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# Simulation Modeling System in Determining the Amount of Oil Inventory

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**ABSTRACT**

Currently, XYZ Gas Stations, in carrying out fuel sales activities, have not yet used a simulation of calculating fuel supply needs at gas stations which functions to support decision making by the leadership, this causes frequent stock shortages at each XYZ gas station branch. because of that the authors are interested in creating a modeling system for calculating fuel inventory simulations using the Monte Carlo method and the LCM pattern. The purpose of this research is to produce a simulated calculation of the supply of purchased fuel so that management knows how much stock of fuel must be provided at each gas station and also to prevent empty fuel stocks at each gas station in the XYZ branch. The data collection methods used in this study were interviews, observations, and literature studies. The system is designed using the JAVA Programming Language. The data processed in this study is transaction activity data for January and February 2022 to determine the amount of inventory that must be provided in March 2022. The final results of the data processing that has been carried out with the trial purchase data transactions for the two current months, namely January and February 2022 to get the simulation results of fuel oil (BBM) supplies in March whose activation has been running with simulation predictions using the Monte Carlo Algorithm.

**Keywords:** BBM ; Modeling ; Simulation ; Monte Carlo ; Java Programming

## 1. INTRODUCTION

Simulation is a method used to conduct experiments using models of real systems. Simulation provides a way to assess an answer and provides direct tracking within a certain time frame (Prawita, 2021)(Nasution, 2016). Inventory is a collection of goods stored for sale in the company's business operations and can be used in the production process or can be used for a specific purpose. Another definition of inventory is material or goods stored to fulfill a certain purpose. For example, it is used for the production or assembly process, as well as for resale ((Yanuarsyah et al., 2021)). Monte Carlo is a probability type simulation that approaches the solution of a problem by sampling from a random process. (Nashrulhaq et al., 2014)Monte Carlo involves establishing a probability distribution of the variable being studied and then taking a random sample of the distribution to generate the data. When the system has elements that exhibit behavior that tends to be uncertain or probabilistic, the Monte Carlo simulation method can be applied (Santony, 2020). XYZ gas station company located in Batam City is engaged in oil, gas and fuel oil (BBM) supplies. Started its business activities since August 15, 2000 and has been operating as a distributor of Fuel Oil (BBM) and Gas in Batam Island and other areas in Indonesia. This company has also obtained a General Trading Permit for Oil Fuel issued by the Directorate General of Oil and Gas. Complete permits and support from the Government and clients. This company will continue to grow into a company that will never stop pioneering distribution channels for fuel oil (BBM) throughout Indonesia, as a commitment by the company to participate actively in the success of regional development. Inventory management at this company is one of the functions of an inventory control system. The control system of a company is very influential for business continuity because it will determine the smooth process of sales and inventory transactions in this company. However, many companies do not yet know the importance of managing control systems properly due to several constraints, including the following. First, external factors that affect a company in identifying inventory: the frequent occurrence of vacancies in fuel oil (BBM) stocks. Second, internal factors, namely the inventory model that is suitable for market share conditions, is not well understood by management; Difficulty calculating handling costs and mistakes in calculating excessive fuel oil (BBM) supplies. In particular, due to uncontrollable external factors, inventory management becomes probabilistic. In this probabilistic condition, the company must take a pragmatic approach in managing the required reserves of fuel oil (BBM) .

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## 2. LITERATURE REVIEW

Published related to forecasting (Apri et al., 2019), conducted a study entitled monte carlo simulation to reduce the number of patient visits. The main data used is data for 2016, 2017 and 2018 starting from January to December. The variable used in this study was the number of visits by Puskesmas patients per month. Data for 2016 is used as training data to predict 2017, data for 2017 is used as training data to predict 2018, and data for 2018 is used as training data to predict 2019. The total number of patients who visited in 2017 was 18117 people, with an average the average visit per month is 1510 patients. Whereas in 2018 the total number of patients who visited was 18,217 with an average of 1,518 patients per month, and for 2019 a total of 2,8327 patients were obtained, with an average monthly of 2,361 patients. (Saragih et al., 2016), This Monte Carlo simulation is very suitable for conducting simulations. to predict the number of patient visits for the future. The results of the simulation can provide information to the puskesmas and be used as a reference in future policy making.

A study Monte Carlo Simulation For Predicting Profits Sale. This study aims to carry out a simulation to predict profits based on sales data at Aneka Rasa Cake Shop using the monte carlo method. A number of The steps taken are first calculating the frequency of sales, then calculating probability distribution and cumulative probability. Then calculate the range of values. After that perform a simulation using a number of random variables. The result is a number of possibilities profits that can be obtained by the company (Rahayu, 2019)

Published related to forecasting (Mahessya, 2017), conducted a study system modeling and simulation of customer service queue using the monte carlo method at PT Pos Indonesia (PERSERO) padang. The purpose of this research is to analyze the customer service queue system that occurs at PT Pos at the delivery counter. Which describes how the queue conditions occur and to find out whether the services provided to customers have been carried out optimally, even though the company already has several goods delivery counters.(Izquierdo et al., 2006) for this reason, modeling and simulation using the Monte Carlo method with a Multi Channel Single Phase queuing system are used. And using the Arena software to create a simulation model of the queuing model at PT Pos. This research uses the observation method or goes directly to the field and conducts library research and laboratory research. The results shown are in the form of a simulation using Arena soware on the desktop layer.

Published related to forecasting (Muhaimin et al., 2020), conducted a study modeling and simulation of office stationery supply management using the monte carlo method. For a tertiary institution, the supply and purchase of goods is something very important, this aims to inventory goods effectively and efficiently in accordance with the goals of the tertiary institution. Simulation is needed to predict the amount of office stationery in the future so as to avoid large losses and be able to coordinate and minimize budget expenses and be able to see the number of needs needed.(Peranginangin, 2006) The data used in this study is data from the Hang Tuah Pekanbaru STIKes Office Stationery for the 2018/2019 Academic Year. The data is processed based on the academic year for the period of Odd Semester 20181, September 2018 to February 2019, and Even Semester 20182, March 2019 to August 2019. Data processing in this study used the Monte Carlo method. The results of the tests that have been carried out obtained an accuracy rate of 92%. And the test results using the Monte Carlo method are in accordance with manual calculations. Estimates and supplies of Office Stationery can be provided to meet demand for the following academic year.

Published related to forecasting (Prajoko & Manurung, 2018), conducted a study scheduling analysis of construction projects using monte carlo simulation (case study of building construction in Bintaro, Jakarta). Scheduling methods in construction projects are often found to be uncertain. To anticipate this, probabilistic scheduling techniques are used which are applied to building construction projects in Bintaro, Jakarta. (Sriwana et al., 2018), The procedures carried out in the form of collecting activity duration data, determining the relationship between activities, and estimating activity duration using Monte Carlo simulation. From the results of 1000 iterations, the duration based on the optimistic and pessimistic percentile confidence of 80% was obtained for 1624 and 1595 days respectively. There are 64 critical activities which need to receive more specific attention regarding risk management, and can be used as material for consideration in accelerating work when a crash program is carried out.

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Published related to forecasting (Naim & Donoriyanto, 2020), conducted a study Drug Inventory Control at XYZ Pharmacy Using Monte Carlo Simulation. The purpose of this study was to produce optimal drug supplies at Prima Farma pharmacies using the Monte Carlo Simulation method. This is intended to obtain a solution in inventory control on the basis of demand forecasting for the next period. In this way, the EOQ and ROP can be determined for each type of drug. Drug inventory control at the Prima Farma pharmacy based on supply and demand forecasting simulations obtained a total cost of Rp. 165,588,329.07 which is smaller than the real total cost of the pharmacy of Rp. 171,583,085.6 with cost savings of Rp. 5,994,756.53 and if the percentage is 3.49%. With sequential EOQ, namely 16 boxes, 68 boxes, 34 boxes, 33 boxes, and 17 boxes. And ROP respectively, namely 7 boxes, 12 boxes, 8 boxes, 4 boxes, and 4 boxes. So that the Monte Carlo Simulation Method can reduce the total cost of inventory.

## 3. METHOD

Research methodology is an important step to solve problems in research. The research methodology is used as a guide in conducting research so that the results achieved do not deviate from the research objectives. The research methodology will describe the methods used in the research included in the research framework. The stages of the research framework aim to make the research directed and in accordance with the objectives of this study. The research framework stage starts from collecting data on the number of laboratory test takers, laboratory exam participant data is stored, input prediction orders, prediction process through least square method calculations and prediction results. The framework in this study will be explained below in figure 1.

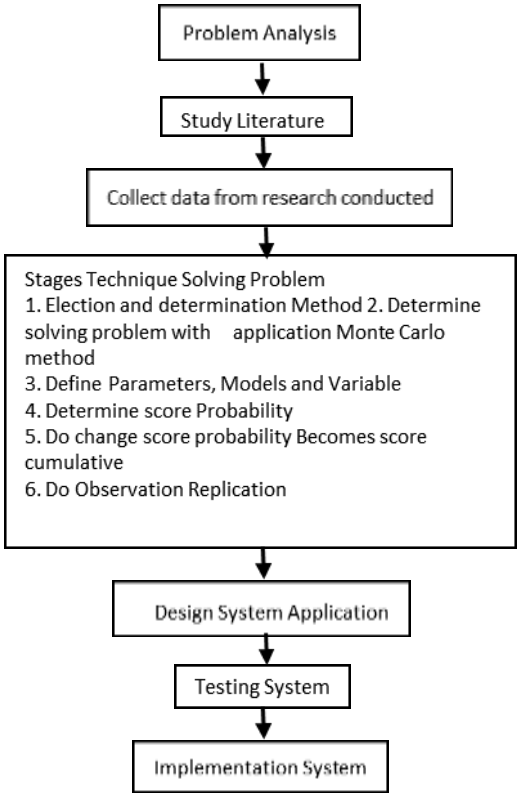


Fig.1 The research methodology

**Frameworks**

The research framework is a description of the sequence of steps that a researcher will take to analyze a problem so that the researcher can solve the problem. The following are the stages of the framework which includes problem

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analysis, literature review, data collection, problem selection techniques, system design, system testing, and system implementation which can be explained in great detail and complete in the following sub-subjects:

1. Problem Analysis

The problem analysis step is a step to be able to understand a problem that has a predetermined scope or boundaries. A stage in analyzing a problem can be understood very well, the analysis technique used can be carried out in several stages as follows:

a. The identify stage is: identifying the problems that occur
b. The understand stage is: understanding more about the existing problems by collecting the required data
c. The analyze stage is: looking for weaknesses in the existing system and gathering information about further requirements required by the user.

The problem faced when this research was conducted was when there was high market demand while inventory was not available in the warehouse.

2. Study Literature

Based on the problem, then the goals to be achieved from this writing can be determined. In this goal, targets can be determined to be achieved, especially in overcoming existing problems. After the problem is analyzed, literature related to the existing problem can be studied. Then the literature that has been studied can be selected which literature will be used in this study. Literature sources can be obtained from libraries, articles, journals, books related to the Monte Carlo Method, Monte Carlo Techniques, Modeling, Simulation, and other reading materials that support research.

3. Collecting the Required Data

Based on the stages of collection, it can be determined from several data sources, while the data used in collecting this data is as follows:

a. Doing a literature study by reading supporting books to be able to analyze the data and information obtained.
b. Field study Namely direct observation at the research site so that the existing problems can be identified clearly.
c. Interview Interviews were conducted with related parties with the aim of obtaining the required data or information. In this study, the parties interviewed were XYZ Gas Station Managers, HRD, Marketing and Head of Warehouse.

4. Stages of Problem Solving Techniques

This stage aims to determine the techniques used in simulating the supply of fuel oil (BBM) requirements using the Monte Carlo Method by representing the problem in a knowledge base. The processes at this stage are:

a. Method selection and determination
b. Determine problem solving with the application of the Monte Carlo Method
c. Define parameters, models and variables.
d. Determine the probability value
e. Make changes to the probability value into a cumulative value
f. Observing the Number of Replications
    1) Analysis Testing
    2) Random number generation
    3) Make a withdrawal number using the LCM method
g. Perform model evaluation

5. System planning

After determining the method to be used, the next step is to design the system. In designing the system, several stages of activity will be carried out as follows:

a. Aggregation Stage

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Aggregation is the process of grouping goods that sell well so that simulation data is more accurate than goods that sell less.

b. Existing table retrieval stage
c. Sales data and *listing* of fuel oil items will be obtained from the existing applications used at this time, to process the need to validate the simulation results of the system that has been designed using the Monte Carlo method.
d. Stage of supporting software design for simulation needs. This software is needed to help simulate the need for fuel oil (BBM) based on needs by referring to the previous sales process which refers to data for the last 3 months.
e. Simulation Stage
Simulation of the demand for fuel oil supplies is carried out to determine the amount of supply needed for the coming month
f. Validation Stage
The stage is to compare the results between the real data and the simulation results for the 2022 period with reference to the last 3 months' data.

6. System Testing

This stage will present the results of the inventory simulation calculation results with the company policy model. By looking at these results, it will be possible to compare which inventory control system is best for the company. Several analyzes of the results of data processing carried out, these analyzes are:

a. Analysis of the supply of fuel oil needs based on the conditions and the next time.
b. Maximum inventory analysis
c. Minimum inventory analysis
d. Changes in the inventory *review period*
e. Changes in the number of inventory requests

7. System Implementation

At this stage, a review of the feasibility of the system that has been designed is carried out, whether the system is appropriate or still needs to be reviewed or refined.

## 4. RESULT AND DISCUSSION

This implementation stage , the Monte Carlo method is used to determine the supply of fuel oil (BBM) at the XYZ gas station company . This analysis was carried out on system requirements based on the problems found at the XYZ Gas Station Company , namely regarding the amount of fuel oil (BBM) that must be provided, then based on the analysis that has been carried out, and to answer these problems in the next stage in this study the activities that must be to do is to make a system design that will be built. To make it easier to understand the process of analysis and design carried out in research . The data used is simulation data for March which is calculated based on January-February data in 2022.

**Creating a Monte Carlo simulation model**

Making a Monte Carlo simulation model, in this stage determining the value of the probability distribution of the existing variable values by analyzing historical data on oil purchases at the XYZ Gas Station Company for the current two months in order to produce information related to the amount of inventory that must be provided for the next month . Probability or relative frequency for each possible outcome of a variable is obtained by calculating the number of purchase frequencies. The following is data on purchasing Pertalite fuel oil supplies (BBM) for January and February 2022.

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Table 1.
Purchases for the year January-February 2022 (Thousand Kilo Liters )

| No | Tanggal Pembelian | Data Pembelian BBM Jenis Pertalite Jumlah (KL) | 17 | 17/01/2022 | 40.000 |
|---|---|---|---|---|---|
| 1 | 01/01/2022 | 24.000 | 18 | 18/01/2022 | 48.000 |
| 2 | 02/01/2022 | 48.000 | 19 | 19/01/2022 | 40.000 |
| 3 | 03/01/2022 | 40.000 | 20 | 20/01/2022 | 32.000 |
| 4 | 04/01/2022 | 40.000 | 21 | 21/01/2022 | 48.000 |
| 5 | 05/01/2022 | 32.000 | 22 | 22/01/2022 | 48.000 |
| 6 | 06/01/2022 | 24.000 | 23 | 23/01/2022 | 48.000 |
| 7 | 07/01/2022 | 48.000 | 24 | 24/01/2022 | 40.000 |
| 8 | 08/01/2022 | 40.000 | 25 | 25/01/2022 | 24.000 |
| 9 | 09/01/2022 | 40.000 | 26 | 26/01/2022 | 40.000 |
| 10 | 10/01/2022 | 48.000 | 27 | 27/01/2022 | 32.000 |
| 11 | 11/01/2022 | 40.000 | 28 | 28/01/2022 | 48.000 |
| 12 | 12/01/2022 | 32.000 | 29 | 29/01/2022 | 48.000 |
| 13 | 13/01/2022 | 40.000 | 30 | 30/01/2022 | 40.000 |
| 14 | 14/01/2022 | 48.000 | 31 | 31/01/2022 | 48.000 |
| 15 | 15/01/2022 | 40.000 | | **Total** | 1256.000 |
| 16 | 16/01/2022 | 48.000 | | | |

Table 2
Year Purchases January-February 2022 (thousand Kilo Liters )

| No | Tanggal Pembelian | Data Pembelian BBM Jenis Pertalite Jumlah (KL) | 15 | 15 February 2022 | 48.000 |
|---|---|---|---|---|---|
| 1 | 01 February 2022 | 48.000 | 16 | 16 February 2022 | 40.000 |
| 2 | 02 February 2022 | 40.000 | 17 | 17 February 2022 | 48.000 |
| 3 | 03 February 2022 | 40.000 | 18 | 18 February 2022 | 48.000 |
| 4 | 04 February 2022 | 48.000 | 19 | 19 February 2022 | 48.000 |
| 5 | 05 February 2022 | 48.000 | 20 | 20 February 2022 | 40.000 |
| 6 | 06 February 2022 | 40.000 | 21 | 21 February 2022 | 48.000 |
| 7 | 07 February 2022 | 48.000 | 22 | 22 February 2022 | 40.000 |
| 8 | 08 February 2022 | 40.000 | 23 | 23 February 2022 | 40.000 |
| 9 | 09 February 2022 | 48.000 | 24 | 24 February 2022 | 48.000 |
| 10 | 10 February 2022 | 16.000 | 25 | 25 February 2022 | 48.000 |
| 11 | 11 February 2022 | 48.000 | 26 | 26 February 2022 | 48.000 |
| 12 | 12 February 2022 | 48.000 | 27 | 27 February 2022 | 40.000 |
| 13 | 13 February 2022 | 40.000 | 28 | 28 February 2022 | 48.000 |
| 14 | 14 February 2022 | 48.000 | | **Total** | 1232.000 |

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Table 3
Purchase Report for January -February 2022 (thousand Kilo Liters )

| No | Jumlah Pembelian |
|---|---|
| 1 | 24.000 |
| 2 | 48.000 |
| 3 | 40.000 |
| 4 | 40.000 |
| 5 | 32.000 |
| 6 | 24.000 |
| 7 | 48.000 |
| 8 | 40.000 |
| 9 | 40.000 |
| 10 | 48.000 |
| 11 | 40.000 |
| 12 | 32.000 |
| 13 | 40.000 |
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| 33 | 40.000 |
| 34 | 40.000 |
| 35 | 48.000 |
| 36 | 48.000 |
| 37 | 40.000 |
| 38 | 48.000 |
| 39 | 40.000 |
| 40 | 48.000 |
| 41 | 16.000 |
| 42 | 48.000 |
| 43 | 48.000 |
| 44 | 40.000 |

| | |
|---|---|
| Nilai Minimum | 16.000 |
| Nilai Maksimum | 48.000 |

After the data is displayed, then the next step is to determine the minimum and maximum values of the attached data so that the range of intervals and frequencies can be found.

Table 4
Relative Frequency for January-February 2022 (thousand Kilo Liters )

| Interval | | Mid Point | Frekuensi |
|---|---|---|---|
| 16.000 | 17999 | 17.000 | 1 |
| 24.000 | 25999 | 25.000 | 3 |
| 32.000 | 33999 | 33.000 | 4 |
| 40.000 | 41999 | 41.000 | 22 |
| 48.000 | 49999 | 49.000 | 29 |
| Total | | | 59 |

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Determines the probability distribution to be a cumulative probability. After determining the next probability distribution is to turn it into a cumulative probability distribution by accumulating the results of the probability distribution which results in the accumulation of each value as the accumulated total of the previous value .

Table 5
Probability (Probability) and Cumulative for January-February 2022 (thousand Kilo Liters )

| Probabilitas | Kumulatif | Interval |
|---|---|---|
| 0,017 | 0,017 | 000-017 |
| 0,051 | 0,068 | 017-068 |
| 0,068 | 0,136 | 069-136 |
| 0,373 | 0,508 | 137-508 |
| 0,492 | 1,000 | 509-000 |

In this Monte Carlo Method simulation, the author draws random numbers using the LCM ( Linear Congruent Method ) formula , so that how many requests for fuel oil (BBM) supplies are based on the results of the simulations carried out.

Table 6
Generating Random Values with LCM Parameters in January-February 2022

| A | C | m | Xo |
|---|---|---|---|
| 128 | 72 | 900 | 321 |

| I | (a*Xi)+c | Xi | Mid | Hasil |
|---|---|---|---|---|
| 0 | | 321 | | 0 |
| 1 | 41160 | 660 | 17000 | 17000 |
| 2 | 84552 | 852 | 25000 | 75000 |
| 3 | 109128 | 228 | 33000 | 132000 |
| 4 | 29256 | 456 | 41000 | 902000 |
| 5 | 58440 | 840 | 49000 | 1421000 |
| Total | | | | 2547000 |
| Rata- rata | | | | 43169,49 |

The results of taking random numbers with the LCM pattern can then be compiled in a table. To compare the results of comparisons between real data, simulations and the average value of the two current months can be seen in Table 7.

Table 7
Simulation Results of Two Data Samples in January and February 2022 with Real Data Comparison Scale

| No | Bulan | Hasil Simulasi | Data Rill |
|---|---|---|---|
| 1 | Maret | 43,169 | 42,169 |

The simulation prediction table above explains that pertalite fuel oil inventories in March were 42,169 while the simulation results of 43,169 have a fairly high level of accuracy approaching the truth value of the existing data.

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**Implementation and Results**

After carrying out the Analysis and Design stages, the next stage is to explain how the process of processing data on the system that has been built. testing using the Monte Carlo method and the LCM pattern. The form of this simulation form can be seen in Figure 2 which explains all the simulation activities carried out so that it can produce relevant information from the research results to determine the amount of fuel oil (BBM) stock at XYZ gas stations.


Fig.2 System Test Results

After inputting data and processing data into the system, it can be concluded that using Monte Carlo Simulation with the LCM pattern has results with values that are almost close to the truth value with a fairly high data accuracy. Figure 3 below is an image of the final results produced for the current 2 months.


Fig.3 Report on Simulation Results of Fuel Oil (BBM) Inventory of XYZ Batam SPBU

## 5. CONCLUSION

Based on the results of the research that has been done, the following conclusions can be drawn, Understanding the use of the Monte Carlo Algorithm to simulate the calculation of fuel oil (BBM) inventory needs can assist managers in predicting earlier. The final results of the data processing that has been carried out with the trial purchase data transactions for the two current months, namely January and February 2022 to get the simulation results of fuel oil (BBM) supplies in March whose activation has been running with simulation predictions using the Monte Carlo Algorithm. By designing a system using the Monte Carlo Method in calculating fuel oil (BBM) supplies according to needs, it makes it easier for the admin to predict earlier how much oil will be provided in the following month. The simulation prediction results explain that the supply of pertalite fuel oil in March 42,169 which has a fairly high level of accuracy is close to the truth value of the existing data.

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