REAGENT STOCK PREDICTION USING MONTE CARLO METHOD AT POPULER CLINICAL LABORATORY SURABAYA

[1]FARAH DIBBA, [2*]WIWIET HERULAMBANG, [3]FARDANTO SETYATAMA

Department of Informatics Engineering, Universitas Bhayangkara Surabaya

Jl. Ahmad Yani No.114, Ketintang, Kec Gayungan, Surabaya, Jawa Timur 60231

e-mail: [1]farahdibba09@gmail.com, [2]herulambang@ubhara.ac.id, [3]fardanto@ubhara.ac.id

[*]Corresponding author

ABSTRACT

Prediction is important as decision are made earlier. Information are needed before prediction is optimally done. Company operational supply can be predicted and depicted in computerized process. By doing so, a decision based on past probabilities could be made efficiently. In the simulation, stock of goods is important. Reagent stock prediction could be done by using Monte Carlo method. Monte Carlo method is one of a tool that can be used to analyze common uncertainty in reagent stock procurement. The result of Monte Carlo prediction can help company to determine the future amount of reagent stock. In this research, the forecast results 95,83% accuracy by using 2022 annual stock data.

Keywords: *Prediction, Monte Carlo, Reagent.*

1. INTRODUCTION

Prediction is important as decision are made earlier. Information are needed before prediction is optimally done. Company operational supply can be predicted and depicted in computerized process. By doing so, a decision based on past probabilities could be made efficiently.

The amount of supply or stock of goods is important in simulation. Supply means stored goods to be used in the future period. Company must make sure the availability of operational stock. Lack of supplies may hindrances operational process. Over-supplies is also not good for the company. They must have the ability to minimize operational cost. For this purpose, prediction of stock of goods is needed.

Reagent stock prediction can be done by using Monte Carlo method. Monte Carlo could be a reliable tool to analyze common uncertainty occurred in reagent stock procurement. The result of prediction can help company to determine the amount of future reagent stock. Based on this problem, so this research is entitled "**Reagent Stock Prediction Using Monte Carlo Method At Populer Clinical Laboratory**".

1.1 Problem Identification

Based on the introduction, the problem identified in this research is how to predict reagent stock by using Monte Carlo method at Populer Clinical Laboratory?

1.2 Research Scope

The scope of this research are:

1) 2 years reagent stock data are retrieved from Populer Clinical Laboratory
2) Reagent stock data period are January-December 2019 and January-December 2020
3) Method used for prediction is Monte Carlo
4) Forecasted data are monthly reagent stock
5) Expiration date of goods, minimum stock of goods, amount of used supplies, amount of incoming supplies are not covered in this research

1.3 Research Purpose

The purpose of this research is to discover prediction result of reagent stock using Monte Carlo method in Populer Clinical Laboratory

2. METHOD

2.1 Prediction

Prediction is a process to forecast or to estimate the value of variable in the future. In a case of prediction usually quantitative data are used. Prediction don't have to give certain answer to an event, however it would try to find a close answer for an upcoming event. Sometimes prediction cannot be done optimally because of some factors, such as excessive or not enough supplies and demand.

2.2 Monte Carlo Algorithm

Monte Carlo is a method which gives all possibilities of value from a variable. Monte Carlo is a method which uses strong law of large number in its calculation, which means the more random variable used would result a better exact approximation. Monte Carlo uses *mean* as the exact value approximation. The advantages of Monte Carlo method are easy to apply for a complex problem solving, and it also gives a confidence interval to check the estimation.

2.3 Stock Data Summary

The summary are data of blood component used to predict the stock. Data shown below are from 2019 until 2020 :

Table 1. Real Data from 2019 - 2020

	Frekuensi 2019	**Frekuensi 2020**
January	3000	1500
February	1500	1000
March	1500	3500
April	3000	2000
May	2500	1000
June	2500	1000
July	3000	2500
August	5500	4500
September	4500	3500
October	3500	3000
November	1500	2.000
December	2000	1.500
Total	34000	27000

2.4 Input Value of Distribution Probability

$$DP = F/J \quad \text{……..….(3.1)}$$

DP : Distribution Probability
F : Frequency
J : Total

A_1 = 3000 : 34.000 = 0,09

A_2 = 1.500 : 34.000 = 0,04

A_3 = 1.500 : 34.000 = 0,04

A_4 = 3.000 : 34. 000 = 0,09

A_5 = 2.500 : 34.000 = 0,07

A_6 = 2.500 : 34.000 = 0,07

A_7 = 3.000 : 34.000 = 0,09

A_8 = 5.500 : 34.000 = 0,16

A_9 = 4.500 : 34.000 = 0,13

A_{10} = 3.500 : 34.000 = 0,10

A_{11} = 1,500 : 34.000 = 0,04

A_{12} = 2000 : 34.000 = 0,06

Table 2. Probability Calculation Results

No	Month	Frequency 2019	Probability
1	January	0,09	0,09
2	February	0,04	0,04
3	March	0,04	0,04
4	April	0,09	0,09
5	May	0,07	0,07
6	June	0,07	0,07
7	July	0,09	0,09
8	August	0,16	0,16
9	September	0,13	0,13
10	October	0,10	0,10
11	November	0,04	0,04
12	December	0,06	0,06
Total		34000	0,09

2.5 Calculate Distribution Probability Cumulative

To determine distribution probability cumulative of blood component supplies each year, all value of probability are added by the previous total value using formula:

$$K_0 = DP_0 \text{……...……..……(3.2)} \quad K_i = DP_i + K_{i-1} \text{……...……..……...(3.3)}$$

K1= A1 = 0,09
K2 = A2 + K1 = 0,04 + 0,09 = 0,13 K3 = A3 + K2 = 0,04 + 0,13 = 0,18 K4 = A4 +

K3 = 0,09 + 0,18 = 0,27 K5 = A5 + K4 =
0,09 + 0,27 = 0,34 K6 = A6 + K5 = 0,07 +
0,34 = 0,41 K7 = A7 + K6 = 0,09 + 0,41 =
0,50 K8 = A8 + K7 = 0,16 + 0,50 = 0,66
K9 = A9 + K8 = 0,13 + 0,66 = 0,80 K10 =
A10 + K9 = 0,10 + 0,80 = 0,90
K11 = A11 + K10 = 0,04 + 0,90 = 0,94 K12 =
A12 + K11 = 0,06 + 0,94 =1,00

Table 3. Result of Probability Cumulative

No	Month	Frequency	Probability	Cumulative
1	January	3000	0,09	0,09
2	February	1500	0,04	0,13
3	March	1500	0,04	0,18
4	April	3000	0,09	0,27
5	May	2500	0,07	0,34
6	June	2500	0,07	0,41
7	July	3000	0,09	0,50
8	August	5500	0,16	0,66
9	September	4500	0,13	0,80
10	October	3500	0,10	0,90
11	November	1500	0,04	0,94
12	December	2000	0,06	1,00
Total		34000		

2.6 Determine Random Number Interval

In the next step, random number interval are determined for each blood component variable.

Table 4. Determine Interval Number

No	Month	Frequency	Probability	Cumulative	Interval
1	January	3000	0,09	0,09	0 - 0,09
2	February	1500	0,04	0,13	0,10 - 0,13
3	March	1500	0,04	0,18	0,14 - 0,18
4	April	3000	0,09	0,27	0,19 - 0,27
5	May	2500	0,07	0,34	0,28 - 0,34
6	June	2500	0,07	0,41	0,35 - 0,41
7	July	3000	0,09	0,50	0,42 - 0,50
8	August	5500	0,16	0,66	0,51 - 0,66
9	September	4500	0,13	0,80	0,67 - 0,80
10	October	3500	0,10	0,90	0,81 - 0,90
11	November	1500	0,04	0,94	0,91 - 0,94
12	December	2000	0,06	1,00	0,95 - 1,00

2.7 Determine Random Number

Random number of blood component can be determined from this formula:

$$W_i = (a.W_{i-1} + b) Mod\ m \quad \text{.....(3.4)}$$

$$U_i = Z_i/m \quad \text{.....(3.5)}$$

Where :

a = Multiplier Constant (a < m)
b = Moving Constant (b < m)
m = Modulus Constant (m > 0)
W_0 = Initial number (integers ≥ 0, $W_0 < m$)

U_i = i_{th} random number
Mod = Modulus

W1 = (13*24+35)mod99 = 50 W2 =
(13*50+35)mod99 = 91 W3 =
(13*91+35)mod99 = 30 W4 =
(13*30+35)mod99 = 29 W5 =
(13*29+35)mod99 = 16 W6 =
(13*16+35)mod99 = 45 W7 =
(13*45+35)mod99 = 26 W8 =
(13*26+35)mod99 = 76 W9 =
(13*76+35)mod99 = 33 W10 =
(13*33+35)mod99 = 68 W11 =
(13*68)+35mod99 = 28 W12 =
(13*28)+35mod99 = 3

Table 5. Random Number Result

Blue Tipe	Frekuensi	Probabilitas	Kumulatif	Interval	W_i	U_i
Januari	3000	0,09	0,09	0 - 0,09	347	50
Februari	1500	0,04	0,13	0,10 - 0,13	685	91
Maret	1500	0,04	0,18	0,14 - 0,18	1218	30
April	3000	0,09	0,27	0,19 - 0,27	425	29
Mei	2500	0,07	0,34	0,28 - 0,34	412	16
Juni	2500	0,07	0,41	0,35 - 0,41	243	45
Juli	3000	0,09	0,50	0,42 - 0,50	620	26
Agustus	5500	0,16	0,66	0,51 - 0,66	373	76
September	4500	0,13	0,80	0,67 - 0,80	1023	33
Oktober	3500	0,10	0,90	0,81 - 0,90	464	68
November	1500	0,04	0,94	0,91 - 0,94	919	28
Desember	2000	0,06	1,00	0,95 - 1,00	399	3

2.8 Simulation Result

Table 6. Simulation Result

Month	Simulation Result 2020	Real Data 2020
January	3000	1500
February	1500	1000
March	2500	3500
April	2500	2000
May	1500	1000
June	3000	1000
July	3000	2500
August	4500	4500
September	2500	3500
October	4500	3000
November	2500	2.000
December	3000	1.500
Total	**34000**	**27000**

2.9 Accuracy Calculation

The accuracy of prediction result can be calculated by comparing reagent stock simulation result and actual stock, using this formula:

$$\text{Accuracy rate} = \frac{Total\ value\ of\ stock}{Total\ value\ of\ predicted\ stock}$$

$$\text{Accuracy rate} = \frac{27000}{34000} = 0{,}794117647$$

$$\text{Accuracy rate} = 79{,}41\ \%$$

2.10 Mean Squared Error (MSE)

$MSE\ Formula:\ \frac{\sum_{t=1}^{n}(A_t - F_t)^2}{n}$ .....(4.3)

Keterangan :

At	=	Actual value
Ft	=	Predicted value
n	=	Data count

3. SYSTEM DESIGN AND ANALYSIS

3.1 System Requirement Analysis

The purpose of this step is to collect data required by the system. In this research, there are 49 types of reagent data stock, for example Albumin Dyasis 25 ml, Bilirubin Direct – A Indiko, Blue Tipe, Calcium Dyasis 25 ml, Cholesterol Indiko, etc.

3.2 System Design

In this step the flow of the system are described in a flowchart. The flowchart is a part of design system which shows a workflow or system process relevant to an actual procedure

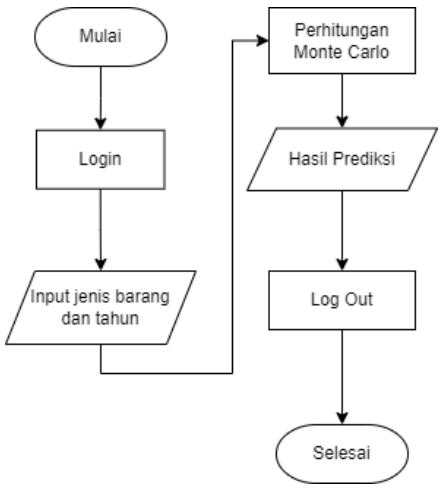

Figure 1. Software Flowchart

Figure 1 represents process flow of the developed software. It starts with a user login into the system, then input the stock data. In the next flow stock data are being used in Monte Carlo calculation. The output of Monte Carlo is a prediction result. User can then logout from the system to finish.

4. DISCUSSION

4.1 Initial Page Monte Carlo Calculation

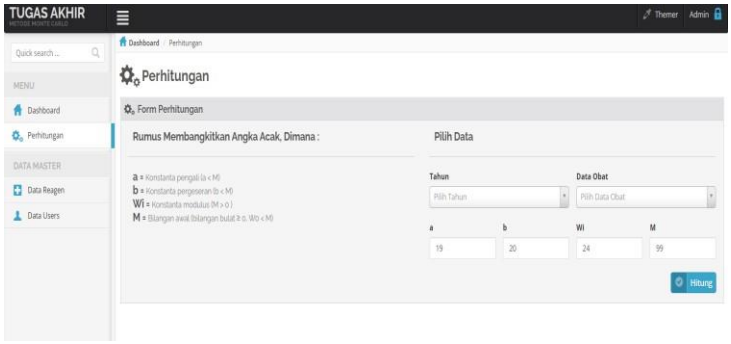

Figure 2. Calculation Page

Figure 2 shows how data are calculated using Monte Carlo method. By choosing year value, reagent type, and inputting multiplier constant (a), moving constant (b), Modulus constant (Wi), initial value (M), then clicking calculate button, the prediction are processed by sistem.

4.2 Result Page

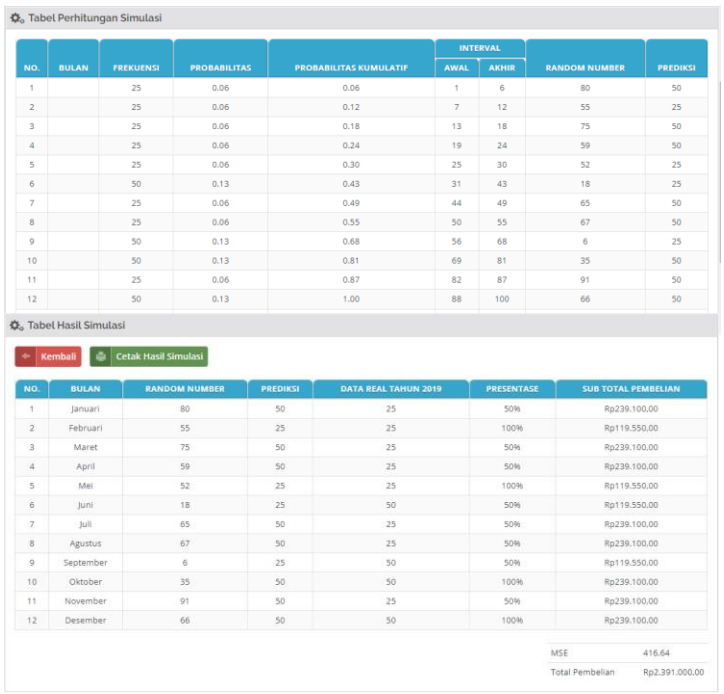

Figure 3. Results page

5. CONCLUSION and SUGGESTION

5.1 Conclusion

In this research there are some conclusions made:

1. A reagent stock prediction system has been succesfully developed by using Monte Carlo method.
2. By using sample data of blood component, the accuracy of the prediction is 79,41%.

5.2 Suggestion

There are some suggestion for this research that might be useful in future development:

3. Accuracy rate can still be improved by using another prediction/forecasting methods.
4. By using another programming language, future research are expected to be more visually informative and more user-friendly.
5. Time-series data cannot be used in Monte Carlo method.
6. Accuracy rate can actually be engineered/improved during generation of random number.

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