

Prediction of Inventory Quantity of Cement Products Using Monte Carlo Method

(Case Study of PT Jaya Mas Utama Makassar)

Aidawayati Rangkuti^{1*}; Very Millyawan Nugraha²; Muh. Nur³

Department of Mathematics, Faculty of Mathematics and Natural Sciences, Hasanuddin University. Jl. Perintis Kemerdekaan Km. 10 Tamalanrea Makassar, Indonesia

Corresponding Author:- Aidawayati Rangkuti^{1*}

Abstract:- Inventory is an important element in company operations with consistent inventory. The method used to control inventory in this study is the Monte Carlo method. This method is a simulation method that can be used as a prediction method to determine future events. The purpose of this study is to determine the optimum accuracy of Tonasa Cement inventory at PT Jaya Mas Utama Makassar with data from 2020-2022. The results show that using the Monte Carlo method is optimal in helping the company PT Jaya Mas Utama Makassar.

Keywords:- Inventory, Monte Carlo Method.

I. INTRODUCTION

The method used to control inventory in this study is the Monte Carlo method. This method is a simulation method that can be used as a prediction method to determine future events. Monte Carlo simulation is used in determining the optimal inventory policy based on the inventory ordering quantity [7]. Monte Carlo is a probabilistic simulation method that makes randomization a given solution using previous data (past data), every variable used in the Monte Carlo technique has probabilistics. This simulation is based on the use of random numbers, there are many random numbers that can be developed with certain patterns or values that make the numbers unpredictable. The Monte Carlo method is useful for solving quantitative problems with real processing [10]. In general, every company aims to make a profit or profit, whether engaged in service, trade or manufacturing businesses. Thus the company must maintain business continuity and growth so that the company can run well. One of the resources that plays an important role in achieving company goals is inventory. This is because most of the company's activities are related to inventory, especially when it comes to trading and manufacturing companies. PT Jaya Mas Utama is a company engaged in the distributor of tonasa cement product providers. Inventory management is also an important step in business. Companies must have a good understanding of the right amount of inventory to meet customer demand. Optimal inventory levels and efficient inventory management allow companies to make the right decisions.

One of the problems in management is excess product inventory. Leepaitoon Sudawan (2019) retail supermarkets that have excess inventory planning caused by inadequate inventory management, one of which is external factors such as competitors, so it is necessary to have proper inventory planning so that excess product inventory can be minimized. Inventory can be said to be effective if the company is able to provide sufficient inventory within a certain period. Monte Carlo simulation is applied to determine policies and simulate sales behavior.. Montororing Yuri Delano (2022) inventory is an important part for the company because if it does not have inventory, the company cannot meet the needs of market demand for goods. However, if the available inventory of goods is too large, there will be other additional costs. For this reason, it is necessary to plan inventory so that the inventory is in a balanced state. Basically, the Monte Carlo method is a method that leads to repeated calculations to obtain the probability distribution of the model to be simulated. In previous research, Syahrini Elvin (2018) has conducted research on modeling sales of herbal products using the Monte Carlo Method. The results of his research show the accuracy of the company's goods data at an accuracy level of 97%. Darnis Rahmi (2020) conducted research on Monte Carlo Simulation to predict blood supplies. From the simulation results obtained, the accuracy rate was 96.21% for 2018 and 76.22% for 2019. Hayati (2020) conducted research on optimizing sales predictions of herbal products using the Monte Carlo Method in increasing transactions. With the conclusion resulting in an accuracy rate of 87.91%.

II. LITERATURE REVIEW

➤ Prediction and Error Value

According to Herdianto (2013), prediction is a process of systematically estimating something that is most likely to happen in the future based on past and present information, so that the error (the difference between something that happens and the estimated results). Predictions do not have to provide answers to the exact events that will occur, but rather try to find answers as close as possible to what will happen. One of the techniques used to measure the accuracy of prediction results by measuring the error value. The error value is used to analyze the accuracy of the prediction results with the following interpretation criteria [8]:

Tabel 1 Interpretation Criteria

Error Value	Interpretation Criteria
<10%	Accurate Prediction
10%-20%	Good Prediction
20%-50%	Feasible Prediction
>50%	Inaccurate Predictions

Source: Adapted from “Sistem Prediksi Permintaan Darah Menggunakan Metode Regresi Linier (STUDI KASUS PADA UTD PMI KABUPATEN BOJONEGORO) ,” by Sumari, A. D. W., Febrianto, A., & Pramitarini, Y.,2021, Jurnal Informatika Polinema, 7(2), 85-90.

➤ Monte Carlo Method

Simulation model is a tool that is flexible enough to solve problems that are difficult to solve with ordinary mathematical models. The Monte Carlo method is numerically described as a statistical simulation method. Monte Carlo simulation is very practical and widely used to solve problems related to uncertainty for systems that cannot be repaired. The basis of Monte Carlo Simulation is an element of probability experiment using random samples [6].

The basis of Monte Carlo simulation is an elemental probability experiment using random samples. This simulation method involves using random numbers to model the system, where time does not play a substantial role in static models. Random number generation is the possibility of generating actual random numbers. This method is divided into several stages [4]:

- Create probability distributions for important variables.
- Construct a cumulative probability distribution for each variable.
- Define intervals with random numbers.
- Create a simulation of the experiment series.

➤ Data Analysis Method

The method applied in this research is the Monte Carlo Simulation method. With the following stages:

- Calculating the Probability Distribution and Performing Cumulative Distribution Calculations.

$$Dp(x) = \frac{fi}{n} \tag{1}$$

And

$$Dk(x) = Dp(x) + Dp-1(x). \tag{2}$$

- Description:

$Dp(x)$: Probability Dstribution of Semen Tonasa Product Inventory

Fi : Number of Ith Inventory (per month) of Semen Tonasa Products

N : Total Inventory of Semen Tonasa Products in 1 year

$Dk(x)$: Cumulative Distrubution of Inventory of the Ith Semen Tonasa Product

- Random Numbers Using LCG (Linear Congruential Generator)

$$Zi = (aZi-1 + b) \bmod m. \tag{3}$$

- Description:

Zi : Ith random number of the sequence

$Zi-1$: Previos random number

a : Free constant number (multiplier)

b : Conditionally independent number

m : Modulus.

- Calculating the Accuracy Rate Value

$$\epsilon_r = \left(\frac{|a - \hat{a}|}{a} \right) \cdot 100\% \tag{4}$$

And

$$Accuracy : 100\% - \epsilon_r. \tag{5}$$

- Description:

ϵ_r : Relative error (error value)

a : Exact value (original value)

\hat{a} : Overlay value (predicted value).

III. RESULT

➤ *Data Collection*

The following data is inventory data for 2020 - 2022 Semen Tonasa products at PT Jaya Mas Utama Makassar.

Table 2 Data on the Total Inventory of Semen Tonasa Products at PT Jaya Mas Utama Makassar during 2020-2022

Month	Inventory		
	2020	2021	2022
January	24.029	24.089	49.076
February	32.825	28.500	66.181
March	19.824	25.550	51.000
April	20.871	20.475	55.400
Mei	25.267	30.850	77.690
June	28.480	63.000	87.275
July	36.459	40.950	69.550
August	34.500	55.250	109.691
September	38.824	53.354	117.827
October	38.992	105.772	122.532
November	36.349	63.275	107.352
December	15.400	38.050	125.596
Total	351.820	549.115	1.039.170

Source: Preliminary Data on Tonasa Cement Product Supply in 2020-2022

From the inventory data of PT Semen Tonasa products. Jaya Mas Utama table 2 can be seen that the increase in the amount of inventory from year to year has increased in 2020 by 351,820, in 2021 by 549,115 and in 2022 by 1,039,170. However, it can be seen that in 2020 the amount of inventory in each month did not experience a significant increase and only in March and September which experienced a significant decrease of 19,824 and 15,400 respectively, the other months are still relatively stable. 2021 also experienced a stable amount of inventory, but in June the total inventory of 63,000 increased 2 times compared to the previous month of 30,850, as well as in October the total inventory of 105,772 increased

2 times compared to the previous month which only amounted to 53,354. In contrast to 2022, the amount of inventory in each month has increased, it can be seen in August-December that the increase in the amount of inventory is quite large.

➤ *Data Processing Analysis*

- *Creating a Probability Distribution and Creating a Cumulative Distribution*

Table 3 Data from the Calculation Process for 2020-2022

Month	Year											
	2020				2021				2022			
	Inventory	PD	CD	Interval	Inventory	PD	CD	Interval	Inventory	PD	CD	Interval
Jan	24.029	0,07	0,07	01-07	24.089	0,04	0,04	01-04	49.076	0,05	0,05	01-05
Feb	32.825	0,09	0,16	08-16	28.500	0,05	0,10	05-10	66.181	0,06	0,11	06-11
Marc	19.824	0,06	0,22	17-22	25.550	0,05	0,14	11-14	51.000	0,05	0,16	12-16
Apr	20.871	0,06	0,28	23-28	20.475	0,04	0,18	15-18	55.400	0,05	0,21	17-21
May	25.267	0,07	0,35	29-35	30.850	0,06	0,24	19-24	77.690	0,07	0,29	22-29
Jun	28.480	0,08	0,43	36-43	63.000	0,11	0,35	25-35	87.275	0,08	0,37	30-37
Jul	36.459	0,10	0,53	44-53	40.950	0,07	0,43	36-43	69.550	0,07	0,44	38-44
Aug	34.500	0,10	0,63	54-63	55.250	0,10	0,53	44-53	109.691	0,11	0,54	45-54
Sept	38.824	0,11	0,74	64-74	53.354	0,10	0,62	54-62	117.827	0,11	0,66	55-66
Oct	38.992	0,11	0,85	75-85	105.772	0,19	0,82	63-82	122.532	0,12	0,78	67-78
Nov	36.349	0,10	0,96	86-96	63.275	0,12	0,93	83-93	107.352	0,10	0,88	79-88
Dec	15.400	0,04	1,00	97-100	38.050	0,07	1,00	94-100	125.596	0,12	1,00	89-100
Total	351.820	1,00			549.115	1,00			1.039.170	1,00		

Source: Data analysis results from 2020-2022

- Note : PD:Probability Distrubution, CD:Cumulative Distribution

By looking at Table 3, it can be seen the probability distribution and cumulative distribution of the 2020 inventory data and the interval of each inventory variable. It can be seen that the highest probability is in September and October of 0.11 indicating that there is a high probability of inventory occurring and the lowest probability is in December of 0.04 indicating that the probability of inventory occurring is small.

By looking at Table 3, it can be seen the probability distribution and cumulative distribution of the 2021 inventory data and the interval of each inventory variable. It can be seen that the highest probability level is in October with a probability level of 0.19 indicating that there is a high probability of inventory occurring and the smallest probability level is around 0.04 which is in January and April indicating that the probability of inventory occurring is small.

By looking at Table 3, it can be seen the probability distribution and cumulative distribution of the 2022 inventory data and the interval of each inventory variable. It can be seen that the highest probability level is in October and December

which ranges from 0.12 indicating that there is a high probability of inventory occurring and the lowest probability level is in January, March and April which ranges from 0.05 indicating that the probability of inventory occurring is small.

- *Creating Random Number*

Table 4 Results of Randomized Values Obtained

No	Random Value
1	59
2	47
3	50
4	74
5	68
6	20
7	32
8	29
9	5
10	11
11	59
12	47

Source: Data Processed 2023

- *Simulation Results and Calculating Accuracy Values*

Table 5 Monte Carlo Simulation Results for 2021-2023

Month	Year								
	2021				2022				2023
	Simulation	Real Data	Error Value	Accuraccy	Simulation	Real Data	Error Value	Accuraccy	Simulation
Jan	34.500	24.089	43%	57%	53.354	49.076	9%	91%	117.827
Feb	36.459	28.500	28%	72%	55.250	66.181	17%	83%	109.691
Marc	36.459	25.550	43%	57%	55.250	51.000	8%	92%	109.691
Apr	38.824	20.475	90%	10%	105.772	55.400	91%	9%	122.532
May	38.824	30.850	26%	74%	105.772	77.690	36%	64%	122.532
Jun	19.824	63.000	69%	31%	30.850	87.275	65%	35%	55.4
Jul	25.267	40.950	38%	62%	63.000	69.550	9%	91%	87.275
Aug	25.267	55.250	54%	46%	63.000	109.691	43%	57%	77.69
Sept	24.029	53.354	55%	45%	24.089	117.827	80%	20%	49.076
Oct	32.825	105.772	69%	31%	25.550	122.532	79%	21%	66.181
Nov	34.500	63.275	45%	55%	53.354	107.352	50%	50%	117.827
Dec	36.459	38.050	4%	96%	55.250	125.596	56%	44%	109.691
Average			47%	53%			45%	55%	95.451

Source: Monte Carlo Simulation Data for 2021-2023

It can be seen that the largest error values, in other words, inaccurate predictions, are 54%, 55%, 69%, 69%, 90% in a row in August, September, June, October and April, the large error value in April is due to the comparison value or division ratio between the difference between the real value and the simulated value and the real value is too small, but there are several error values that are fairly small, namely 4% listed in December. And for Table 3.4 shows that the results of the calculation of the error value and the accuracy level of PT Semen Tonasa product inventory. Jaya Mas Utama Makassar is considered feasible to apply in accordance with using the Monte Carlo Method with an average accuracy level of 53%.

It can be seen that the largest error value, in other words, inaccurate predictions are 56%, 65%, 79%, 80%, 91% in December, June, October, September and April, the large error value in April is due to the comparison value or division ratio between the difference between the real value and the simulated value and the real value is too small, and there are several error values that are fairly small, namely in March by 8% and January and July respectively 9%. And Table 3.4 shows that the results of the calculation of the error value and the accuracy level of PT Semen Tonasa product inventory. Jaya Mas Utama Makassar is considered feasible to be applied in accordance with using the Monte Carlo Method with an average accuracy level of 55%.

It can be seen that the simulation results for 2023 have increased in April by 122,532 and decreased in June by 55,400 and increased again in November by 117,827. By looking at Table 3.4, it can be seen that the series of simulation values obtained from the calculation results.

IV. CONCLUSION

From some descriptions of the results and discussions in the previous chapter, it can be concluded that the results of this study indicate that the Monte Carlo Method is optimal in helping the company PT Jaya Mas Utama Makassar to estimate the inventory of Semen Tonasa PT Jaya Mas Utama Makassar based on the frequency of past inventory. With the average error value and the average accuracy value in predicting the amount of PT. Jaya Mas Utama Makassar's Tonasa Cement product inventory in 2021 of 47% and 53% respectively and for 2022 of 45% and 55% respectively. Meanwhile, in 2023 the simulation results show that the amount of inventory has increased and decreased in each month.

REFERENCES

- [1]. Darnis, R., Nurcahyo, G. W., Yunus, Y. (2020) Monte Carlo untuk Memprediksi Persediaan Darah. *Jurnal Teknologi dan Informasi*, 2(4), 139-144.
- [2]. Hayati, N. (2020) Optimalisasi Prediksi Penjualan Produk Herbal Menggunakan Metode Monte Carlo dalam Meningkatkan Transaksi. *Jurnal Informatika Ekonomi Bisnis*, 2(4), 117-122.
- [3]. Herdianto. (2013), *Prediksi Kerusakan Motor Induksi Menggunakan Metode Jaringan Saraf Tiruan Backpropagation*. Medan: Universitas Sumatera Utara.
- [4]. Hutahean, H. D., (2018), Analisa Simulasi Monte Carlo Untuk Memprediksi Tingkat Kehadiran Mahasiswa Dalam Perkuliahan, *Journal Of Informatic Pelita Nusantara*, 3(1), 2541-3724.
- [5]. Leepaitoon, S., & Bunternghehit, C. (2019). The Application of Monte Carlo Simulation for Inventory Management: A Case Study of a Retail Store, *International Journal of the Computer, the Internet and Management*, 27(2), 76-83.
- [6]. Mahessya, R. A. (2017). Pemodelan dan Simulasi Sistem Antrian Pelayanan Pelanggan Menggunakan Metode Monte Carlo Pada PT Pos Indonesia (Persero) Padang. *Jurnal Ilmu Komputer*, 6(1), 15-24.
- [7]. Putra, B. M. (2020). Simulasi Monte Carlo dalam Memprediksi Tingkat Pendapatan Advertising. *Jurnal Informatika Ekonomi Bisnis*, 2(3), 80-85.
- [8]. Sumari, A. D. W., Febrianto, A., & Pramitarini, Y. (2021). Sistem Prediksi Permintaan Darah Menggunakan Metode Regresi Linier: (STUDI KASUS PADA UTD PMI KABUPATEN BOJONEGORO). *Jurnal Informatika Polinema*, 7(2), 85-90.
- [9]. Syahrini, E., Santony, J., & Na'am, J. (2018). Pemodelan Penjualan Produk Herbal Menggunakan Metode Monte Carlo. *Jurnal KomtekInfo*, 5(3), 33-41.
- [10]. Thoriq, M., Aldo, E. S., Yofhanda, S. E. (2022). Model Simulasi untuk Memperkirakan Tingkat Penjualan Garam Menggunakan Metode Monte Carlo. *Jurnal Informasi dan Teknologi*, 4(4), 242-246.