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Monte Carlo Simulation Of Estimating Clean Water Supplies

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ABSTRACT

Estimates are important tools in effective and efficient planning for predicting future events. Identical estimates of the future values of a variable for planning or decision making of a situation to estimate future values. Monte Carlo simulation is a simulation model that involves a series of random and sampling with a probability distribution that can be known and determined, then this simulation can be used. In this study, data is taken from the amount of water usage in PDAM Tirtanadi H.M branch. Yamin, North Sumatra from January 2018 to June 2019. Then, the data is processed and analyzed using Monte Carlo Simulation to determine the forecast results in the years that follow. The result is an estimated amount of water usage in 2019 and 2020 at PDAM Tirtanadi H.M branch. Yamin, North Sumatra is 8,604,556 and 8,592,873. The estimated amount of water use is down from the amount of water use in 2018 which reached 8,685,356. The amount of water usage in 2018, 2019 and 2020 decreases by about $\pm 100.000 m^3$.

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1. INTRODUCTION

Inventory is a stock of an item or resource that is used in a company organization. Determining the amount of inventory that is too much will result in waste in saving costs, but if it is too little, it will result in a loss of opportunity for the company to profit if the demand is greater than the estimated demand.

Clean water is the most important part of human life, so the availability of clean water is very influential for human life. The effect of clean water availability is not only on household needs, but also on the social, economic, and public facilities sectors, along with population growth rates. The need for clean water in Medan is managed by the Regional Drinking Water Company (PDAM) Tirtanadi Water Treatment (IPA) built by Tirtanadi as a manifestation of efforts to improve the quality of clean water or drinking water.

Simulation is a process of designing a model of a real system that aims to understand behavior or to develop strategies in connection with the operation of the system.

2. RESEARCH METHODE

2.1 Water

Water (Dihydrogen monoxide) is a compound that is essential for all forms of life known to date on Earth. Water is needed by humans to fulfill various purposes, including: drinking, cooking, bathing, washing, worship, agriculture, livestock, etc.

2.2 Stock

Indrajit (2003) states that inventory is all items that can usually be found in closed warehouses, fields, open warehouses, or other storage places.

2.3 Forecasting

Forecasting (forecasting) is an estimate or estimate of the occurrence of events or events from the future. Forecasting does not give definite answers about what will happen, but tries to find as close as possible to what will happen.

2.4 Simulation

Simulation is a way to solve various problems in real life which are full of uncertainty by not using or using certain models or methods. The concept of simulation arises as a result of its occurrence in looking at the problem, where a problem is considered to be described according to the parts that interact simultaneously which can be observed to give feasible results, where the results can be obtained quickly.

Frequency Distribution

Frequency distribution is the arrangement of data according to certain interval classes or according to certain categories in a list in order to easily understand data, both quantitative and qualitative data, which are presented in a concise and clear form.

To calculate the class length and class interval, the formula is used according to the Sturgess rules, that is (Fathoni. 2011):

$$k = 1 + 3,3 \log n$$

$$c = \frac{\max - \min}{K}$$

Random Number Generator (RNG)

Random number generator(RNG) is a tool used to generate random numbers. The RNG value used is the value generated from the Linear Congruential Method (LCM). The formula for generating random numbers using this method is :

$$x_{i+1} = (a.x_i + c) \bmod m \qquad i = 0,1,2,...$$

3. RESULT AND ANALYSIS

Min and Max

The minimum value (Min) is the smallest value of data, and the Maximum value (Max) is the greatest value of data. From the table of demand for clean water in January 2018 to June 2019 obtained from PDAM Tirtandi, the Min value is 699,030 and the Max value is 741,630.

Frequency Distribution

The next step is to make the range of the initial interval to the final interval from the difference in the highest maximum value.

a) Reach (J)

J = Max Data - Min Data

J = 741,630 - 699,030

J = 42,600

b) Number of interval classes (k)

K = 1 + 3,3\log n, where n = amount of data

K = 1+3,3 log18

K = 1+3,3(1,26)

K = 1+4,158

K = 5,158

K ≈ 5

c) Class interval length (c)

$$c = \frac{J}{K}$$

$$c = \frac{42.600}{5}$$

c = 8,520

From the results of the above calculations, the data range is obtained from the smallest to the largest data, namely 42,600. The number of class intervals is 5.158 or about 5. And for the class interval length, the class spacing is 8,520. Initial data starts from the Min value, namely 699,030 plus the interval length value of 8,520, then the first interval value is 699,030 - 707,550 and so on.

To maximize the results of the simulation, the total quantity of water that must be provided by PDAM Tirtanadi and the Cumulative probability must be determined in advance, the probability is given by the formula.

$$c = \frac{a}{b}$$

then the result is obtained

$$c_1 = \frac{a}{b} = \frac{4}{18} = 0,22$$

The probability that the results have been obtained will then be cumulative so that the first cumulative value is the total of the first probability (c_1). So that the sum of the random number intervals is seen from the cumulative value whose value will be multiplied by 100.

Random Numbers

To generate random values, it is used (LCM) Linear Congruental Method

$$x_{i+1} = (a.x_i + c) \bmod m$$

If c ≠ 0 is interpreted as a mixed congruential method, and c = 0, it is called a multiplicative congruental method. Selection of values a, c, m, and x_0 affect the completeness of statistical values and cycle length values.

Generate random numbers using the linear Congruental method if known;

X_0= 49; a = 17, c = 31; and m = 100

The integer value of random numbers generated is between 0 and 99 because the modulus value is 100.

Solution:

$$x_1 = (a.x_0 + c) \bmod m$$

$$x_1 = ((17).(51) + 31) \bmod 100$$

$$x_1 = (867 + 31) \bmod 100$$

$$x_1 = (898) \bmod 100$$

$$x_1 = 98$$

4.3 Results and Discussion

The estimation results to determine the water supply in 2020 using the Monte Carlo simulation are obtained from random numbers that have been generated from the above method, in which the random number values will be adjusted to the random number interval value. The first random number value (x_1) the result is 870 where the number 870 is in the 5th random number interval, then the value to be taken for the Monte Carlo simulation value is the Mid value, where the Mid value in the number 870 is 737,374. For the second random number value (x_2) you get the result 442 where the number 442 is in the 3rd random number interval, where the Mid value in the number 442 is 720,332 until the last random value (x_{18}) you get

the 802 results where the 802 number is in the 4th random number interval, where the Mid value in the 802 number is 728,858. All of these are listed in Table 4.6.

From Table 4.6 above, the estimated water supply in PDAM Tirtanadi HM Yamin branch from July 2019 to December 2020 is 12,931,912

4. CONCLUSIOON

Forecasting is an important tool in planning an effective and efficient way to predict future events. Monte Carlo simulation isa simulation model involving a random series and sampling with a known and determined probability distribution, this simulation can be used.

In this study, data was taken from the amount of water consumption in PDAM Tirtanadi HM Yamin branch, North Sumatra from January 2018 to June 2019. The resultsThe estimated amount of water use in 2019 and 2020 in PDAM Tirtanadi is 8,647,166 and 8,541,742 .

The estimated amount of water use is down from the amount of water used in 2018 which totaled 8,685,356 . The amount of water use in 2018, 2019 and 2020 decreased by approx . The decline in water use from 2018 to 2020 could be caused by leaking water pipes from the Central PDAM.

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