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Determination of minimum stock on system retail using forecast, economic order quantity and reorder point methods

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Determination of minimum stock on system retail using forecast, economic order quantity and reorder point methods

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Abstract In a globalization era, where retail business competition is getting tougher, a retail business has to have more advantages such as competitive selling prices, stock availability and others. In order to have competitive selling prices, a retail business should be able to arrange planning regarding goods availability to maintain balance between demand and existing stock (supply). The need for information on the availability of stock of goods in accordance with the sales that occur becomes very important. It is needed to avoid the goods accumulated excessively in the warehouse or even shortage of goods. If this kind of information about stocks both in a warehouse or the one that has been sold does not properly provided, it can cause reduction on the company's profit because it can lead to more expenses on buying other goods as guessing that the stock of certain goods are running low or even more miscalculating to buy more goods that is actually still on the warehouse with sufficient quantities. These kind of situations were often occurred when a retail business do not have a tool to ensure the estimated purchase of stock needed for a certain period of time during selling. Therefore, it is required a system to help facilitate companies in carrying out retail business activities by using the Forecasting Method to help estimate quantitatively what will happen in the future with the stocks, based on relevant data in the past. In accordance with the results of the identification of demand patterns, the Forecasting Method used is Moving Average (MA), Weighted Moving Average (WMA), Single Exponential Smoothing (SES) and Double Exponential Smoothing (DES). After Forecasting, the best Forecast Method which has the lowest Mean Absolute Deviation (MAD) selection is made. This Economic Order Quantity (EOQ) method helps to determine the optimal purchase frequency. Through determining the optimal number and frequency of purchases, then optimal inventory control is obtained. The Reorder Point method can be used to find out what the minimum point is to be able to order a stock back, so that it is expected that the amount of stock that is not excessive and can meet sales needs optimally.

1. Background

The development of science and technology in the era of globalization is increasingly advanced and greatly increased rapidly, so that it brings a positive impact and facilitates all matters of daily life. The results of the development of science and technology have been very widely used by the community, such as at home, offices, companies, schools, universities, and other public places. The development of science and technology has also brought many changes in various fields of life, ranging from social life to the use of technology in the business world, as for retail businesses. The increasing development of science and technology has also resulted in the increasing role of information systems in fulfilling accurate information which will make the company have a competitive advantage and to meet these information needs, information technology that can process data to be accurate is needed.

Retail business these days are really need a system to help and facilitate business activities, such as providing better customer service, increasing data security related to customers, facilitating and speeding up the process of buying and selling goods, managing stock of goods, and accurate financial reports and data. The system of determining the minimum stock in a retail system uses the Forecast, Economic Order Quantity and Reorder Point methods that will be designed based on data obtained from spare parts and motorcycle repair shops CV SJM is engaged in the distribution of spare parts and garage service for 2-wheeled vehicles, serving sales to wholesalers and retails

2. Literature Study

In this system a research will be conducted which aims to establish an appropriate forecasting system in order to determine the inventory stock of goods that must be carried out in accordance with past sales data that has occurred. The method used in this research is Forecasting to determine Reorder Points. Forecasting method to forecast future stock needs. Then do the Economic Order Quantity (EOQ) calculation to determine the optimal purchase frequency. Through determining the optimal number and frequency of purchases, optimal inventory control is obtained. inventory of goods that can be ordered in a period for the purpose of minimizing the cost of the inventory of goods, then do a Reorder Point calculation to find out when to reorder stock, with the data used is sales data for several periods that have occurred.

3. Method and Materials

The method used in the research is the Forecast, Economic Order Quantity and Reorder Point methods.

3.1 Forecast Method

This Forecasting method estimates quantitatively what will happen in the future with the stocks, based on relevant data in the past. In accordance with the results of the identification of demand patterns, Forcasting methods that can be used are Moving Average (MA), Weighted Moving Average (WMA), Single Exponential Smoothing (SES) and Double Exponential Smoothing (DES).

3.1.1. Moving Average

Moving Average method is a method of forecasting which is done by taking a group of observations, looking for the average value as a forecast for the coming period [1].
The steps are as follows:
Step 1: Calculate Forecasting for period t

$$F_{t+1} = \frac{A_t + A_{t-1} + \ldots A_{t-(n-1)}}{n} \quad (1)$$

Step 2: Calculate Absolute Deviation for Period of t value

$$AD_t = |F_t - A_t| \quad (2)$$

Step 3: Calculate Mean Absolute Deviation value

$$MAD = \frac{\sum_{t=1}^{n} AD_t}{n} \quad (3)$$

Where:

F_{t+1} = Forecast for period t + 1
F_t = Forecast for period t
A_t = Actual demand period t
n = The amount of request data involved
AD_t = Absolute Deviation in the period t
MAD = Mean Absolute Deviation

3.1.2. Weighted Moving Average

Weighted Moving Average method, as explained is the same as the moving average or Moving Average, but the latest value in a periodic sequence is given a greater weight or weight to calculate forecasting. The Weighted Moving Average method is given a different weight for each available past data, assuming that the last recent or the newest recent data will have a greater weight than the old data because the last recent or the newest recent data is the most relevant data for forecasting. The closer to forecasting data then the weight will be greater because the data closest to forecasting is data that greatly affects the results of the forecast. [2].

The steps are as follows:
Step 1: Calculate Forecast for Period of t value

$$F_t = \frac{(\sum (Dt * weight))}{(\sum weight)} \quad (4)$$

Step 2: Calculate Absolute Deviation for Period of t value

$$AE_t = |F_t - A_t| \quad (5)$$

Step 3: Calculate Mean Absolute Deviation value

$$MAD = \frac{\sum_{t=1}^{n} AE_t}{n} \quad (6)$$

Where:

F_t = Forecast for period t
A_t = Actual demand period t
D_t = Actual data for the period t
AE_t = $Absolute\ Error$
Weight = Weights are given for each month
n = Amount of request data involved
MAD = Mean Absolute Deviation

3.1.3. Single Exponential Smoothing

The Single Exponential Smoothing method is a development of the Moving Average method. This method uses the recording of very little past data, and assumes the data fluctuates around a fixed average value, without following patterns or trends [3].
The steps are as follows:
Step 1: Calculate Forecast for Period of t value

$$F_t = \alpha A_{t-1} + (1-\alpha) F_{t-1} \quad (7)$$

Step 2: Calculate Absolute Deviation for Period of t value

$$AD_t = |F_t - A_t| \quad (8)$$

Step 3: Calculate Mean Absolute Deviation value

$$MAD = \frac{\sum_{t=1}^{n} AD_t}{n} \quad (9)$$

Where:

F_t = Forecasting value for period t
F_{t-1} = Forecasting value for period t-1
α = Smoothing constant
AD_t = Absolute Deviation in the period t
A_t = Actual demand period t
MAD = Mean Absolute Deviation
n = Amount of request data involved
A_{t-1} = Actual data for the previous period

3.1.4. Double Exponential Smoothing

The Double Exponential Smoothing (DES) method is a linear model proposed by Brown. In this method the smoothing process is carried out twice. The premise of Brown's linear exponential smoothing method is similar to the linear moving average, because both the single and double smoothing scores lagged behind the actual data if there is an element of trend. The difference between single and multiple smoothing scores can be added to the score of single smoothing and adjusted for trends. This method is used in this application because there is a trend in sales data, which happened in a several important months such as Eid month and New Year when sales are increasing in general [4].
The steps are as follows:
Step 1: Calculate a single exponential smoothing for a period t

$$S'_t = \alpha X_t + (1-\alpha) S'_{t-1} \quad (10)$$

Step 2: Calculate double exponential smoothing in period t

$$S''_t = \alpha S'_t + (1-\alpha) S''_{t-1} \quad (11)$$

Step 3: Calculate constant value

$$a_t = 2\ S'_t + S''_t \quad (12)$$

Step 4: Calculate Slope value

$$b_t = \frac{\alpha}{1-\alpha}(S'_t + S''_t) \quad (13)$$

Step 5: Calculate Forecast for Period of t value

$$F_t = a_t + b_t \quad (14)$$

Step 6: Calculate Absolute Deviation for Period of t value

$$AD_t = |F_t - A_t| \quad (15)$$

Step 7: Calculate Mean Absolute Deviation value

$$MAD = \frac{\sum_{t=1}^{n} AD_t}{n} \quad (16)$$

Where:

S'_t	= The value of a single exponential smoothing in the period t
S''_t	= The value of double exponential smoothing in the period t
S'_{t-1}	= The value of a single exponential smoothing in the period t-1
S''_{t-1}	= The value of double exponential smoothing in the period t-1
$X_t + (1-\alpha)$	= *actual time series value*
α	= Smoothing constant
F_t	= Forecasting value for period t
a_t	= Value of smoothing constant
b_t	= S*lope value*
AD_t	= *Absolute Deviation in the period* t
A_t	= Actual demand period t
MAD	= Mean Absolute Deviation
n	= The amount of request data involved

3.2. Ordering Cost

Ordering costs are all costs incurred in the process of ordering an item. The cost of the message is variable or changes which changes are according to the order frequencies.
The order formula costs each time ordered:

$$Ordering\ Cost = \frac{total\ cost\ of\ the\ order}{order\ frequency} \quad (17)$$

3.3. Holding Cost

Holding costs are costs incurred by the company in the context of storing an item purchased. Save costs are costs incurred by the company to store inventory for a certain period [5].
Storage cost formula:

$$Holding\ cost = \frac{total\ cost\ of\ holding}{total\ demand\ for\ goods} \quad (18)$$

3.4. Mean Absolute Deviation

Mean Absolute Deviation (MAD) is the average absolute error over a certain period regardless of whether the forecast result is greater or smaller than the reality, in other words MAD is the average of the absolute value of the deviation. The intended deviation is the difference between actual data and forecasting results for a certain period [6].

3.5. Economic Order Quantity

Economic Order Quantity (EOQ) is an inventory management method that determines the number of orders or purchases that must be made and how many quantities must be ordered so that the total cost (the sum of the order costs and storage costs) is minimum. Thus, to calculate the economical number of

orders, it is necessary to see the increase in ordering and storage costs as well as the average inventory size [7].

Step 1: Calculate Economic Order Quantity Value

$$Q = \sqrt{2DS/H} \quad (19)$$

Step 2: Calculate Order Frequency Value

$$F = \frac{D}{Q} \quad (20)$$

Where:

Q = The optimum number of units per order
D = Number of requests for a period (month)
S = Order fees for each order
H = Holding costs for each unit per month

3.6. Reorder Point

Reorder Point (ROP) is the level of a reorder is a point or limit of the amount of inventory that exists at a time where an order must be held back [8].

$$ROP = (D * lead\ time) + safety\ stock \quad (24)$$

Where:

ROP = Reorder Point
D = Average number of requests

4. Results and discussion

Based on point number 2 above, the final result of the Forecast method, Economic Order Quantity method and Reorder Point method, then obtained as follows:

Table 1. Final Result for Forecast Method and the Smallest Mean Absolute Deviation

Name of goods	Forecast MA for 3 months	Forecast MA for 4 months	Forecast WMA for 3 months	Forecast WMA for 4 months	Forecast SES	Forecast DES	The Smallest MAD
C7 NGK Spark plug	57,7778	64,3750	63,4221	60,1455	69,4181	83,0298	57,7778
K44 Honda V-belt	30	34,0625	30,3826	33,0887	32,6921	39,7664	29,5493

Table 2. Final Result for Economic Order Quantity method

Name of goods	Q (Economic Order Quantity)	F (Order Frequency)
C7 NGK Spark plug	79 Pcs	18 times
K44 Honda V-belt	53 Pcs	18 times

Table 3. Final Result for Reorder Point method

Name of goods	Safety Stock	Reorder Point
C7 NGK Spark plug	65 Pcs	121Pcs
K44 Honda V-belt	34 Pcs	72Pcs

5. Conclusion

Following are the conclusions that can be drawn in this calculation:

1. The system of determining the minimum stock in a retail system using the Forecast, Economic Order Quantity and Reorder Point methods designed is based on data obtained from spare parts shops and motorbike repair shops CV SJ The results of testing the data on

the Forecast method using the Forecasting method that can be used are Moving Average (MA), Weighted Moving Average (WMA), Single Exponential Smoothing (SES) and Double Exponential Smoothing (DES). The smallest MAD results obtained from each Forecast method. It can be concluded that the C7 NGK Spark plug with the smallest MAD is 57.77778 using the Forecast Moving Average method for 3 months and the K44 Honda V-belt with the smallest MAD that is 30.5555 using the 3 months Forecast Moving Average method.

2. The results of testing the data on the Economic Order Quantity method obtained results in the form of Economic Order Quantity values to get how many quantities of goods are economical in ordering at the time of ordering goods to suppliers, and the frequency of orders to get how many orders must be done within 1 year, can be concluded that the C7 NGK Spark Plug with EOQ value = 78.4651 ~ 79pcs and Ordering Frequency = 18.3521 ~ 18 times, also on the K44 Honda V-belt can be concluded that the K44 Honda V-belt item with an EOQ value = 52.5825 ~ 53pcs And Ordering Frequency = 18,3521 ~ 18 times.
3. The results of testing data on the Safety Stock and ROP methods are obtained with Safety Stock values. It can be seen and concluded that the C7 NGK Spark Plugs with Safety Stock values are 64.9262 ~ 65pcs and ROP = 120.9302 ~ 121pcs as well as the K44 Honda V-belt with Safety Stock values of 34.3358 ~ 34pcs and ROP = 71.8663 ~ 72pcs.

6. References

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