The Applications of Ordering Materials using Time Series Forecasting with CB-Predictor

Tri Pujadi[1], Witarsyah[1], Haris Setia Budi[1], Wahyu Sardjono[1], Bachtiar H. Simamora[2] and Ximing Ruan[3]
[1]*Information Systems Department, School of Information Systems, Bina Nusantara University, Jakarta, Indonesia*
[2]*Department of Management, Binus Business School, Bina Nusantara University, Jakarta, Indonesia*
[3]*MSc-International Management, Bristol Business School, University of the West of England, U.K.*

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Abstract: Shortage of raw materials may occur in manufacturing companies, which is caused by inaccurate orders for raw materials, and lack of raw material supplies. This problem causes inefficient costs due to the production process, the possibility of having to emergency procurement to fulfill customer orders. The solution to this problem is to develop a web-based system that supports ordering of raw materials. The calculation based on the estimated time series with the CB-Predictor. The methodology in the calculation is (1) collecting historical data on the use of raw materials, step (2) forecasting raw material needs, step (3) calculating the order quantity based on forecasting data, by comparing the deterministic method and the probabilistic method. For calculation of safety stock for each raw material, for situations outside normal conditions, for example increasing orders. The design method, the system to be developed uses the Unified Modeling Language (UML) modeling language based on the concept of Object-Oriented Analysis and Design (OOAD). The result is a web-based system application model to support a more efficient and accurate calculation of ordering raw materials. With the proposed application of information systems, the company can estimate raw material needs more quickly and accurately and can determine the quantity of orders that are tailored to the needs. So that the costs associated with ordering and storing raw materials can be minimized.

1 INTRODUCTION

An important factor that influences serving customers is the availability of products. For this reason, it is necessary to order raw materials for production in the right quantity. If raw materials can be ordered in sufficient quantity and time, the production process can run smoothly because the raw materials are available, and the costs associated with inventory can also be minimized. The cost of inventory consists of the cost of ordering, storage costs and backorder costs (Undersander et all 2017).

Unavailability of raw materials, resulting in loss of production processes, expensive order costs, and reduced customer trust, may have to pay inefficient of inventory costs. For all these increase costs, because the company cannot fulfill customer orders on time. According to Mart et all (2013) timelines must be measured correctly by the company from the beginning of the order being recorded, production is carried out, until the goods are delivered to the customer. Important factors (Citra et all, 2013)that support the punctuality of time are the right quantity of raw material orders, and the time to place orders for these raw materials. If the raw materials can be ordered in the right quantity and at a time, the production process can run smoothly because the raw materials are always available. So that inventory costs can be minimized (Irmayanti et all, 2019).

This study aims to develop a material ordering process information system model that can assist in arranging and managing raw material stocks quickly and precisely so that the company will be able to fulfill customer orders on time and can maintain credibility and trust in the eyes of its customers.

The purposes for making this ordering model include:

1. Make a planning regarding forecasting raw material requirements in accordance with historical production data.
2. Provide suggestions regarding the method of ordering raw materials in the right quantity,

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considering the comparison of storage costs and the cost of ordering raw materials. As well as providing suggestions when to order raw materials, in accordance with the forecasting of raw material needs that have been done previously

3. Making suggestions regarding the safety stock quantity of each type of raw material.

Propose an information system model to support the process of recording raw material stocks that are out and received, the calculation of forecasting raw material requirements, and the calculation of the quantity of raw material orders

The results of implementing the system model that have been made will be useful for companies to:

a. Improve the accuracy of determining raw material requirements in future periods.
b. Improve the accuracy of recording raw material stocks in the warehouse.
c. Increase the accuracy of determining the quantity of raw material orders.
d. Minimizing storage costs and ordering costs of raw materials.
e. Increase the work efficiency of employees in the warehouse of raw materials and the purchasing department because with the system they can work faster.
f. Assisting the warehouse in calculating the raw material requirements for each incoming order. g) Increase customer satisfaction by providing on time delivery of orders.
g. Increase the company's credibility in the eyes of customers.

Inventories are classified into raw materials, work in process, finished goods, supporting materials, complementary materials, components stored in anticipation of demand. Inventory control is a very important managerial function, because the majority of companies involve large investments in this aspect (20% to 60%). This is a dilemma for the company. When inventory is excess, storage costs and the required capital increase. The excess supply also makes capital stagnate, the capital should be invested in other sectors that are more profitable (opportunity cost). Conversely, if the inventory is reduced, it can cause out of raw materials (stock out). If the company does not have sufficient supplies, emergency procurement costs will be more expensive, another impact is consumer disappointment with the company(Sukmawati et all, 2009)..

The method of ordering raw materials can be classified as Fig. 1 below (Chen et all, 2009):

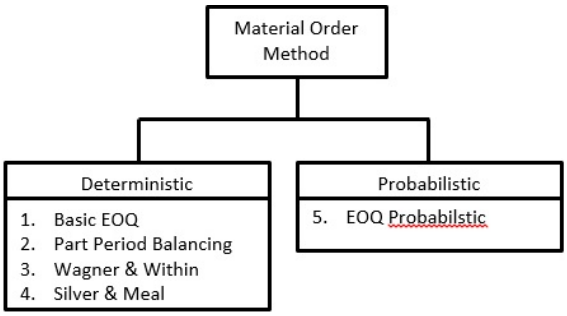

Figure 1: Classification of method an ordering material.

To select the method of ordering raw materials according to the demand data pattern. Demand patterns are grouped into:

- Static data, if demand is a stationary data pattern, or with a tendency to be constant / stable.
- Dynamic data, which is demand with data patterns that fluctuate or tend to move, also known as "lumpy demand"

Ordering is the procurement of goods or the purchase of goods and services for companies that have been regulated in their supply chain. There are two types of procurement of goods, namely direct procurement, and indirect procurement. This is related to the purpose of procurement, whether to support the production process (production related) or non-production related. Good procurement management will improve ordering services which in turn result in budget savings and simplify the procurement process so that it will be more efficient (Nadella et all 2020).

There are three areas that will be supported by online procurement of goods and services, namely in the order transaction process, inventory management and support in marketing. Thus, the use of e-procurement will impact four business to business (B2B) activities, namely search and identifying of right products, order processing, monitoring & control as well as coordination between the company and its partners.

Forecasting is the prediction of the value of a variable based on the known value of that variable or related variables. Forecasting can be based on appraisal expertise, which in turn is based on historical data and experience. The main reason for forecasting is because of the grace period between awareness of future events or needs and the events themselves (Salais-Fierro et all 2020). If the grace period is zero or small, planning and forecasting are not required, whereas if the grace period is long and the outcome of the event depends on known factors,

forecasting is needed to determine when an event will occur or arise, then appropriate action can be taken done.

According to Subramanian and Render, (Voulgaris (2019) forecasting is the art and science of predicting future events with some form of mathematical model, it can be a subjective or intuitive prediction about the future or it can also include a combination of mathematical models that are adapted to good judgment by managers.

Forecasts are usually classified based on the underlying future time horizon:

a. Short-term forecasting, usually used to plan purchases, work scheduling, number of workers, assignments, and production levels, and the time span reaches one year but generally less than three months.
b. Forecasting is medium-term, typically of three months to three years, and is very useful in sales planning, production planning and budgeting, cash budgeting, and analyzing various operating plans.
c. Long-term forecasting, usually spanning three years or more, is used in planning new products, capital expenditure, facility locations, or expansion and research and development

Today, much software are available that support forecasting calculations, so that users can more easily perform forecasting calculations

CB Predictor is a type of software that can support forecasting (Goldman 2002). CB Predictor is a program built into Crystal Ball. This software is a program for predicting data that will occur in the future by analyzing past data. In the gallery of this program, there are eight forecasting models (Glasser 1969):

a. Single Moving Average is a forecasting method used for stationary data (does not contain seasonal or trend elements).
b. Double Moving Average is a forecasting method used for data containing trend elements.
c. Single Exponential Smoothing, is a forecasting method used for stationary data (does not contain seasonal or trend elements)
d. Double Exponential smoothing is a forecasting method used for data that contains trend elements.
e. Seasonal Additive is a forecasting method used for data containing seasonal elements.
f. Holt Winter's Additive is a forecasting method used for data that contains elements of seasonality and trends.
g. Seasonal Multiplicative, is a forecasting method used for data containing seasonal elements. This method is the best method for data with the highest aggregation, such as product sales and data on raw material requirements.

The calculation of the Seasonal Multiplicative method is influenced by α and γ. The first step is determine the seasonal elements of n periods, to determine the seasonal term.

The block replacement process is a replacement action that is carried out at a fixed interval (Dekker et all, 1991). This method is applied by replacing the damage that occurs at intervals (0, *tp*) by ignoring any replacements that occur during that time interval, as well as making preventive changes at each interval *tp* but constantly (Bahtera, 2017).

Block replacement allows replacement in a close period, where the new components installed after replacement of the damage must be replaced again at the time of preventive replacement (*tp)*.

$$D(tp) = \frac{\text{Expected downtime damage x Preventive replacement downtime}}{\text{Cycle length}}$$

$$D(t_p) = \frac{(H(t_p)T_f)+T_p}{t_p+T_p} \quad (1)$$

Where (1):
$D(t_p)$ = unity time downtime
t_p = preventive replacement time interval
$H(t_p)$ = expected amount of damage at the interval (0, t)
T_f = downtime that occurs due to replacement damage
T_p = downtime due to preventive replacement

2 METHOD

The method of calculation for forecasting and inventory of raw materials is carried out through the following steps:

1. From the data on the use of raw materials for the last three years, then forecasting the raw material needs for the next twelve periods is carried out using the help of software, namely CB Predictor.
2. From several forecasting results for each type of raw material, a forecasting method is chosen with the smallest error percentage value (MAPE ◊ Mean Absolute Percentage Error (Salais-Fierro et all, 2013).
3. After the prediction result is determined according to the method with the smallest error rate, the Variability Coefficient (VC) calculation is performed. The calculation of VC is the calculation of the coefficient from the results of

forecasting calculations to determine the deterministic method for calculating the quantity of raw material orders, where if the VC is less than 0.25 then the monthly raw material requirements are stable, and to determine the quantity of raw material orders, the EOQ (Economic Order Quantity) method is sufficient. Meanwhile, if the VC is greater than 0.25, the raw material needs are unstable each month, sometimes it increases and sometimes it decreases, so to determine the quantity of the order, a comparison of several methods must be used, namely the Silver & Meal (S&M), Wagner & Within (W&W) method.), and Part Period Balancing (PPB).

The system design method uses an object-based information system development method using the artifact Unified Model Language (UML). The activity begins with an analysis of the current information system. This analysis is to determine user information requirements and user interaction with existing system functions. System requirements are used to propose system improvements related to information availability and system functions

3 RESULT AND DISCUSSION

Current Business Processes

The company does not yet have a computer-based raw material ordering system. Recording of raw material inventory and ordering of raw materials is done manually. The rich picture in Fig. 2 describes the current business process for procuring materials.

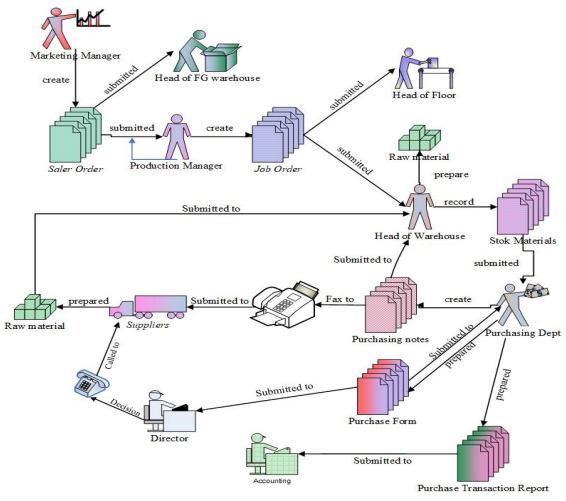

Figure 2: Rich picture current business process.

For every month, the raw material warehouse department sends a record of the amount of raw material stock to the purchasing department. Based on this raw material record, the purchasing department then determines when to place an order for raw materials and what is the order quantity. This determination is not based on any calculation, but only based on intuition. Then the purchasing department makes a purchase note containing the types of raw materials to be purchased and their quantity. For ordering local raw materials, the purchase receipt that has been made by the purchasing manager is sent directly to the supplier via a fax machine. As for imported raw materials, a purchase note is given to the director, then the director orders directly to the supplier. In addition to purchase notes, the purchasing manager creates a transaction report for the purchase of raw materials and sends it to the accounting department.

If the raw materials have arrived at the warehouse, then the raw material warehouse section will match the purchase note with the travel letter from the supplier whether the raw materials sent by the supplier match the raw materials ordered. Raw materials that have been checked and are in accordance with the order are then entered into the raw material warehouse and the head of the raw material warehouse records the raw material stock.

The Proposed Forecasting System for the Procurement of Raw Materials

This raw material ordering system model consists of one main menu where every user who has logged in can enter the system according to their authority. The Order menu consists of one order form. This form can only be seen by the marketing department which has the task of entering customer order data into the system. The Raw Material Menu is a menu consisting of five forms. This menu can be accessed by the raw material warehouse and purchasing department. But not all forms can be accessed, but only a few forms. The forecasting calculation form can only be accessed by the head of the raw material warehouse, where the head of the warehouse has the task of forecasting raw material needs for the next few periods based on historical data on the use of material

The calculation menu consists of two forms:

a) Forecast Calculation Form
The Forecast Calculation form in Fig. 3, can be accessed by the Head of raw material Warehouse, where the task of forecasting raw material requirements for the next few periods based on historical data on the use of raw materials.

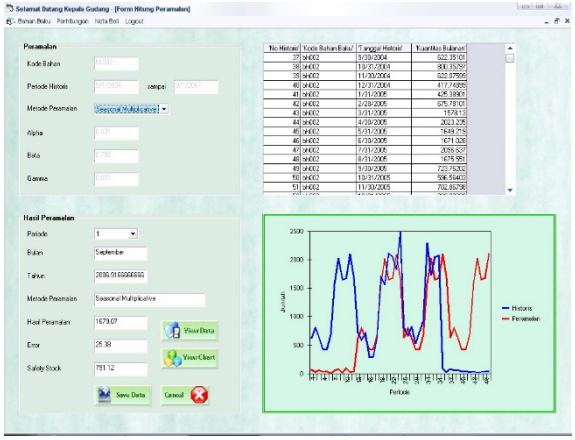

Figure 3: Forecast Calculation Form.

The purchasing department also plays an important role where a purchasing manager must calculate the correct quantity of raw material orders. An incorrect, excessive or insufficient order can cause losses to the company. Of course, every company always wants multiple profits. Therefore, the determination of the order quantity should be calculated using several methods, and the method that produces the lowest total cost should be chosen.

b) Order Calculation Form
This Order Calculation form in Fig. 4 can accessed by Head of Department of Purchasing, where the is tasked with calculating the most economical quantity of raw material orders, by comparing several calculation methods.

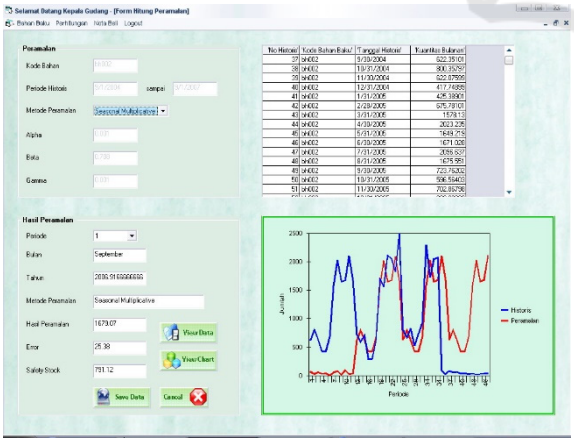

Figure 4: Order Calculation Form.

4 CONCLUSION

The system is designed to have a purpose and function for ordering raw materials, starting to record the incoming or outgoing raw materials, calculating the forecast, calculating the order quantity, then making a purchase note for each type of raw material with the quantity according to the calculation.

The warehouse section enters incoming and outgoing data, calculates the use of raw materials each month, calculates forecasting raw material needs for the future period, and changes the status of the purchase note if the ordered raw materials have been sent by the supplier. With the raw material ordering system, it will increase the accuracy of raw material stock data.

The system facilitates the work of the raw material warehouse section, where when the order is received the system has already carried out a breakdown of the needs for each type of raw material for the order, so that when the warehouse department clicks the order number, the details of the raw materials are immediately displayed, and the raw materials can be immediately prepared. Likewise, when the raw materials are received, the warehouse department only needs to look at the purchase notes ordered whether they match the raw materials received. Finally, the system will have a positive impact in terms of controlling raw materials, maintaining raw material stocks so that they can always be monitored and controlled.

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