IMPLEMENTING ECONOMIC ORDER INTERVAL FOR MULTI ITEM TO REDUCE TOTAL INVENTORY COST

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This thesis entitled “IMPLEMENTING ECONOMIC ORDER INTERVAL FOR MULTI ITEM TO REDUCE TOTAL INVENTORY COST“ prepared and submitted by Yosua Christiananda in partial fulfillment of the requirements for the degree of Bachelor of Engineering in the Faculty of Engineering has been reviewed and found to have satisfied the requirements for a thesis fit to be examined. Therefore, I recommended this thesis for Oral Defense.

Cikarang, Indonesia, May 30th, 2013

Anastasia Lidya Maukar ST, M.MT.
DECLARATION OF ORIGINALITY

I declare that this thesis, entitled “IMPLEMENTING ECONOMIC ORDER INTERVAL FOR MULTI ITEM TO REDUCE TOTAL INVENTORY COST” is to the best of my knowledge and belief, an original piece of work that has not been submitted, either in whole or in part, to another university to obtain a degree.

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ABSTRACT

Nowadays, Inventory management has become a major concern for company because it can bring value added. Inventory management focused on maintaining and managing the inventory level in order to fulfill the customer demand with the lowest cost. In retailing and wholesaling, the item from the same supplier is order jointly. This means, the order interval between one and another product must be same. But, there is several manufacturing company that have not achieving the optimum solution in inventory management for multi item. It leads the company to increasing the total inventory cost. Most of them are caused by the improper order interval. Thus, appropriate of inventory management reduce total inventory cost. This research tried to identify this problem. The first step that should be done is by identifying the problems, scopes, and objectives of the research which aimed to minimize the inventory control management. Then collecting data and analyzing the supported data in inventory management. By using the total inventory cost analysis as a parameter in comparing the actual system and the proposal system. This research also used forecasting methodology in order to predicting the future demand. In the final section is by implementing the Economic Order Interval in ordering process for determining the optimum order interval. The result in this thesis show that the proposal system can reduce the total inventory cost over 21% from the current condition.

Keyword: Inventory Control and Management, Multi-item, Economic Order Interval, Total Inventory Cost, Forecasting.
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CHAPTER I
INTRODUCTION

1.1 Problem Background

Nowadays, the business competition is getting harder. The companies compete to one another in order to show their strength in quality and service. Due to survive in the Business competition, the companies should give their best performance. Beside the customer, satisfaction has become the major concern for company. The criteria of customer satisfaction are on-time delivery, product quality, and price. Based on that qualification, the company challenged to have continuous improvements in every aspect to reduce the total cost. One of its aspects is a logistic element.

Logistic deals with planning, managing and controlling the flow of good and service. Furthermore, logistic controls the effectiveness of a business operation. There are several aspect that cover by logistic such as warehousing, transportation, inventory, and others. Raw material is a major need for manufacturing company. Ordering the raw material in a right time and quantity is a part of logistic function in inventory management aspect. In order to run the business smoothly, the company should have a good inventory management system.

Inventory management has become a major concern for company in order to improve customer satisfaction and reduce cost. Furthermore, inventory management focused on maintaining and managing the inventory level in order to fulfill the customer demand with the lowest cost. According to inventory principle, the fewer inventories that company has, the less cost that they will spend. However, inventory is necessary to cover the demand during lead-time and become a buffer if the demand suddenly increases. This mean, good inventory management system is important for company to run the business well and reduce cost.
This research is conducted in PT. X, one of the developing chemical industry in Cikarang. It runs on manufacturing chemical product for wet processing in textile industry. PT. X has five major groups of products, there are pretreatment products, printing products, dyeing products, finishing products and others. There are two main processes in PT. X, there are blending process and simple mixing. Blending process is manufacturing process that need high pressure and longer time using boiler. Simple mixing is manufacturing process using mixer.

In this research, finishing products are observed because it has the biggest demand than others product group. The finishing products consist of Silofin Hals-B, Silofin Ham, Silofin AM25E, Finisoft RWT Pasta, Finisoft NIT, Lubric WE and Fillant SH. In retailing and wholesaling, ordering process from the same supplier is doing by joint order. In order to do joint order, the order interval between one and another item must be the same. Therefore, determining the right order interval will minimize the inventory cost for a group as a whole.

After doing the observation, the author found that the number of order occurrence between one and another product is different. The ordering process cannot do in joint order. Therefore, the ordering cost is high. In the end, the total inventory cost is increasing 2% year by year as shown in figure 1.1.

![Figure 1.1 Total Inventory Cost Current Condition](image-url)
From the observation, it was found that PT. X does not use any inventory management method in determining the order interval decision based on management opinion. The order interval between one and another product is different. Therefore, the ordering process cannot do in joint order. Thus, appropriate inventory management will reduce the total inventory cost without neglecting the customer satisfaction.

1.2 Problem Statement
As state in the previous section, the inappropriate of inventory management may cause to increasing the total inventory cost. Therefore, this research is aiming to answer this following question:

- How to reduce total inventory cost in PT. X?

1.3 Objective
The main objective of this research is:

- Proposed an appropriate inventory management system in order to reduce the total inventory cost.

1.4 Scopes and Limitation of Research
Due to the limitation of time and resources in doing this research, there will be some scopes and limitations in this research:

- The research conducted in purchasing division of PT. X.
- This research used supporting data from January – December 2012. The supporting data include product demand, product composition, ordering cost, and holding cost.
- The research observed a group of products that have the biggest demand, which is finishing products. The finishing products consists of Silofin Hals-B, Silofin Ham, Silofin AM25E, Finisoft RWT Pasta, Finisoft NIT, Lubric WE, and Fillant SH.
- The ordering cost only consider the fixed cost for ordering the materials from supplier.
• The holding cost only consider the cost for holding the materials in a certain time. It does not consider the overhead cost, labor, etc.

1.5 Assumption
There are several assumptions that researcher have made in order to run this model properly:
• The product demand rate is known, constant and continuous.
• The lead-time is known and constant.
• The material ordered delivered at the same time.
• There is no quantity discount.
• There is no stock out since the demand known.

1.6 Research Outline
Chapter I Introduction
This chapter consists of background of PT. X, problem identification, research objective, scope and assumption of the research.

Chapter II Literature Study
This chapter delivers the information about previous study. The theories are includes inventory management, forecasting, and other method which support this research to achieve the objectives.

Chapter III Research Methodology
The flow of the research methodology explained in this chapter. Furthermore, research framework explained and described in order to give clear explanation to the reader about flow of the research to solve the problems.

Chapter IV Data Calculation and Analysis
The data observation is processed and analyze in this chapter to obtain the current total cost. After that, calculate the proposed inventory management cost. The result of total inventory cost for proposed system will be compare with the current total cost to get the saving percentage. Then, find the best forecasting method to
determine future demand for the next period. From the forecasted demand, calculate the future total cost.

Chapter V Conclusion and Recommendation
This chapter will give the result of this research to answer the problem statement. Furthermore, the recommendation given to the company regarding the purposed method and encouraging the company and other researcher to conduct future research about this topic.
CHAPTER II
LITERATURE STUDY

2.1 INVENTORY MANAGEMENT

Inventory management has become a major concern in business activity. The purposed of inventory management is maintaining and managing the inventory level in order to fulfill the customer demand with the lowest cost. According to inventory principle, the fewer inventories that company has, the less cost that will be spend. However, inventory is needed in order to cover the demand during lead-time and become a buffer if the demand suddenly increases. Therefore, company should has a good inventory management.

Based on Lambert, et al. (1998) and Muller (2003), there are some important reasons for obtaining and holding inventory as explained below:

- **Economies of Scale.**
  Purchasing the raw material in big scale is more economically. It can save the cost in purchasing, ordering or transportation. Often obtained various discounts for purchasing products in larger rather than in small quantities.

- **Balancing supply and demand.**
  In seasonal time, such as Idul Fitri or Christmas, the demand can increase sharply, inventory is necessary to hold. The company does not know exactly quantity are needed at any given time, but the company needs to satisfy customer or production demand on time.

- **Uncertainty demand and order cycle.**
  When material is rare and the supply is difficult or not steady, inventory can cover the company from unreliable material. Whenever the supplier is unreliable, it should be replaced with the new one.

- **Enables specialization in manufacturing.**
  Inventory makes possibilities for manufacturing plant to focus on the production. While the finish product would be sent to the central
warehouse and the central warehouse which would handle the transportation to every customer.

- **Price protection.**
  Buying quantities of inventory at appropriate time helps avoid the impact of cost inflation. Many suppliers prefer to deliver periodically rather than to ship an entire year’s supply of particular stock keeping unit (SKU) at one time.

- **Inventory as a Buffer.**
  Inventory is necessary in order to ensure the successful of the supply chain to achieve time and place utility. From the availability of raw material for production purposes until the finish products for order fulfillment purposes, inventory acts as buffering.

From the reasons above, it could be taken as a consideration for placing inventory. Therefore, it would give value added in business activity.

### 2.2.1 Inventory Classification

The inventory can be classified base on the reason for which inventory is accumulated (Lambert, et al, 1998). The classification are:

- **Cycle stock.**
  In the condition of certainty demand and lead-time, cycle stock is inventory which used for replenishment of product sold or material used for production.

- **In-Transit Inventories.**
  It is unavailable inventory for use or sale because the stock is in the middle of shipment.

- **Safety or Buffer Stock.**
  Safety or Buffer Stock is held when the demand or lead time is not uncertainty. The purpose is to prevent from the loss sales.

- **Speculative Stock.**
  Inventory is held for the reason besides for satisfying the demand. For example, for production or transportation economies.
• **Seasonal Stock.**
  It is the other form of speculative stock. The inventory is accumulated to face the seasonal period when the demand is on the peak.

• **Dead Stock.**
  It refers to items which have no demand at all. Dead stock may be from obsolete product which never been sold.

Besides that, there are some classifications about inventory based on the flow of materials:

• **Raw material.** The goods that have not been processed yet.

• **Work-in-process material.** The material which being worked or waiting to be worked.

• **Finished goods.** The finish product that is ready to be sold.

Besides the inventory, classification based on the flow of material, inventory also classified based on the function. There are several classifications below:

• **Anticipation inventory.**
  The stock that stored in order to help level production and to reduce the costs of changing production rates.

• **Fluctuation inventory.**
  Fluctuation inventory or safety stock is the stock of products that stored to cover unpredictable fluctuation in supply and demand. Fluctuation inventory, it also usually called buffer stock, is covering unpredictable fluctuations in supply or demand or lead-time. It prevent from the stock out condition.

• **Lot size inventory.**
  The inventory which purchase or transport in the huge quantity in order to get discount or cost reduction.

• **Transportation inventory.**
  Transportation inventory is the inventory which still on the transportation process from one place to another.
2.2.2 Inventory Cost

The total inventory cost is consist of carrying cost plus with the ordering cost. Minimizing the total cost of inventory is compulsory for every business processing. Since spending the money in inventory means investing a company’s capital cost. Thus if there is a few total of inventory cost means few amount of investment money. There several costs are used in inventory management decisions (Chase Jacobs, 2011):

- **Holding (or Carrying) cost.** This broad category includes the cost for storage facilities, handling, insurance, pilferage, breakage, obsolescence, depreciation, taxes, and the opportunity cost of capital. obviously, high cost tend to favor low inventory levels and frequent replenishment.

- **Setup (or production change) costs.** To make each different product involves obtaining the necessary materials, arranging specific equipment setups, filling out the requirement papers, appropriately charging time and materials, and moving out the previous stock of material. If there were no cost or loss of time in changing from one product to another, many small lots would be produced. This would reduce inventory levels, with a resulting saving in cost. One challenge today is to try to reduce these setup cost to permit smaller lot sizes. (This is the goal of a JIT system.)

- **Ordering Costs.** These cost refer to the managerial and clerical cost to prepare the purchase or production order. Ordering cost include all the detail, such as counting items and calculating order quantities. The costs associated with maintaining the system needed to track order are also included in ordering costs.

- **Shortage costs.** When the stock of an item is depleted, an order for that item must either wait until the stock is replenished or be canceled. There is a trade-off between carrying stock to satisfy demand and the costs resulting from stockout. This balance is sometimes difficult to obtain, because it may not be possible to estimate lost profits, the effects of lost customers, or lateness penalties. Frequently, the assumed shortage cost is little more than a guess, although it is usually possible to specify a range of such costs.
2.2.3 Inventory Management

The objective of inventory management is to increase the profitability of company through improvement in inventory control in order to minimize the total inventory cost. Sipper and Bulfin (1997) determined the steps to manage inventory effectively. The steps are quantity decision and timing decision.

2.2.3.1 Quantity Decision

Quantity decision, also called lot sizing model, is one of the three major decisions related to inventory system. This model is to determine the amount of order and it directly influences the inventory cost. There are two types of Lot sizing models, those are:

- **Static Lot Sizing Models**
  This model is used for constant demand over the time horizon. There are several methods for static lot sizing such as Economic Order Quantity, Economic Production Quantity, and other.

- **Dynamic Lot Sizing Models**
  This model is used for changing demand, lumpy demand, over the time horizon. There are several methods for dynamic lot sizing such as Wagner-Whitin Algorithm, Silver-Meal Algorithm and other.

In order to measure the lumpiness of demand, Peterson and Silver (1979) propose a method called **Peterson-Silver Rule**. The formula is:

\[ V = \frac{n \sum_{t=1}^{n} D_t^2}{(\sum_{t=1}^{n} D_t)^2} - 1 \]  

where:

- \( D_t \) = Demand per period
- \( n \) = Horizon period length

Peterson and Silver determine the condition for lumpiness test:

- If \( V < 0.25 \) then, the demand is not lumpy. Thus, use static lot sizing.
- If \( V \geq 0.25 \) then, the demand is lumpy. Thus, use deterministic lot sizing.
2.2.3.2 Timing Decision
Timing decision, also called fixed order interval system. This model is based on a periodic rather than a continues review of the stock position. Fixed order interval can be used for single or multi item. In retailing and wholesaling, ordering process from the same supplier is ordered jointly. Therefore fixed order interval is one of inventory model for multi item. Economic order is inventory model base on time decision.

- **Economic Order Interval**

  The objective of Economic Order Interval is to determine the optimum order interval in order to minimize the total inventory cost.

  The formula of EOI is:

  \[
  T^* = \frac{2(C + nc)}{\sqrt{F \sum_{i=1}^{n} P_i R_i}}
  \]

  where:

  - \( R_i \) = annual requirement for item \( i \),
  - \( P_i \) = purchase cost of item \( i \),
  - \( n \) = total number of joint order item,
  - \( C \) = order cost for the joint order,
  - \( c \) = order cost associated with each individual item,
  - \( T \) = order interval in years,
  - \( F \) = annual holding cost as a fraction of purchase cost.

  In deterministic situation, there is no difference between the fixed order size system and the fixed order interval. The order quantity for fixed order interval is:

  \[
  Q_i^* = R_i T^*
  \]
where:

\[ Q_i^* = \text{Order quantity for item } i, \]
\[ T^* = \text{Optimum order quantity}. \]

In order to satisfy the customer demand, the maximum inventory for each item must be large enough. Therefore, the maximum number of inventory must be set.

The formula is:

\[ E_i = \frac{R_i(T^* + L)}{N} \]  \hspace{1cm} (2-4)

where:

\[ E_i = \text{maximum inventory for item } i, \]
\[ L = \text{lead time}, \]
\[ N = \text{operating day in year}. \]

Figure 2.1 Fixed Order Interval System
After calculate the fixed order interval, the total inventory cost can be calculate:

\[ \text{Ordering Cost} = \frac{C + nc}{T} \]  \hspace{1cm} (2-5)

\[ \text{Holding Cost} = \frac{TF}{2} \sum_{i=1}^{n} P_i R_i \]  \hspace{1cm} (2-6)

The minimum total inventory cost per year is:

\[ T C (T^*) = \left( \frac{C + nc}{T^*} \right) + \left( \frac{T^* F}{2} \sum_{i=1}^{n} P_i R_i \right) \]  \hspace{1cm} (2-7)

![Figure 2.2 Annual Inventory Costs](image)

2.2 FORECASTING

Forecasting is the prediction, projection or estimation of the occurrences of uncertain future events or level of activity (Tersine, 2000). In today’s market, forecasting is more important ever to predict or estimate future demand. Forecasting is very crucial; it could bring high rewards as well as high penalties. By using personal computer package, forecasting is easier and cheaper than ever, but the understanding of the forecasting principles is still a requirement. After all,
the program would give an answer, even it is bad. For forecasting the future demand, independent demand is needed. In contradiction, the dependent demand, such as components, could not be forecasted since the demand is related to another demand. Thus, in order to calculate the dependent demand, the demand of end item of dependent product (independent demand) should be forecasted.

2.2.1 Designing a Forecasting System

There are some steps in designing forecast system. As the figure 2.2 shows, historical data is not mandatory in qualitative method. Actually, there is no calculation required for determine the future projection in qualitative method but historical data could help the forecaster to determine the forecasting value for the future projection. Section 2.3.2.1 would explain more detail about qualitative method.

Besides that, Quantitative method need historical data because it employs mathematical model for projecting the future value. There are two type of quantitative methods, Causal and Time series. Both of them have the same steps in calculating future value.

In this thesis, time series method would be used as forecasting. First step in calculating forecasting for projecting future value is choosing the right time series method in which suit with the data pattern. After that, calculate the forecast accuracy using Mean Squared Error (see section 2.4.2) and validate the forecast result by using tracking signal (see section 2.4.2). If the result is in control, then the forecast result could be used. If the result is out of control, try the other time series method and repeat the process.

The other way in calculating forecasting is by calculating all of the time series methods. After that, calculate the Mean Squared Error (MSE) for each of the result and choose which one has the smallest result. The method in which has smallest MSE would go to the next step which is validating the forecast using tracking signal. If the tracking signal is in control, thus, that forecasting method is
the best method for that case. If it is not in control, then choose the other method which has smaller MSE. The forecast system can be seen in figure 2.2 below:

![Forecast System Diagram](image-url)

**Figure 2.3 Forecasting System (Sipper and Bulfin, 1997)**
2.2.2 **Forecasting Methodology**

Based on Sipper and Bulfin (1997) the forecasting methodology is classified into two groups, which are:

### 2.2.2.1 Qualitative Methodology

Qualitative methodology relies on human judgment and experiences. Historical demand would not reflect this type of forecasting. In this method, no calculation is required. The examples of qualitative methods are market survey, expert opinion and delphi technique.

- **Market Survey**
  
  Market survey is the collection and analysis of facts related to the information needed to determine the forecasting. Usually the survey is using questionnaire to gather the needed data and then the data is analyzed for forecasting purposes.

- **Expert Opinion**
  
  The forecasting is gain by asking to the expert about their opinion for the future sales. This is based on the experiences and knowledge of the expert for the particular situation. It is usually used in sales and marketing personnel.

- **Delphi Technique**
  
  A more formal variation of expert opinion is called Delphi Technique. In the Delphi technique, the questionnaire is sent to committee members which expert in different field. Each of the members would fill the questionnaire and give the reason of the forecast. The result would be summarized and then the information from the summary would be modified and become the question for the next iteration. This process may go through one or more additional iterations in which model more detailed questions are asked.

### 2.2.2.2 Quantitative Methodology

Quantitative Methodology is a procedure that employs mathematical models to project the future from the past data. Quantitative Methodology is divided into two approaches. These are:
a) **Causal Approach**

Causal Approach is based on the relationship between the dependent variable to be forecasted and an independent variable. There are 3 types of causal approach, these are:

- **Regression**
  A mathematical equation relates a dependent variable to one or more independent variables that are believed to influence the dependent variable

- **Econometric models**
  System of interdependent regression equations that describe some sector of economic activity

- **Input-Output Models**
  Describes the flows from one sector of the economy to another, and so predicts the inputs required to produce outputs in another sector

b) **Time Series Approach**

A time series approach is a sequence of observations data taken at some intervals over a period of time (such as monthly or yearly). By using time series, future values are assumed that it could be predicted from the past values. Analysis of a time series could identify the behavior of the series in term of:

- **Horizontal Pattern**
  In this pattern, the distribution of the data is around the constant average value. There is no neither increasing nor decreasing.

- **Trend Pattern**
  In this pattern, the data fluctuation is increasing or decreasing continuously. The pattern is looks like a straight line with gradient which may be either positive or negative.

- **Seasonal Pattern**
  The data fluctuation of this pattern is affected by seasonal factors such as weather, holiday, Idul Fitri and so on. The data would give the same pattern repeatedly every certain period.
• **Cycles Pattern**
  The pattern of the data fluctuation is influenced by economical fluctuation such as business cycles and economic cycles. It usually happened in a long range.

  **The time series methodologies are divided into:**

  1) **Simple average (SA)**
     Simple average is simply the average of all of previous period’s actual data value. The formula of this methodology is:

     \[
     F_{t+k} = \frac{1}{N} \sum_{n=1}^{N} A_n
     \]

     where:
     \( F_{t+k} \) = forecast for time period \( t+k \),
     \( A_n \) = actual demand with period \( n \),
     \( N \) = number of time periods.

  2) **Moving Average (MA)**
     Moving average is a forecasting methodology where summing up the value of demand in the last period. This methodology used several values from the last period for predicting the demand in the future time. This methodology is suitable for predicting items which has a stable distribution and does not show the special pattern such as trend pattern, cycles, and seasonal.

  • **Simple Moving Average (SMA)**
     While simple average uses data from all of previous period, a moving average forecast uses a number of the most recent actual data values. The formula of this methodology is:

     \[
     F_{t+k} = SMA_n = \frac{1}{n} \sum_{m=0}^{n} A_{t-m}
     \]
where:

\[ F_{t+k} = \text{forecast for time period } t+k, \]
\[ SMA_n = \text{simple moving average with } n \text{ periods}, \]
\[ A_{t-m} = \text{actual demand with period } t-m, \]
\[ n = \text{number of periods in moving average}. \]

- **Weighted moving average (WMA)**

A weighted average is similar to a simple moving average but in weighted moving average, weight could be assigned to the most recent values in time series. The formula of this methodology is:

\[
F_{t+k} = WMA_n = \frac{\sum_{m=0}^{n} \omega_{t-m} \cdot A_{t-m}}{\sum_{m=0}^{n} \omega_{t-m}}
\]

where:

\[ F_{t+k} = \text{forecast for time period } t+k, \]
\[ WMA_n = \text{weighted moving average with } n \text{ periods}, \]
\[ \omega_{t-m} = \text{weight for each period } t-m, \]
\[ A_{t-m} = \text{actual demand with period } t-m, \]
\[ n = \text{number of periods in moving average}. \]

- **Moving Average with Trend (MAT)**

A Moving Average with Trend is similar to a simple moving average as well. In MAT, there is additional component to indicate the growth (trend). MAT uses a number of the most recent actual data values.

3) **Exponential Smoothing**

Exponential smoothing is a procedure for continually revising a forecast. It is exponentially decreasing weights as the actual data gets older. Thus, recent actual data are given more weight than the older
Forecasting with exponential weighting is the simplest of the professional forecasting technique (Wild, 2002).

- **Single Exponential Smoothing (SES)**
  This is also known as simple exponential smoothing. Single exponential smoothing is used for stable fluctuate data (consistent pattern of growth) which do not have trend.

- **Single Exponential Smoothing with Trend (SEST)**
  This method is used when there is a trend in the pattern. SEST works like single exponential smoothing with trend component which might be updated each period. The trend is a smoothed of average growth for each period.

- **Double Exponential Smoothing (DES)**
  This method is similar with single exponential smoothing. The similarity is both of this method is used for stable fluctuate data (consistent pattern of growth) which do not have trend but DES uses double smoothing.

- **Double Exponential Smoothing with Trend (DEST)**
  This method is used when there is a trend in the pattern. DEST works like double exponential smoothing with trend component which might be updated each period. The trend is a smoothed of average growth for each period.

4) **Linear Regression (LR)**
In this method, actual data randomly fluctuated around a linear pattern with a certain gradient where it is called a linear equation. Linear regression is the simplest technique of regression because this method only has correlation with two variables. The independent variable
would impact the dependent variable. This methodology is used in forecasting for long term or short term planning.

5) **Triple Exponential Smoothing**
This method is used when trend and seasonality appeared in the data pattern. To handle seasonality, third parameter should be added. The set of equations is called the “Holt-Winter” (HW) method. Kalekar (2004) explain in his journal that triple exponential smoothing is divided into two main HW methods, depending on the type of seasonality. The methods are:

- **Holt-Winter Additive Algorithm (HWA)**
  In this HW type model, the seasonality is expressed as a quantity. It would be added or subtracted from the series average in order to incorporate seasonality.

- **Holt-Winter Multiplicative Algorithm (HWM)**
  In this HW type model, the seasonality is expressed as a percentage of average amounts. It would be multiplied by the value of series in order to incorporate seasonality.

### 2.2.3 Forecast Control
The forecasting system needs feedback to ensure the best results. Forecasts could go out of control for some reason. Therefore, it needs forecast control for monitoring the forecast so that the forecast would accurate and statistically in control.

#### 2.2.3.1 Accuracy Measurement in Forecasting
It is nearly impossible to forecast the future values correctly in this complex nature of the real world. Inadequate forecasting method or improperly forecasting technique may cause error between the forecasting value and the
real value happened in the future. Measuring forecast accuracy could influence the selection among the forecasting method.

Two aspects of forecast accuracy have potential to influence the selection of forecast method are:

- To shows historical error performance of a forecast method.
- To shows the ability of a forecast method to respond to changes.

There are three forecast accuracy methodologies which commonly used to measure historical error:

- **Mean Absolute Deviation (MAD)**
  MAD places equal weight on all errors. The lower value of MAD, the more accurate the forecast. The formula is:
  
  \[
  MAD = \frac{\sum |Actual - Forecast|}{n}
  \]  
  (2-11)

- **Mean Square Error (MSE)**
  MSE is average quadratic of forecast error. The formula is:
  
  \[
  MSE = \frac{\sum (Actual - Forecast)^2}{n}
  \]  
  (2-12)

- **Mean Absolute Percent Error (MAPE)**
  MAPE measures the absolute error as a percentage of actual value rather than per period. It avoids the problem of interpreting the measure of accuracy relative to the magnitudes of the actual and the forecast value. The formula is:
  
  \[
  MAPE = \frac{\sum |Actual - Forecast|}{\sum Actual} \times 100%
  \]  
  (2-13)
2.2.3.2 Tracking Signal

Tracking signal measures whether the forecast is statistically in control in actual value. A tracking signal is computed for each period, with cumulative forecast error (CFE) divided by MAD.

\[
Tracking \ Signal = \frac{\sum \text{(Actual} - \text{Forecast})}{MAD}
\]  

(2-14)

Positive tracking signal shows that the actual value is greater than forecast value, and the other side, negative tracking signal shows that the actual value less than forecast value. A tracking signal called good tracking signal if have low CFE and a balance number of positive and negative tracking signal. Tracking signal is called in control if the tracking signal have value within ±4 which corresponds roughly to three standard deviation.
CHAPTER III
RESEARCH METHODOLOGY

This chapter showed the steps that the author did in making this research, as it illustrated in Figure 3.1. Furthermore, this following section will give more explanation of each step and methodology of this research.

**Initial Observation:**
- Interview
- Direct observation
- Data Collection

**Problem Identification:**
- Identify current problem.
- Define the objective, scope and assumption of this research.

**Literature Study:**
- Inventory Management
- Economic Order Interval for multi item
- Forecasting (Time Series, Measurement accuracy)

**Data Collection:**
- Historical data (Product demand)
- Product Composition
- Related Cost (Purchase, Ordering, Holding Cost)
- Direct Observation (Ordering Material process,)

**Data Calculation and Analysis:**
1. **Data Calculation**
   - Current inventory cost calculation
   - Aggregate of raw material calculation
   - Economic Order Interval using current data.
   - Total Cost calculation for proposed system.
   - Forecasting calculation
   - Total cost calculation for future planning.

---

*Figure 3.1 Research Framework*
3.1 Initial Observation

The first step of this research is initial observation. The purpose of initial observation is to gather information about the current condition happened in company. Firstly, the author did observation in the area that will be focusing in this research. After determine the area that will be focused in this research, then observation and direct interview technique is used to gather the information and data needed. The direct interview with the supervisor and some staff needed to get more information.

3.2 Problem Identification

The next step is identifying the problem. After gathering the information and data needed during the initial observation, the author found that the number of order occurrence between one and another product was different. The ordering process could not do in joint order. Therefore, the ordering cost is high. As the result, the total inventory cost is increasing as explained in Chapter I. According from the observation, it found that PT. X does not use any inventory management method in determining the order interval. The order interval decision based on management opinion. The order interval between one and another product is different. Thus, the ordering process cannot do in joint order. This situation may cause to increasing the total inventory cost. If this problem does not solve, it can make the company may suffer on loss. Therefore, the author tries to implement Economic Order Interval to reduce total inventory cost.
3.3 Literature Study
After the problem has been identifying, the next step is conducting a literature studies. The objective of literature study is to obtain relevant references, theories and concepts that related to this research. These activities will give understanding and give the guidance for author to solve the problems found in this research as explained in Chapter II. The references are:

- **Inventory Management**
  Economic Order Interval is one of inventory management base on timing decision. The objective of Economic Order Interval is to determine the optimum order interval in order to minimize the total inventory cost. Besides that, the advantage of Economic Order Interval is the ordering process can order jointly.

- **Forecasting**
  Forecasting is important to predict or estimate future demand. The forecasting system needs feedback to ensure the best results. Forecasts control used to monitoring the forecast so that the forecast would accurate and statistically in control.

3.4 Data Collection
The next step is collecting necessary data for this research. The historical taken from January 2012 until December 2012. There are:

- **Products Demand**
  Products demand data is the data about the customer demand that gather monthly.

- **Product Composition**
  Product composition data used as the information about the raw material needed to produce the finishing products.

- **Ordering Cost**
  Ordering Cost is the cost for order the raw materials per order per item.

- **Holding Cost**
  Holding cost is cost for holding the materials time.
3.5 Data Calculation and Problem Analysis

After gathering supporting data that needed in this research, the next following step is calculating the data. Several steps used in data calculation, there are:

- Calculating the aggregate of raw material using demand data.
- Calculating current total inventory cost (ordering cost and holding cost).
- Measuring the demand pattern lumpiness using Peterson-Silver Rule.
- Applying Economic Order Interval as inventory management system to determine optimum order interval.
- Calculating the optimum order interval using Economic Order Interval.
- Calculating the order quantity and maximum inventory for each item.
- Calculating the total inventory cost using proposed method.
- Comparing the total inventory cost of current and proposed method.
- Plotting the demand data to know the demand pattern.
- Forecasting the current demand for future planning.
- Calculating the aggregate of raw material for future planning.
- Calculating total inventory cost for the future planning.
- Analyzing the problem, current and proposed system.

![Figure 3.2 Data Calculation Flow Chart](image-url)
Developing forecast (plotting data and chose the method base on date pattern)

Choosing the smallest Mean Square Error (MSE)

Validation using Tracking Signal

Calculating the aggregate of raw material for future plan

Calculating the order interval using EOI for future planning

Calculate the total inventory cost for future planning

Finish

Figure 3.2 Data Calculation Flow Chart (Count.)
3.6 Conclusion and Recommendation

The final step will be discuss about conclusion and recommendation. The conclusion will answer the problem statement and show how far the proposed system will reduce the total cost of inventory rather than the current situation. Furthermore, the recommendations will give suggestion in order to run the purposed method smoothly and give encourage the company and other researcher to conduct other researches in order to make better improvement in inventory management and other sector.
CHAPTER IV
DATA CALCULATION AND ANALYSIS

4.1 INITIAL OBSERVATION
4.1.1 Problem Overview
PT. X is one of developing companies in chemical industry. PT. X produces chemical products for textile industry. As explained in the previous section, the number of order occurrence between one and another product is different; as a result, the order cannot be done jointly. It happens because PT. X does not use any inventory management method in determining the order interval. The order interval decision is based on management opinion. Therefore, the ordering cost is high, as shown in figure 4.1. In the end, the total inventory cost is increasing.

![Figure 4.1 Actual Total Inventory Cost](image)

Inappropriate order frequency may cause the increase of inventory cost. Thus, calculating appropriate inventory management could reduce the total inventory cost.
4.12 Products Overview

Finishing product is used for the final step process in textile industry. It is used to reduce the friction of fiber metal and make the fabric become smooth. The company has seven finishing products that is categorized into Silicone softener, Organic softener and Filler as shown in figure 4.2.

Table 4.1 Raw Material of Finishing Product

<table>
<thead>
<tr>
<th>No.</th>
<th>Raw Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RMN006</td>
</tr>
<tr>
<td>2</td>
<td>RMF001</td>
</tr>
<tr>
<td>3</td>
<td>RMF003</td>
</tr>
<tr>
<td>4</td>
<td>RMF005</td>
</tr>
<tr>
<td>5</td>
<td>RMS002</td>
</tr>
<tr>
<td>6</td>
<td>RMS25E</td>
</tr>
<tr>
<td>7</td>
<td>RME005</td>
</tr>
<tr>
<td>8</td>
<td>RML019</td>
</tr>
<tr>
<td>9</td>
<td>RMF06S</td>
</tr>
<tr>
<td>10</td>
<td>RMA001</td>
</tr>
</tbody>
</table>

Raw material is a major need for manufacturing company. In order to manufacture the products above, some of raw materials are needed as shown in table 4.1 above.
4.1.3 Inventory Cost Data

Total inventory cost is the sum of ordering cost and holding cost. In this section, the total inventory cost will be explained.

1. Ordering Cost

Ordering cost is the expenses for processing an order from supplier. In PT. X, there are two kinds of ordering cost, which are:

- Ordering cost associated with each individual item, which consists of:
  - Shipping: 100,000
  - Receiving: 25,000
  - Communication: 20,000
  - Administration: 5,000
  - Total ordering cost per item per order is IDR 150,000.

- Ordering cost for joint order is IDR 500,000.
  This cost incurred due to the certain amount of two or more items where the cost of ordering single item cannot be logically used for multi item. The cost for joint order covers documents such as invoice, bill of landing, insurance certificate, and inspection certificate.

2. Holding Cost

Holding cost is the cost to hold the goods for a certain time. It consists of:

- Warehouse Expense, 3% of purchasing cost
- Cost of capital, 6% of purchasing cost
- Tax and Insurance, 6% of purchasing cost.
- Damage and Obsolescence, 5% of purchase cost.

The total holding cost is 20% of purchasing material per year.

4.1.4 Demand Data

In this research, finishing products demand data is gathered from January 2012 to December 2012. The finishing products consist of Silofin Hals-B, Silofin Ham, Silofin AM25E, Finisoft RWT Pasta, Finisoft NIT, Lubric WE, and Fillant SH. The products demand can be seen in Table 4.2.
Table 4.2 Products Current Demand from January to December 2012

<table>
<thead>
<tr>
<th>Month</th>
<th>Silicone Softener</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Silofin Hals-B</td>
<td>Silofin Ham</td>
<td>Silofin AM25E</td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td>1,240.00</td>
<td>1,030.00</td>
<td>5,950.00</td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>1,850.00</td>
<td>1,540.00</td>
<td>6,650.00</td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td>1,050.00</td>
<td>880.00</td>
<td>6,350.00</td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>1,750.00</td>
<td>1,460.00</td>
<td>7,100.00</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>920.00</td>
<td>730.00</td>
<td>7,520.00</td>
<td></td>
</tr>
<tr>
<td>Jun</td>
<td>1,650.00</td>
<td>1,380.00</td>
<td>6,850.00</td>
<td></td>
</tr>
<tr>
<td>Jul</td>
<td>1,100.00</td>
<td>920.00</td>
<td>7,150.00</td>
<td></td>
</tr>
<tr>
<td>Aug</td>
<td>2,230.00</td>
<td>1,520.00</td>
<td>6,350.00</td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td>1,100.00</td>
<td>1,250.00</td>
<td>6,750.00</td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td>1,520.00</td>
<td>890.00</td>
<td>5,850.00</td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td>900.00</td>
<td>1,350.00</td>
<td>7,450.00</td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td>1,300.00</td>
<td>920.00</td>
<td>7,150.00</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>16,610.00</td>
<td>13,870.00</td>
<td>81,120.00</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2 Products Current Demand from January to December 2012 (Count.)

<table>
<thead>
<tr>
<th>Month</th>
<th>Organic Softener</th>
<th>Filler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Finisoft RWT Pasta</td>
<td>Finisoft NIT</td>
</tr>
<tr>
<td></td>
<td>17,450.00</td>
<td>11,250.00</td>
</tr>
<tr>
<td>Jan</td>
<td>12,400.00</td>
<td>9,860.00</td>
</tr>
<tr>
<td>Feb</td>
<td>16,700.00</td>
<td>12,450.00</td>
</tr>
<tr>
<td>Mar</td>
<td>20,510.00</td>
<td>10,200.00</td>
</tr>
<tr>
<td>Apr</td>
<td>14,820.00</td>
<td>13,200.00</td>
</tr>
<tr>
<td>May</td>
<td>18,670.00</td>
<td>10,200.00</td>
</tr>
<tr>
<td>Jun</td>
<td>15,420.00</td>
<td>11,530.00</td>
</tr>
<tr>
<td>Jul</td>
<td>17,250.00</td>
<td>9,250.00</td>
</tr>
<tr>
<td>Aug</td>
<td>19,750.00</td>
<td>12,050.00</td>
</tr>
<tr>
<td>Sep</td>
<td>12,650.00</td>
<td>10,100.00</td>
</tr>
<tr>
<td>Oct</td>
<td>16,800.00</td>
<td>8,340.00</td>
</tr>
<tr>
<td>Nov</td>
<td>18,520.00</td>
<td>12,300.00</td>
</tr>
<tr>
<td>Dec</td>
<td>200,940.00</td>
<td>130,730.00</td>
</tr>
</tbody>
</table>

From the product demand data, the raw materials needs can be determined. The calculation for raw materials needs will be explained in the next sub chapter.
4.1.5 Product Composition

The raw materials needs can be calculated using product composition. The product composition is shown in figure 4.3.

Table 4.3 Composition of Each Product

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Silofin Hals-B</th>
<th>Silofin Ham</th>
<th>Silofin AM25E</th>
<th>Finisoft RWT</th>
<th>Finisoft NIT</th>
<th>Lubric WE</th>
<th>Fillant SH</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMN006</td>
<td>20%</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMF001</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>15%</td>
<td>10%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>RMF003</td>
<td>10%</td>
<td>5%</td>
<td>5%</td>
<td>15%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>RMF005</td>
<td></td>
<td>30%</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMS002</td>
<td></td>
<td></td>
<td>30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMS25E</td>
<td></td>
<td></td>
<td>30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RME005</td>
<td></td>
<td></td>
<td></td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RML019</td>
<td></td>
<td></td>
<td></td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMF06S</td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMA001</td>
<td>60%</td>
<td>60%</td>
<td>55%</td>
<td>40%</td>
<td>60%</td>
<td>55%</td>
<td>45%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

From the data above, the raw materials needs can be determined. The calculation of RMN006 for Silofin Hals-B in January is:

\[ R = 1,240.00 \times 0.2 \]

\[ R = 248.00 \text{ Kg} \]

RMN006 demand for Silofin Hals-B in January is 248.00 Kg.

Table 4.4 Current Raw Material Needs of Silofin Hals-B

<table>
<thead>
<tr>
<th>Month</th>
<th>Silofin Hals-B (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RMN006</td>
</tr>
<tr>
<td>JAN</td>
<td>248.00</td>
</tr>
<tr>
<td>FEB</td>
<td>370.00</td>
</tr>
<tr>
<td>MAR</td>
<td>210.00</td>
</tr>
<tr>
<td>APR</td>
<td>350.00</td>
</tr>
<tr>
<td>MAY</td>
<td>184.00</td>
</tr>
<tr>
<td>JUN</td>
<td>330.00</td>
</tr>
<tr>
<td>JUL</td>
<td>220.00</td>
</tr>
<tr>
<td>AUG</td>
<td>446.00</td>
</tr>
<tr>
<td>SEP</td>
<td>220.00</td>
</tr>
<tr>
<td>OCT</td>
<td>304.00</td>
</tr>
<tr>
<td>NOV</td>
<td>180.00</td>
</tr>
<tr>
<td>Dec</td>
<td>260.00</td>
</tr>
</tbody>
</table>

The Silofin Hals-B raw materials needs can be seen in table 4.4. Other products calculation can be seen in appendix 2.
The next step is calculating the aggregate of raw materials needs. The summary of raw materials needs for current condition can be seen in Table 4.5.

**Table 4.5 Aggregate of Raw Material Needs**

<table>
<thead>
<tr>
<th>Month</th>
<th>RMN006</th>
<th>RMF001</th>
<th>RMF003</th>
<th>RMF005</th>
<th>RMS002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>505.50</td>
<td>5,249.50</td>
<td>5,013.00</td>
<td>8,047.50</td>
<td>2,055.00</td>
</tr>
<tr>
<td>Feb</td>
<td>755.00</td>
<td>4,628.00</td>
<td>4,204.00</td>
<td>6,185.00</td>
<td>2,334.00</td>
</tr>
<tr>
<td>Mar</td>
<td>430.00</td>
<td>5,235.00</td>
<td>5,029.50</td>
<td>8,122.50</td>
<td>1,971.00</td>
</tr>
<tr>
<td>Apr</td>
<td>715.00</td>
<td>5,892.50</td>
<td>5,490.00</td>
<td>8,703.00</td>
<td>2,295.00</td>
</tr>
<tr>
<td>May</td>
<td>366.50</td>
<td>5,092.00</td>
<td>4,555.00</td>
<td>7,746.00</td>
<td>1,896.00</td>
</tr>
<tr>
<td>Jun</td>
<td>675.00</td>
<td>5,556.50</td>
<td>5,418.50</td>
<td>8,151.00</td>
<td>2,244.00</td>
</tr>
<tr>
<td>Jul</td>
<td>450.00</td>
<td>5,048.00</td>
<td>4,538.00</td>
<td>7,508.50</td>
<td>1,995.00</td>
</tr>
<tr>
<td>Aug</td>
<td>826.00</td>
<td>5,384.50</td>
<td>5,103.50</td>
<td>7,487.50</td>
<td>2,586.00</td>
</tr>
<tr>
<td>Sep</td>
<td>532.50</td>
<td>5,702.50</td>
<td>5,180.00</td>
<td>8,937.50</td>
<td>1,875.00</td>
</tr>
<tr>
<td>Oct</td>
<td>526.50</td>
<td>4,438.50</td>
<td>4,349.00</td>
<td>6,320.00</td>
<td>2,115.00</td>
</tr>
<tr>
<td>Nov</td>
<td>517.50</td>
<td>4,979.00</td>
<td>4,612.00</td>
<td>7,125.00</td>
<td>1,965.00</td>
</tr>
<tr>
<td>Dec</td>
<td>490.00</td>
<td>5,630.00</td>
<td>5,236.50</td>
<td>8,631.00</td>
<td>2,055.00</td>
</tr>
<tr>
<td>Total</td>
<td>6,789.50</td>
<td>62,836.00</td>
<td>58,729.00</td>
<td>92,964.50</td>
<td>25,386.00</td>
</tr>
</tbody>
</table>

**Table 4.5 Aggregate of Raw Material Needs (Count.)**

<table>
<thead>
<tr>
<th>Month</th>
<th>RMS25E</th>
<th>RME005</th>
<th>RML019</th>
<th>RMF065</th>
<th>RMA001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>1,785.00</td>
<td>5,087.50</td>
<td>3,052.50</td>
<td>2,035.00</td>
<td>31,289.50</td>
</tr>
<tr>
<td>Feb</td>
<td>1,995.00</td>
<td>4,337.50</td>
<td>2,602.50</td>
<td>1,735.00</td>
<td>28,654.00</td>
</tr>
<tr>
<td>Mar</td>
<td>1,905.00</td>
<td>5,535.00</td>
<td>3,321.00</td>
<td>2,214.00</td>
<td>32,377.00</td>
</tr>
<tr>
<td>Apr</td>
<td>2,130.00</td>
<td>4,590.00</td>
<td>2,754.00</td>
<td>1,836.00</td>
<td>32,624.50</td>
</tr>
<tr>
<td>May</td>
<td>2,256.00</td>
<td>4,257.50</td>
<td>2,554.50</td>
<td>1,703.00</td>
<td>30,113.50</td>
</tr>
<tr>
<td>Jun</td>
<td>2,055.00</td>
<td>5,787.50</td>
<td>3,472.50</td>
<td>2,315.00</td>
<td>33,705.00</td>
</tr>
<tr>
<td>Jul</td>
<td>2,145.00</td>
<td>4,012.50</td>
<td>2,407.50</td>
<td>1,605.00</td>
<td>29,110.50</td>
</tr>
<tr>
<td>Aug</td>
<td>1,905.00</td>
<td>5,030.00</td>
<td>3,018.00</td>
<td>2,012.00</td>
<td>31,987.50</td>
</tr>
<tr>
<td>Sep</td>
<td>2,025.00</td>
<td>3,962.50</td>
<td>2,377.50</td>
<td>1,585.00</td>
<td>30,822.50</td>
</tr>
<tr>
<td>Oct</td>
<td>1,755.00</td>
<td>5,525.00</td>
<td>3,315.00</td>
<td>2,210.00</td>
<td>29,606.00</td>
</tr>
<tr>
<td>Nov</td>
<td>2,235.00</td>
<td>4,087.50</td>
<td>2,452.50</td>
<td>1,635.00</td>
<td>28,131.50</td>
</tr>
<tr>
<td>Dec</td>
<td>2,145.00</td>
<td>4,837.50</td>
<td>2,902.50</td>
<td>1,935.00</td>
<td>32,527.50</td>
</tr>
<tr>
<td>Total</td>
<td>24,336.00</td>
<td>57,050.00</td>
<td>34,230.00</td>
<td>22,820.00</td>
<td>370,949.00</td>
</tr>
</tbody>
</table>

The data show the aggregate of raw materials demand from January to December 2012 in order to fulfil customer demand. These data are used to calculate the total inventory cost in the next sub chapter.
4.1.6 Current Total Inventory Cost for Current Demand

The current total cost will be used as a parameter for the proposed inventory model. By using the data from company, the author can find the current total cost of inventory as explained in Table 4.6.

<table>
<thead>
<tr>
<th>Item</th>
<th>Demand in year</th>
<th>Order Occurance (Time)</th>
<th>Ordering Cost (IDR)</th>
<th>Holding Cost (IDR)</th>
<th>Total Cost (IDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMN006</td>
<td>6,789.50</td>
<td>12</td>
<td>1,800,000.00</td>
<td>212,171.88</td>
<td>2,012,171.88</td>
</tr>
<tr>
<td>RMF001</td>
<td>62,836.00</td>
<td>21</td>
<td>3,150,000.00</td>
<td>1,346,485.71</td>
<td>4,496,485.71</td>
</tr>
<tr>
<td>RMF003</td>
<td>58,729.00</td>
<td>36</td>
<td>5,400,000.00</td>
<td>938,032.64</td>
<td>6,338,032.64</td>
</tr>
<tr>
<td>RMF005</td>
<td>92,964.50</td>
<td>24</td>
<td>3,600,000.00</td>
<td>2,517,788.54</td>
<td>6,117,788.54</td>
</tr>
<tr>
<td>RMS002</td>
<td>25,386.00</td>
<td>16</td>
<td>2,400,000.00</td>
<td>1,427,962.50</td>
<td>3,827,962.50</td>
</tr>
<tr>
<td>RMS25E</td>
<td>24,336.00</td>
<td>33</td>
<td>4,950,000.00</td>
<td>811,200.00</td>
<td>5,761,200.00</td>
</tr>
<tr>
<td>RME005</td>
<td>57,050.00</td>
<td>64</td>
<td>9,600,000.00</td>
<td>579,414.06</td>
<td>10,179,414.06</td>
</tr>
<tr>
<td>RML019</td>
<td>34,230.00</td>
<td>30</td>
<td>4,500,000.00</td>
<td>1,540,350.00</td>
<td>6,040,350.00</td>
</tr>
<tr>
<td>RMF06S</td>
<td>22,820.00</td>
<td>58</td>
<td>8,700,000.00</td>
<td>590,172.41</td>
<td>9,290,172.41</td>
</tr>
<tr>
<td>RMA001</td>
<td>370,949.00</td>
<td>72</td>
<td>10,800,000.00</td>
<td>437,925.90</td>
<td>11,237,925.90</td>
</tr>
</tbody>
</table>

| Total  | 65,301,503.65 |

The total inventory cost for current condition is IDR 65,301,503.65.

4.2 PROPOSED INVENTORY MANAGEMENT CALCULATION

4.2.1 Demand Pattern Lumpiness

Before determining the proposed inventory management, the demand pattern needs to be determined whether it is static or dynamic by using Peterson-Silver Rule. The formula is (2-1).

Below is the Silofin Hals-B calculation to measure the lumpiness of demand pattern by using Peterson-Silver Rule:

\[ V_1 = \left( \frac{12 \left( (1,240.00)^2 + (1,850.00)^2 + \cdots + (1,300.00)^2 \right)}{(1,240.00 + 1,850.00 + \cdots + 1,300.00)^2} \right) - 1 \]

\[ = 1.08 - 1 \]

\[ V_1 = 0.08 \]
The detailed calculation of Peterson Silver Rule can be seen in appendix 4.

Table 4.7 Demand Pattern Lumpiness using Peterson-Silver Rule

<table>
<thead>
<tr>
<th>No.</th>
<th>Product</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Silofin Hals B</td>
<td>0.08</td>
</tr>
<tr>
<td>2.</td>
<td>Silofin Ham</td>
<td>0.06</td>
</tr>
<tr>
<td>3.</td>
<td>Silofin AM25E</td>
<td>0.01</td>
</tr>
<tr>
<td>4.</td>
<td>Finisoft RWT Pasta</td>
<td>0.02</td>
</tr>
<tr>
<td>5.</td>
<td>Finisoft NIT</td>
<td>0.02</td>
</tr>
<tr>
<td>6.</td>
<td>Lubric WE</td>
<td>0.01</td>
</tr>
<tr>
<td>7.</td>
<td>Fillant SH</td>
<td>0.02</td>
</tr>
</tbody>
</table>

From table 4.7 above, it can be concluded that the demand pattern (V) is static because the value of V is less than 0.25.

As stated in the previous section, the number of order occurrence between one and another product is different so the ordering process cannot be done jointly. It can be concluded that the order interval is not optimum. The Economic Order Interval has the objective to minimize total inventory cost by determining the optimum order interval. Besides that, it can be used for multi item since the order interval is fixed. Therefore, Economic Order Interval system will be used in this research.

4.2.2 Economic Order Interval for Current Condition

Before calculating the total inventory cost, fixed order interval should be determined. By using the formula in (2-2), Economic Order Interval for the current situation is:

\[ T^* = \sqrt{\frac{2 (500,000 + (10 \times 150,000))}{0.2 (3,236,890,055.00)}} \]

\[ = 0.08 \text{ year} \]

\[ T^* = 0.96 \approx 1 \text{ month} \]

From the calculation above, the optimum order interval is 12 times or once a month.
In deterministic situation, there is no difference between the fixed order size system and the fixed order interval. By using formula in (2-3), the RMN006 order quantity for fixed order interval is:

\[ Q_i^* = 6,789.50 \left( \frac{1}{12} \right) \]
\[ Q_i^* = 565.79 \text{ Kg} \]

The order quantity of RMN006 is 565.79 Kg/ Month. The summary of order quantity for each item is listed in table 4.8.

The maximum inventory for each item must be large enough to satisfy demand during the lead time (L), which is known to be one month. By using formula in (2-4), the maximum inventory for RMN006 is:

\[ E_i = \frac{6,789.50 \cdot (1 + 1)}{12} \]
\[ E_i = 1,131.58 \text{ Kg} \]

The Maximum Inventory for RMN006 is 1,131.58 Kg. The summary of maximum inventory for each item is listed in table 4.8.

<table>
<thead>
<tr>
<th>Item</th>
<th>( Q_i^* ) (Kg)</th>
<th>( E_i ) (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMN006</td>
<td>565.79</td>
<td>1,131.58</td>
</tr>
<tr>
<td>RMF001</td>
<td>5,236.33</td>
<td>10,472.67</td>
</tr>
<tr>
<td>RMF003</td>
<td>4,894.08</td>
<td>9,788.17</td>
</tr>
<tr>
<td>RMF005</td>
<td>7,747.04</td>
<td>15,494.08</td>
</tr>
<tr>
<td>RMS002</td>
<td>2,115.50</td>
<td>4,231.00</td>
</tr>
<tr>
<td>RMS25E</td>
<td>2,028.00</td>
<td>4,056.00</td>
</tr>
<tr>
<td>RME005</td>
<td>4,754.17</td>
<td>9,508.33</td>
</tr>
<tr>
<td>RML019</td>
<td>2,852.50</td>
<td>5,705.00</td>
</tr>
<tr>
<td>RMF06S</td>
<td>1,901.67</td>
<td>3,803.33</td>
</tr>
<tr>
<td>RMA001</td>
<td>30,912.42</td>
<td>61,824.83</td>
</tr>
</tbody>
</table>

The next subchapter will show the detail calculation of the proposed total inventory cost.
4.2.3 Proposed Total Inventory Cost for Current Demand

After calculating the optimum order interval, the result is used to calculate the proposed total inventory cost. Since the order interval between one and another item is the same, the materials are ordered jointly. The detailed calculation can be seen in table 4.9.

<table>
<thead>
<tr>
<th>Item</th>
<th>Demand in year</th>
<th>Order Occurance (Time)</th>
<th>Ordering Cost (IDR)</th>
<th>Holding Cost (IDR)</th>
<th>Total Cost (IDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>$R_i$</td>
<td>(T)</td>
<td>(n.c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMN006</td>
<td>6,789.50</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>212,171.88</td>
<td>2,012,171.88</td>
</tr>
<tr>
<td>RMF001</td>
<td>62,836.00</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>2,356,350.00</td>
<td>4,156,350.00</td>
</tr>
<tr>
<td>RMF003</td>
<td>58,729.00</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>2,814,097.92</td>
<td>4,614,097.92</td>
</tr>
<tr>
<td>RMF005</td>
<td>92,964.50</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>5,035,577.08</td>
<td>6,835,577.08</td>
</tr>
<tr>
<td>RMS002</td>
<td>25,386.00</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>1,903,950.00</td>
<td>3,703,950.00</td>
</tr>
<tr>
<td>RMS25E</td>
<td>24,336.00</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>2,230,800.00</td>
<td>4,030,800.00</td>
</tr>
<tr>
<td>RME005</td>
<td>57,050.00</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>3,090,208.33</td>
<td>4,890,208.33</td>
</tr>
<tr>
<td>RML019</td>
<td>34,230.00</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>3,850,875.00</td>
<td>5,650,875.00</td>
</tr>
<tr>
<td>RMF06S</td>
<td>22,820.00</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>2,852,500.00</td>
<td>4,652,500.00</td>
</tr>
<tr>
<td>RMA001</td>
<td>370,949.00</td>
<td>12.00</td>
<td>1,800,000.00</td>
<td>2,627,555.42</td>
<td>4,427,555.42</td>
</tr>
<tr>
<td>Cost for Join Order</td>
<td>12.00</td>
<td>6,000,000.00</td>
<td></td>
<td></td>
<td>6,000,000.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50,974,085.63</td>
</tr>
</tbody>
</table>

From the Table 4.9, the total inventory cost for proposed inventory model is IDR 50,974,085.63

4.2.4 Total Inventory Cost Comparison

In this section, the current total inventory cost will be compared with the proposed inventory cost. The proposed inventory cost should have the lower cost than the current cost. The detailed comparison can be seen in table 4.10.
Table 4.10 Total Inventory Cost Comparison of Current and Proposed system

<table>
<thead>
<tr>
<th></th>
<th>Current system</th>
<th>Proposed system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordering Cost (IDR)</td>
<td>Rp 54,900,000.00</td>
<td>Rp 24,000,000.00</td>
</tr>
<tr>
<td>Holding Cost (IDR)</td>
<td>Rp 10,401,503.65</td>
<td>Rp 26,974,085.63</td>
</tr>
<tr>
<td>Total (IDR)</td>
<td>Rp 65,301,503.65</td>
<td>Rp 50,974,085.63</td>
</tr>
</tbody>
</table>

Percentage 21.94%

The table 4.10 concludes that the proposed inventory model is better than the current model. Economic Order Interval succeeds in reducing the total inventory cost by determining the optimum order interval, so the raw material can be ordered jointly. Furthermore, by using proposed system, the company could save IDR 14,327,418.02 or save more than 21% of the cost. It can be seen in figure 4.3.

Figure 4.3 Total Inventory Cost Comparison of current and proposed system.

4.2.5 Future Planning

4.2.5.1 Forecasting Calculation

Before making forecasting calculation for the future planning, the data pattern needs to be determined. Data pattern is used to classify the forecast technique. The monthly product demand will be used to make data plotting. Silofin Hals-B data plotting is showed in figure 4.4.
Figure 4.4 Silofin Hals-B Data Plotting

Other products data plotting can be seen in appendix 5.

<table>
<thead>
<tr>
<th>Item</th>
<th>Data pattern</th>
<th>Data plotting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silofin Hals-B</td>
<td>Static</td>
<td>Horizontal Dynamic</td>
</tr>
<tr>
<td>Silofin Ham</td>
<td>Static</td>
<td>Horizontal Dynamic</td>
</tr>
<tr>
<td>Silofin AM25E</td>
<td>Static</td>
<td>Horizontal Dynamic</td>
</tr>
<tr>
<td>Finisoft RWT Pasta</td>
<td>Static</td>
<td>Horizontal Dynamic</td>
</tr>
<tr>
<td>Finisoft NIT</td>
<td>Static</td>
<td>Horizontal Dynamic</td>
</tr>
<tr>
<td>Lubric WE</td>
<td>Static</td>
<td>Horizontal Dynamic</td>
</tr>
<tr>
<td>Fillant SH</td>
<td>Static</td>
<td>Horizontal Dynamic</td>
</tr>
</tbody>
</table>

From the data plotting and Peterson-Silver rule calculation above, it can be concluded that the data patterns are static and horizontal dynamic as shown in Table 4.11. Since the data patterns are static and horizontal dynamic, the forecast methods are:

1. Simple Average
2. Moving Average with $N=2$ and $N=4$
3. Weight Moving Average with $N=2$ and $N=4$

In this research, WinQSB is used as forecasting software. The forecasting calculation of finishing products can be seen in appendix 6 until appendix 12.
The forecast result of Silofin Hals-B can be seen in table 4.12 below:

**Table 4.12 Forecast Result for Silofin Hals-B**

<table>
<thead>
<tr>
<th>Silofin Hals-B</th>
<th>SA</th>
<th>2-MA</th>
<th>4-MA</th>
<th>2-WMA</th>
<th>4-WMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAD</td>
<td>416.74</td>
<td>384.00</td>
<td>378.44</td>
<td>436.60</td>
<td>422.88</td>
</tr>
<tr>
<td>MSE</td>
<td>221,256.40</td>
<td>194,635.00</td>
<td>212,585.20</td>
<td>249,722.00</td>
<td>261,233.90</td>
</tr>
<tr>
<td>MAPE</td>
<td>32.06</td>
<td>30.41</td>
<td>30.86</td>
<td>34.85</td>
<td>34.34</td>
</tr>
<tr>
<td>Trk.Signal</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Chosen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the forecast calculation, tracking signal is used as forecast method validation. Then, the valid forecast method that has the smallest value of MSE will be chosen as the best forecast method. From table 4.12, the used forecast methods for Silofin Hals-B is valid. Then, the value of MSE from SA, 2-MA, 4-MA, 2-WMA and 4-WMA are compared. The value of 2-MA is the smallest one. The best forecast method for Silofin Hals-B is 2-MA. The other product forecast result can be seen in appendix 13.

The Summary of best forecast method for each product can be seen in table 4.13.

**Table 4.13 Best Forecast Methods for Each Product**

<table>
<thead>
<tr>
<th>Product</th>
<th>Forecast Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silofin Hals-B</td>
<td>2-MA</td>
</tr>
<tr>
<td>Silofin Ham</td>
<td>4-MA</td>
</tr>
<tr>
<td>Silofin AM25E</td>
<td>2-MA</td>
</tr>
<tr>
<td>Finisoft RWT</td>
<td>4-MA</td>
</tr>
<tr>
<td>Finisoft NIT</td>
<td>SA</td>
</tr>
<tr>
<td>Lubric WE</td>
<td>SA</td>
</tr>
<tr>
<td>Fillant SH</td>
<td>SA</td>
</tr>
</tbody>
</table>
From the result above, the forecast methods are SA, 2-MA and 4-MA. Those methods could only forecast one period. The result for the next period would be the same since the demand pattern is static.

4.2.5.2 Future Demand

As stated in the previous sub chapter that the data is static, the forecast result for several months will be the same. From the best forecast methods, the future products demand can be shown in table 4.14.

<table>
<thead>
<tr>
<th>Product</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silofin Hals-B</td>
<td>1,100.00</td>
</tr>
<tr>
<td>Silofin Ham</td>
<td>1,102.50</td>
</tr>
<tr>
<td>Silofin AM25E</td>
<td>7,300.00</td>
</tr>
<tr>
<td>Finisoft RWT Pasta</td>
<td>16,930.00</td>
</tr>
<tr>
<td>Finisoft NIT</td>
<td>10,894.17</td>
</tr>
<tr>
<td>Lubric WE</td>
<td>7,051.67</td>
</tr>
<tr>
<td>Fillant SH</td>
<td>19,016.67</td>
</tr>
</tbody>
</table>

From the data in table 4.14 and product composition, the future raw materials needs can be calculated. The calculation of RMN006 for Silofin Hals-B for January 2013 is:

\[ R = 1,100.00 \times 0.2 \]
\[ R = 220.00 \text{ Kg} \]

RMN006 demand for Silofin Hals-B in January 2013 is 220.00 Kg. The Silofin Hals-B raw materials needs can be seen in table 4.15, while the other products can be seen in appendix 14.

<table>
<thead>
<tr>
<th>Month</th>
<th>Silofin Hals-B (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RMN006</td>
</tr>
<tr>
<td>JAN</td>
<td>220.00</td>
</tr>
</tbody>
</table>
By using aggregate, the raw material needs for January 2013 can be calculated as shown in Table 4.16.

Table 4.16 Aggregate of Raw Material needs for January 2013

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMN006</td>
<td>495.63</td>
</tr>
<tr>
<td>RMF001</td>
<td>5,284.33</td>
</tr>
<tr>
<td>RMF003</td>
<td>4,917.75</td>
</tr>
<tr>
<td>RMF005</td>
<td>7,802.54</td>
</tr>
<tr>
<td>RMS002</td>
<td>2,115.50</td>
</tr>
<tr>
<td>RMS25E</td>
<td>2,190.00</td>
</tr>
<tr>
<td>RME005</td>
<td>4,754.17</td>
</tr>
<tr>
<td>RML019</td>
<td>2,852.50</td>
</tr>
<tr>
<td>RMF06S</td>
<td>1,901.67</td>
</tr>
<tr>
<td>RMA001</td>
<td>31,080.92</td>
</tr>
</tbody>
</table>

The data shows the aggregate of raw materials demand from January 2013. This data is used to calculate the total inventory cost for future planning.

**4.2.5.3 Economic Order Interval for Future Planning**

From the data above, the total inventory cost for future planning can be calculated. Before calculating the total inventory cost, the optimum order interval should be determined. The EOI calculation can be seen below.

From the inventory cost data, the holding cost for one year is 20%, but in this case, the inventory cost will be calculated monthly. Thus, the holding cost for one month is:

\[ F = \frac{20\%}{12} \]

\[ F = 1,7\% \]

By using the formula in (2-2), Economic Order Interval for the future planning is:

\[ T^* = \sqrt{\frac{2 \left(500,000 + (10 \times 150,000)\right)}{0.017 \times (272,115,831.58)}} \]

\[ T^* = 0.94 \approx 1 \text{ month} \]

From the calculation above, the optimum order interval is once a month.
### 4.2.5.5 Future Total Inventory Calculation

After calculating the optimum order interval, the next step is to calculate total inventory cost for future planning. The detailed calculation can be seen in table 4.17.

**Table 4.17 Total Inventory Cost for Future Planning**

<table>
<thead>
<tr>
<th>Item</th>
<th>Demand (Kg)</th>
<th>Order Occurrence (Time)</th>
<th>Ordering Cost (IDR)</th>
<th>Holding Cost (IDR)</th>
<th>Total Cost (IDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Ri</td>
<td>(T)</td>
<td>(n.c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMN006</td>
<td>495.63</td>
<td>1</td>
<td>150,000.00</td>
<td>15,488.28</td>
<td>165,488.28</td>
</tr>
<tr>
<td>RMF001</td>
<td>5,284.33</td>
<td>1</td>
<td>150,000.00</td>
<td>198,162.53</td>
<td>348,162.53</td>
</tr>
<tr>
<td>RMF003</td>
<td>4,917.75</td>
<td>1</td>
<td>150,000.00</td>
<td>235,642.21</td>
<td>385,642.21</td>
</tr>
<tr>
<td>RMF005</td>
<td>7,802.54</td>
<td>1</td>
<td>150,000.00</td>
<td>422,637.72</td>
<td>572,637.72</td>
</tr>
<tr>
<td>RMS002</td>
<td>2,115.50</td>
<td>1</td>
<td>150,000.00</td>
<td>158,662.58</td>
<td>308,662.58</td>
</tr>
<tr>
<td>RMS25E</td>
<td>2,190.00</td>
<td>1</td>
<td>150,000.00</td>
<td>200,750.00</td>
<td>350,750.00</td>
</tr>
<tr>
<td>RME005</td>
<td>4,754.17</td>
<td>1</td>
<td>150,000.00</td>
<td>257,517.41</td>
<td>407,517.41</td>
</tr>
<tr>
<td>RML019</td>
<td>2,852.50</td>
<td>1</td>
<td>150,000.00</td>
<td>320,906.31</td>
<td>470,906.31</td>
</tr>
<tr>
<td>RMF06S</td>
<td>1,901.67</td>
<td>1</td>
<td>150,000.00</td>
<td>237,708.38</td>
<td>387,708.38</td>
</tr>
<tr>
<td>RMA001</td>
<td>31,080.92</td>
<td>1</td>
<td>150,000.00</td>
<td>220,156.53</td>
<td>370,156.53</td>
</tr>
<tr>
<td>Cost for Join Order</td>
<td>1</td>
<td>500,000.00</td>
<td>-</td>
<td></td>
<td>500,000.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4,267,631.93</td>
</tr>
</tbody>
</table>

As seen in table 4.17, the total inventory cost for January 2013 is IDR 4,267,631.93

### 4.3 ANALYSIS

#### 4.3.1 Inventory Management Problem Analysis

In manufacturing company, inventory is needed to cover demand during the lead-time and act as a buffer if demand suddenly increases. Besides that, holding inventory is considered as cost until it is used or sold. Conclusively, inventory adds the value to the company if managed properly. In this case, the number of order occurrence between one and another product is different, so the order cannot be done jointly. It happens because PT. X does not use any inventory management method in determining the order interval. The order interval decision is merely
based on management opinion. This condition would lead to an increase in the total ordering cost. In the end, the total inventory cost will increase as well.

4.3.2 Forecasting Result Analysis
Forecasting is important in order to predict the future demand. From data pattern and data plotting above, Single Average (SA), Moving Average with N=2 (2-MA), Moving Average with N=4 (4-MA), Weight Moving Average with N=2 (2-WMA), and Weight Moving Average with N=4 (4-WMA) are chosen as the forecast methods. From the forecast calculation, tracking signal is used as forecast method validation. The limit of tracking signal is ± 4. Then, the valid forecast method with the smallest value of Mean Square Error (MSE) would be chosen as the best forecast method.

The best forecast for each product is summarized in table 4.18 below:

<table>
<thead>
<tr>
<th>Product</th>
<th>MAD</th>
<th>MSE</th>
<th>MAPE</th>
<th>Trk.Signal</th>
<th>Forecast Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silofin Hals-B</td>
<td>384.00</td>
<td>194,635.00</td>
<td>30.41</td>
<td>Pass</td>
<td>2-MA</td>
</tr>
<tr>
<td>Silofin Ham</td>
<td>292.81</td>
<td>100,258.60</td>
<td>29.31</td>
<td>Pass</td>
<td>4-MA</td>
</tr>
<tr>
<td>Silofin AM25E</td>
<td>494.00</td>
<td>369,235.00</td>
<td>7.16</td>
<td>Pass</td>
<td>2-MA</td>
</tr>
<tr>
<td>Finisoft RWT</td>
<td>2,205.00</td>
<td>6,988,963.00</td>
<td>14.04</td>
<td>Pass</td>
<td>4-MA</td>
</tr>
<tr>
<td>Finisoft NIT</td>
<td>1,483.81</td>
<td>2,610,749.00</td>
<td>14.14</td>
<td>Pass</td>
<td>SA</td>
</tr>
<tr>
<td>Lubric WE</td>
<td>681.30</td>
<td>619,564.40</td>
<td>9.56</td>
<td>Pass</td>
<td>SA</td>
</tr>
<tr>
<td>Fillant SH</td>
<td>2,635.95</td>
<td>8,228,908.00</td>
<td>14.24</td>
<td>Pass</td>
<td>SA</td>
</tr>
</tbody>
</table>

From the observation, the demand data is static. The forecast methods could only forecast one period. The result for the next period would be the same.

4.3.3 Proposed Inventory Management System Analysis
The current order interval is not optimum. The order interval between one and another item is different, so the ordering process cannot be order jointly. Thus, the author proposes Economic Order Interval system. The objective of Economic Order Interval is to determine the optimum order interval to reduce total inventory
The order interval for multi item is same, therefore the ordering process can be ordered jointly as can be seen in table 4.19.

Table 4.19 Order Interval Comparison of Current and Proposed System

<table>
<thead>
<tr>
<th>Item</th>
<th>Current Order Interval (Time)</th>
<th>Proposed Order Interval (Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMN006</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>RMF001</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>RMF003</td>
<td>36</td>
<td>12</td>
</tr>
<tr>
<td>RMF005</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>RMS002</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>RMS25E</td>
<td>33</td>
<td>12</td>
</tr>
<tr>
<td>RME005</td>
<td>64</td>
<td>12</td>
</tr>
<tr>
<td>RML019</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>RMF06S</td>
<td>58</td>
<td>12</td>
</tr>
<tr>
<td>RMA001</td>
<td>72</td>
<td>12</td>
</tr>
</tbody>
</table>

From figure 4.5, 85% of the current total cost comes from ordering cost and the remaining 15% from holding cost. The proposed inventory has almost the same percentage of ordering and holding cost. The equal composition of ordering and holding can reduce total inventory cost. Based on Economic Order Interval method, it successfully reduces the total inventory cost. Total inventory cost for current system is IDR 65,301,503.65. The proposed method can minimize the total inventory cost into IDR 50,974,085.63. The company could save IDR 14,327,418.02 or save more than 21% of the cost.

![Figure 4.5 Inventory Cost Comparison of current and proposed system.](image-url)
CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION
This chapter will summarize all of the research calculation and analysis in previous chapter. The objective of this research is to reduce the total inventory cost. Based on the observation, there is no optimum order interval in the ordering process. The ordering process based on the management opinion. The ordering interval between one and another item is different. As the result, the ordering process cannot do in joint order. Therefore, the total inventory cost is increasing. The development of appropriate inventory management in order to reduce the total inventory cost that has been conducted by the researcher as close possible to the real situation in principle.

The proposed system that have been discussed in chapter IV could improve the current inventory management system and minimize the total of inventory cost. The improvement result are:

- The order interval developed using Economic Order Interval method. The ordering process can be done as joint order. It can reduce the ordering cost to 56%.
- The total inventory cost for proposed system can reduced to 21% of current total inventory cost. The company could save IDR 14,327,418.02.

From the result above, the research objective achieved by implementing Economic Order Interval.

5.2 RECOMMENDATION
This research has been able to bring improvement to the company. However, the research can only cover the designing steps. Thus, the future studies regarding this topic is needed in order to give better development and improvement in more
complex situation and condition or to be integrated to the other areas in the industry both internal or external.

The recommendations are:

1. Implementing integrated inventory management software will help the user for ordering process in the right time and quantity.
2. Next researcher should cover all the total inventory cost detailed, such as purchase cost, electricity cost, workers salary and other in order to get the detailed cost.
3. Covering all PT.X Product in calculating the total inventory cost.
4. Combining two or more inventory management systems in order to get the best result, such as Economic Order Interval and Joint order, Economic Order Quantity and Material Requirement Planning, others.