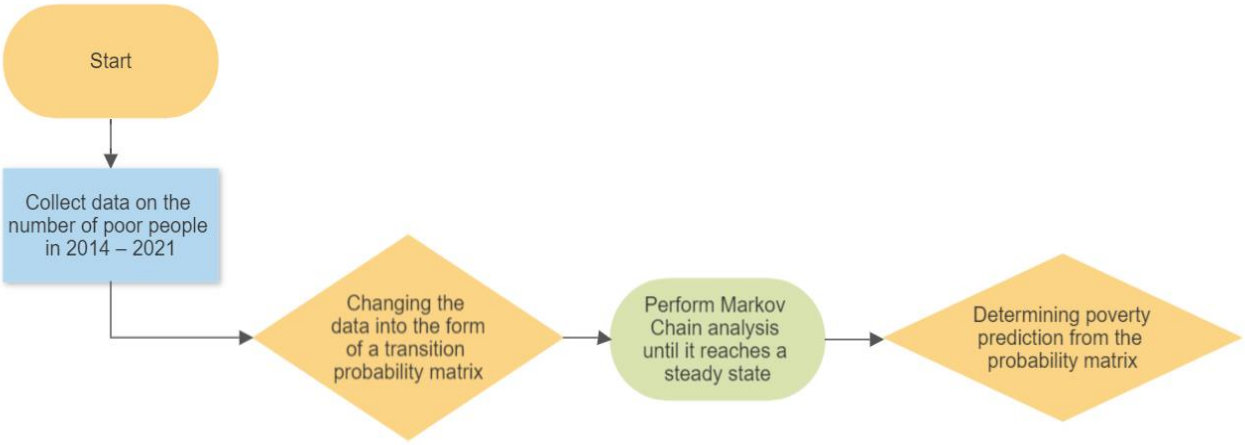

Figure 1. Research Flowchart

C. RESULT AND DISCUSSION

Before conducting data analysis and further discussion of the research data, the following will be presented a descriptive statistical form of the research data.

1. Descriptive Statistics

Descriptive statistics are an analysis to describe data to facilitate the reading of the average value, maximum value and minimum value from data on the number of poor people in Banten Province in 2014-2021. The following are descriptive statistics as shown in Table 1.

Table 1. Average Value, Maximum Value and Minimum Value from Data on the Number of Poor People in Banten Province 2014-2021 (in thousand people)

Regency/City	Maximum Value	Minimum Value	Average
Pandeglang Regency	131,43	113,14	119,11
Lebak Regency	134,75	107,93	117,11
Tangerang Regency	272,35	173,10	204,61
Serang Regency	83,09	61,54	70,89
Tangerang City	134,24	98,37	107,98
Cilegon City	18,89	13,20	15,58
Serang City	47,91	36,18	39,04
South Tangerang City	44,57	25,29	31,15

2. Transition Probability

According to (Wahyuningrum, 2020) to calculate the probability of transition use the formula :

$$P_i = \frac{n_i(t)}{n(t)} \quad (1)$$

Information:

$n_i(t)$: The number of poor people of the district or city i.

$n(t)$: Number of poor people of period t.

P_i : Probability of transition of i.

The above formula is used to convert the data on the number of poor people in Banten Province into a transition probability matrix. The data on the number of poor people can be seen in Table 2.

Table 2. Number of Poor People According to Regencies/Cities in Banten Province Year 2014-2021

Regency/City	Number of Poor People (Thousand People)							
	2014	2015	2016	2017	2018	2019	2020	2021
Pandeglang Regency	113,14	124,42	115,90	117,31	116,16	114,09	120,44	131,43
Lebak Regency	115,83	126,42	111,21	111,08	108,81	107,93	120,83	134,75
Tangerang Regency	173,10	191,12	182,52	191,62	190,05	193,97	242,16	272,35
Serang Regency	71,38	74,85	67,92	69,10	64,46	61,54	74,80	83,09
Tangerang City	98,76	102,56	102,88	105,34	103,49	98,37	118,22	134,24
Cilegon City	15,53	16,96	14,90	14,89	13,96	13,20	16,31	18,89
Serang City	36,18	40,19	36,40	36,97	36,21	36,21	42,24	47,91
South Tangerang City	25,29	25,89	26,38	28,73	28,21	29,16	40,99	44,57
Banten Province	649,21	702,41	658,11	675,04	661,35	654,47	775,99	867,23

The probability of the number of poor people in Banten Province in 2014 Pandeglang Regency was obtained from 113.14/649.21 = 0.17. For Lebak Regency obtained from 115.83/649.21 = 0.18. For Tangerang Regency obtained from 173.10/649.21 = 0.27. For Serang Regency obtained from 71.38/649.21 = 0.11. And so on until the probability of the number of poor people in Banten Province in 2021 South Tangerang City according to the formula above.

3. Transition Probability Matrix

Based on the probability calculation, the transition probability matrix can be written as follows:

$$P = \begin{bmatrix} 0{,}17 & 0{,}18 & 0{,}27 & 0{,}11 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}18 & 0{,}18 & 0{,}27 & 0{,}10 & 0{,}15 & 0{,}03 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}18 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}16 & 0{,}30 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}16 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}15 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}05 \end{bmatrix}$$

A state j is said to be accessible (Accessible) from state i if $P_{ij}^{(n)} > 0$ for $n \geq 0$. This implies that state j is accessible (Accessible) from state i if and only if a state starts from state i it is possible that the process will be at state j. Two states i and j that are accessible (Accessible) between one state and another state are said to communicate with each other (Communicate) denoted by $i \leftrightarrow j$. Two states that communicate with each other (Communicate) are said to be in the same class. In other words, the concept of Communicate divides state space into separate classes. The Markov chain is said to be irreducible if there is only one class, that is, if all states communicate with each other between one state and another (RL & Ross, 1998). Based on this analysis, the transition probability matrix above is an Irreducible transition probability matrix. Because it meets the three conditions, namely Accessible, Communicate,

and only has one Communicate class. The Markov Chain plot of the above transition probability matrix is as shown in Figure 2.

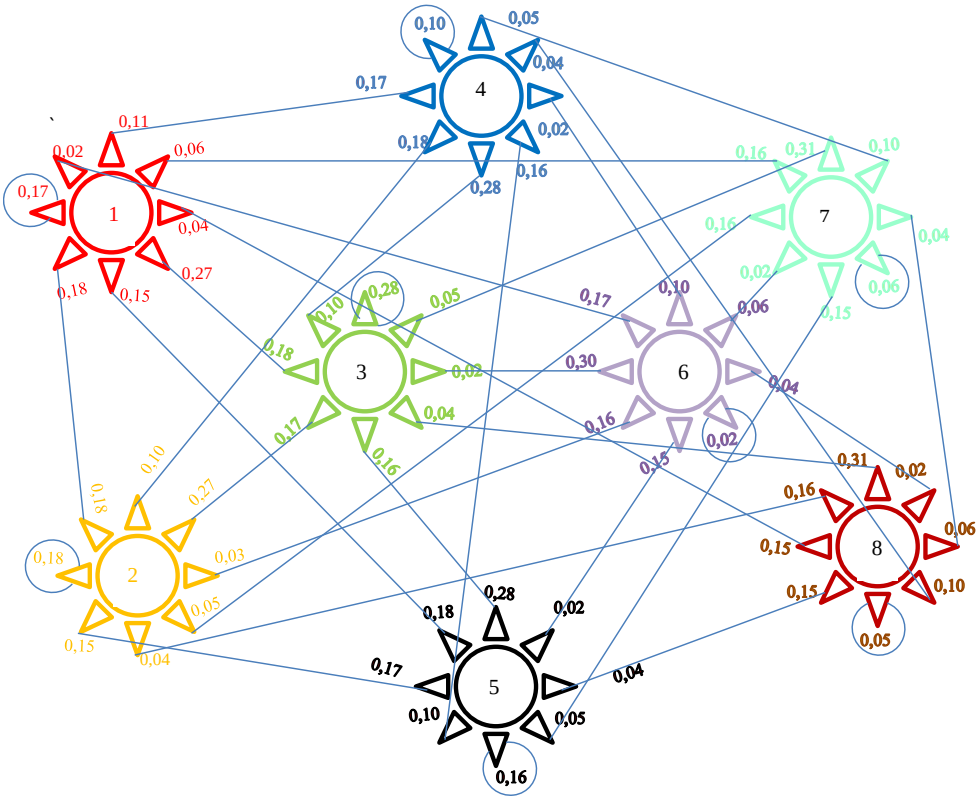

Figure 2. Markov Chain Plot

Information:
1 = Pandeglang Regency
2 = Lebak Regency
3 = Tangerang Regency
4 = Serang Regency
5 = Tangerang City
6 = Cilegon City
7 = Serang City
8 = South Tangerang City

As a transition probability matrix with the number of odds each row is equal to 1. Then the vector $\bar{1} = [1 \quad 1 \quad \dots \quad 1]^T$ which is the right eigen vector corresponding to the value $\lambda = 1$. The eigenvalue $\lambda = 1$ has a multiplitas of 1, at the same time it is said to be the value of the Perron-Frobenius eigen. Because it has element 1 located on the first row of the first column as the only element that is not zero (Massalesse, 2016). The state vector for the Markov Chain at the first observation is expressed by $\pi(0)$ (Wijayanti et al., 2018). Therefore, researchers use the initial state as follows:

$$\text{Initial state} = [1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0]$$

Initial state (π(0)) is a type of state denoted by a binary number 0 or 1. In this case, there are eight elements of the initial state to predict the number of poor people, namely Pandeglang Regency, Lebak Regency, Tangerang Regency, Serang Regency, Tangerang City, Cilegon City, Serang City and South Tangerang City. Which if annotated with the following letters:

[P L T S KT KC KS KTS].

Information:
P = Pandeglang Regency
L = Lebak Regency
T = Tangerang Regency
S = Serang Regency
KT = Tangerang City
KC = Cilegon City
KS = Serang City
KTS = South Tangerang City

4. Predicted Results

Predicting the percentage of poor people in 2022 is as follows:

$\pi(1) = \pi(0).P$

$$\pi(1) = [1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0] \begin{bmatrix} 0{,}17 & 0{,}18 & 0{,}27 & 0{,}11 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}18 & 0{,}18 & 0{,}27 & 0{,}10 & 0{,}15 & 0{,}03 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}18 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}16 & 0{,}30 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}16 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}15 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}05 \end{bmatrix}$$

$\pi(1) = [0{,}17 \quad 0{,}18 \quad 0{,}27 \quad 0{,}11 \quad 0{,}15 \quad 0{,}02 \quad 0{,}06 \quad 0{,}04]$

$\pi(1).100\% = [17\% \quad 18\% \quad 27\% \quad 11\% \quad 15\% \quad 2\% \quad 6\% \quad 4\%]$

To get a result in the form of percent (%) then the result of π (1) is multiplied by 100%. So, it is likely that the percentage of poor people in 2022 in Pandeglang Regency is 17%, Lebak Regency by 18%, Tangerang Regency by 27%, Serang Regency by 11%, Tangerang City by 15%, Cilegon City by 2%, Serang City by 6% and South Tangerang City by 4%. Predicting the percentage of poor people in 2023 is as follows:

$\pi(2) = \pi(0).P^2$

$$\pi(2) = [1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0] \left(\begin{bmatrix} 0{,}17 & 0{,}18 & 0{,}27 & 0{,}11 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}18 & 0{,}18 & 0{,}27 & 0{,}10 & 0{,}15 & 0{,}03 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}18 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}16 & 0{,}30 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}16 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}15 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}05 \end{bmatrix}^2 \right)$$

$\pi(2) =$

$$[1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0] \begin{bmatrix} 0{,}1746 & 0{,}1734 & 0{,}2799 & 0{,}1017 & 0{,}1553 & 0{,}0218 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2797 & 0{,}1018 & 0{,}1552 & 0{,}0218 & 0{,}0530 & 0{,}0404 \\ 0{,}1748 & 0{,}1734 & 0{,}2796 & 0{,}1018 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1749 & 0{,}1734 & 0{,}2796 & 0{,}1017 & 0{,}1554 & 0{,}0218 & 0{,}0528 & 0{,}0404 \\ 0{,}1748 & 0{,}1734 & 0{,}2796 & 0{,}1018 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1731 & 0{,}2801 & 0{,}1017 & 0{,}1555 & 0{,}0216 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1730 & 0{,}2802 & 0{,}1016 & 0{,}1556 & 0{,}0216 & 0{,}0528 & 0{,}0404 \\ 0{,}1746 & 0{,}1728 & 0{,}2806 & 0{,}1015 & 0{,}1556 & 0{,}0216 & 0{,}0528 & 0{,}0405 \end{bmatrix}$$

$\pi(2) = [0{,}1746 \quad 0{,}1734 \quad 0{,}2799 \quad 0{,}1017 \quad 0{,}1553 \quad 0{,}0218 \quad 0{,}0529 \quad 0{,}0404]$

$\pi(2).100\% = [17{,}46\% \quad 17{,}34\% \quad 27{,}99\% \quad 10{,}17\% \quad 15{,}53\% \quad 2{,}18\% \quad 5{,}29\% \quad 4{,}04\%]$

To get a result in the form of percent (%) then the result of π (2) is multiplied by 100%. So, the possible percentage of poor people in 2023 in Pandeglang Regency is 17.46%, Lebak Regency by 17.34%, Tangerang Regency by 27.99%, Serang Regency by 10.17%, Tangerang City by 15.53%, Cilegon City by 2.18%, Serang City by 5.29% and South Tangerang City by 4.04%. Predicting the percentage of poor people in 2024 is as follows:

$\pi(3) = \pi(0).P^3$

$$\pi(3) = [1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0] \left(\begin{bmatrix} 0{,}17 & 0{,}18 & 0{,}27 & 0{,}11 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}18 & 0{,}18 & 0{,}27 & 0{,}10 & 0{,}15 & 0{,}03 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}18 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}16 & 0{,}30 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}16 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}15 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}05 \end{bmatrix}^3 \right)$$

$\pi(3) =$

$$[1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0] \begin{bmatrix} 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1733 & 0{,}2798 & 0{,}1018 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \end{bmatrix}$$

$\pi(3) = [0{,}1748 \quad 0{,}1733 \quad 0{,}2798 \quad 0{,}1017 \quad 0{,}1554 \quad 0{,}0217 \quad 0{,}0529 \quad 0{,}0404]$

$\pi(3).100\% = [17{,}48\% \quad 17{,}33\% \quad 27{,}98\% \quad 10{,}17\% \quad 15{,}54\% \quad 2{,}17\% \quad 5{,}29\% \quad 4{,}04\%]$

To get a result in the form of percent (%) then the result of π (3) is multiplied by 100%. So, the possible percentage of poor people in 2024 in Pandeglang Regency is 17.48%, Lebak Regency by 17.33%, Tangerang Regency by 27.98%, Serang Regency by 10.17%, Tangerang City by 15.54%, Cilegon City by 2.17%, Serang City by 5.29% and South Tangerang City by 4.04%. Predicting the percentage of poor people in 2025 is as follows:

$\pi(4) = \pi(0).P^4$

$$\pi(4) = [1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0] \left(\begin{bmatrix} 0{,}17 & 0{,}18 & 0{,}27 & 0{,}11 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}18 & 0{,}18 & 0{,}27 & 0{,}10 & 0{,}15 & 0{,}03 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}18 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}16 & 0{,}30 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}16 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}15 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}05 \end{bmatrix}^4 \right)$$

$$\pi(4) =$$

$$[1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0] \begin{bmatrix} 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1733 & 0{,}2798 & 0{,}1018 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \end{bmatrix}$$

$$\pi(4) = [0{,}1748 \quad 0{,}1733 \quad 0{,}2798 \quad 0{,}1017 \quad 0{,}1554 \quad 0{,}0217 \quad 0{,}0529 \quad 0{,}0404]$$
$$\pi(4).100\% = [17{,}48\% \quad 17{,}33\% \quad 27{,}98\% \quad 10{,}17\% \quad 15{,}54\% \quad 2{,}17\% \quad 5{,}29\% \quad 4{,}04\%]$$

To get a result in the form of percent (%) then the result of π (4) is multiplied by 100%. So, the possible percentage of poor people in 2025 in Pandeglang Regency is 17.48%, Lebak Regency by 17.33%, Tangerang Regency by 27.98%, Serang Regency by 10.17%, Tangerang City by 15.54%, Cilegon City by 2.17%, Serang City by 5.29% and South Tangerang City by 4.04%. After iterating the n-step until it reaches a steady state, that is, when the probability matrix of the next transition converges against the probability matrix of the previous transition. This happens in the fourth n-step (P^4), because in the fourth n-step (P^4) it converges in the previous n-step, namely in the third n-step (P^3).

$$P^4 = \begin{bmatrix} 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1733 & 0{,}2798 & 0{,}1018 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \end{bmatrix} \text{x}$$
$$\begin{bmatrix} 0{,}17 & 0{,}18 & 0{,}27 & 0{,}11 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}18 & 0{,}18 & 0{,}27 & 0{,}10 & 0{,}15 & 0{,}03 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}18 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}18 & 0{,}17 & 0{,}28 & 0{,}10 & 0{,}16 & 0{,}02 & 0{,}05 & 0{,}04 \\ 0{,}17 & 0{,}16 & 0{,}30 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}16 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}04 \\ 0{,}15 & 0{,}16 & 0{,}31 & 0{,}10 & 0{,}15 & 0{,}02 & 0{,}06 & 0{,}05 \end{bmatrix}$$

$$= \begin{bmatrix} 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1734 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1747 & 0{,}1733 & 0{,}2798 & 0{,}1018 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \\ 0{,}1748 & 0{,}1733 & 0{,}2798 & 0{,}1017 & 0{,}1554 & 0{,}0217 & 0{,}0529 & 0{,}0404 \end{bmatrix}$$

Based on the results of the fourth n-step transition matrix probability (P^4) above, it shows that the steady state probability value of Pandeglang Regency is 17.48%, Lebak Regency is 17.33%, Tangerang Regency is 27.98%, Serang Regency is 10.17%, Tangerang City is 15.54%, Cilegon City is 2.17%, Serang City is 5.29% and South Tangerang City is 4.04%.

D. CONCLUSION AND SUGGESTIONS

From the results of the analysis of the application of the Markov Chain method on the problem of poverty in regencies/cities in Banten Province. The researcher concluded that the poverty prediction results for Pandeglang Regency in 2022, 2023 and 2024-2025 will increase by 2%, 0.46%, and 0.02%, respectively. Lebak Regency in 2022 will increase by 2%, in 2023 and in 2024-2025 it will decrease by 0.66% and 0.01%, respectively. Tangerang Regency in 2022 will decrease by 4%, in 2023 it will increase by 0.99%, and will fall back in 2024-2025 by 0.01%. Serang Regency in 2022 will increase by 1%, in 2023-2025 it will decrease by 0.83%. Tangerang City in 2022 remains, in 2023 and 2024-2025 it will increase by 0.53% and 0.01%, respectively. The city of Cilegon in 2022 remains, in 2023 it will increase by 0.18% and 2024-2025 will decrease by 0.01%. Serang City in 2022 remains, in 2023-2025 it will decrease by 0.71%. South Tangerang City in 2022 will decrease by 1%, in 2023-2025 it will increase by 0.04%. The steady state probability value of Pandeglang Regency is 17.48%, Lebak Regency is 17.33%, Tangerang Regency is 27.98%, Serang Regency is 10.17%, Tangerang City is 15.54%, Cilegon City is 2.17%, Serang City is 5.29% and South Tangerang City is 4.04%.

Some suggestions that researchers can convey are that for subsequent research it is recommended to predict poverty throughout Indonesia and even around the world using the Markov Chain method or using other prediction methods, as well as increasing accuracy in conducting subsequent research. For the government, it is recommended that this research can be used as a source of information in determining policies so as to reduce the number of poor people in Banten Province. For readers of this research, hopefully it can become new knowledge and can be a reference for conducting continuous research.

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