Conference Paper

# Determining the Appropriate Demand Forecasting Using Time Series Method: Study Case at Garment Industry in Indonesia

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## Abstract

PT XYZ is a subsidiary company which responsible to distribute the clothing line product. This company could be categorized as merchandising business because it only sells products or finished goods from parent company. The method that used by XYZ to predict future demand is based on the judgment of previous sales and does not apply forecasting methods to predict demand. As distributor, it is important to reach sales target from parent company. To maintain the sustainability of the company, this can be prevented by improving the method of forecasting their demand. This research will be analyzed using time series method including moving average, simple exponential smoothing, holt's model and winter's model. Mean Absolute Deviation (MAD) is used to calculate the error and to compare the model in terms of their forecast performance since the characteristic of their forecast errors are not symmetric distribution and Tracking Signal (TS) to track and control whether the method is still appropriate or not. The calculation concluded that simple moving average is the best method to applied for predicting the future demand. To utilize the methods provided in this study, director of XYZ required to record the historical sales data systematically, measure the forecast error properly, use the proposed method in the right time period, and commit to learn the proposed demand forecasting method.

**Keywords:** supply chain management, operation management, demand forecasting

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## 1. Introduction

### 1.1. Background

Demand forecasting is a very important factor for a business to do in the proper way. It is a crucial issue for a company to achieve efficient operations management planning since all organizations will deal with uncertainty in the future, some error between

forecast and actual demand is to be expected [3]. The purpose of an accurate demand forecast is to minimize the deviation between actual demand and forecasting.

Currently, XYZ has no method for predicting the demand forecast. As a subsidiary, XYZ has an obligation to place an order to their parent company to make a stock in inventory, so XYZ can fulfill the demand from the customers. They only used judgement or self-estimate based on previous sales. Therefore, due to the uncertainty demand from the customers, they often find obstacles to overcome the magnitude and the least amount of inventory products that have been ordered. If the shortage happened, it can harm the company in the terms of cost, while if there is an excess inventory, it can give adversely affects to their products such as the packaging is broken or even the products get yellowing and it will result in large cost because they should pay large trade payables to their parent company.

### 1.2. Research question

Based on the background above, the research question is formulated as "What is the most appropriate demand forecasting method that should be implemented in PT XYZ?"

### 1.3. Research objectives

The aims of this study are to develop an appropriate demand forecasting method for PT XYZ that will give a good impact to sales performance and to increase their profitability. Then, to give a recommendation of demand forecasting for 2018 using the proposed forecasting method.

### 1.4. Limitation

1. The research will be limited for the AAA brand with selected articles, i.e., 704 BW-XL, 704 BW-L, 704 BW-M, 302B (S) -36, 302B (S) -34, 708-L and 708-M.
2. The research will be limited only for PT XYZ.
3. The historical data needed is only the annual sales of AAA brand in May 2015 to April 2018.

## 2. Theoretical Foundation

## 2.1. Demand forecasting

Forecasting is about predicting future events. Demand forecast is used to predicting the future demand of company's product and services, with the aim to be able to fulfill the customer desires over a specified time period which is done by using the historical data, usually based on demand data. Having a good forecast is crucial for having an efficient service and for manufacturing operations [2].

The general demand forecasting methods can be classified into four types, which are qualitative, time-series, causal, and simulation. Qualitative forecast is forecasts which based on the instinct, emotions, background, and value system. Time-series forecast is a method that relies on historical data and assumes if the historical data is the good indicator to forecast the future, it will be appropriate if the demand pattern is not varied significant in each year. Causal forecast is a method that assume if the demand will be influence by the current condition in environment such as the state of the economy and interest rate. Simulation forecast is a method by combining the time-series and causal method. This method emulates the consumer decision that cause demand to arrive at a forecast [1].

## 2.2. Time series methods

The forecasting techniques that are examined in this study are simple moving average, simple exponential smoothing, holt's model and winter's model [1].

### 2.2.1. Simple moving average

To determine the next forecast, this method requires historical data. This method will be useful if we assume that demand will stay steady over time or then the demand has no trend or seasonality. The advantages of this method are the simplicity of us, easy to understand and implement [4].

The formula of moving average is expressed as:

The level in period t is intimated as the average demand over the recent N, the equation is shown below [1]:

$$L_t = (D_t + D_{t-1} + \cdots + D_{t-N+1})/N \quad (1)$$

The current forecast for all future periods is the same and is based on the current estimates of level. The forecast is stated as [1]:

$$F_{t+1=}L_t \text{ and } F_{t+n} = L_t \quad (2)$$

Where:

$D_t$ = Observed demand in time period t

$F_{t+1}$ = Forecasted demand for t+1 made in time period t

N = Number of time periods

### 2.2.2. Simple exponential smoothing

This method uses if there is no trend or seasonality in the demand. The Simple Exponential Smoothing technique takes into account the smoothing factor which is this helps in reacting more strongly to recent changes in demand [4]. The formulas are expressed below:

The $L_o$ is consider to be the average from all historical data, given demand data from period 1 until n:

$$L_o = \frac{1}{n}\int_{i=1}^{n} D_i \quad (3)$$

For all future periods is the same as the current level and is given as:

$$F_{t+1=}L_t \text{ and } F_{t+n} = L_t \quad (4)$$

Then, we revise the estimate of the level as follows:

$$L_{t+1} = \alpha D_{t+1} + (1-\alpha)L_t \quad (5)$$

Where:

$\alpha$ = Smoothing constant for level (0< $\alpha$ <1)

$D_t$ = Actual demand in time period t

$F_t$ = Forecast made in period t

### 2.2.3. Holt's model

This method uses if there is a level and a trend in the demand but no seasonality thus, uses linear regression between the demand and the time to determine the initial level [1]:

The future forecast period is expressed as:

$$F_{t+1} = L_t + T_t \; and \; F_{t+n} = L_t + nT_t \tag{6}$$

Then, the revised estimate is the weighted average that has been observed and also from the old estimates. How to revise the approximate levels are as follows:

$$L_{t+1} = \alpha D_{t+1} + (1-\alpha)\,(L_t + T_t) \tag{7}$$

$$T_t = \beta(L_{t+1} - L_t) + (1-\beta)\,T_t \tag{8}$$

Where:

$\alpha$ = Smoothing constant for level (o< $\alpha$ <1)

$\beta$ = Smoothing constant for trend (o<β<1)

n = Number of periods ahead to be forecast

$F_{t+n}$ = Holt's forecast for period t+n

### 2.2.4. Winter's model

This model will be appropriate if the demands have a level, trend and also a seasonal factor. The systematic component of demand is level plus trend ad times seasonal factor. To start forecast, we must find out the level, trend, and seasonal factors first using static model [1].

To find out the future forecast is expressed as:

$$F_{t+1} = \left(L_t + T_t\right) S_{t+1} \;\; and \;\; F_{t+1} = (L_t + lT_t)S_{t+1} \tag{9}$$

Then, revise the estimate level, trend, and seasonal factors as follows:

$$L_{t+1} = \alpha(D_{t+1}/S_{t+1}) + (1-\alpha)\,(L_t + T_t) \tag{10}$$

$$T_{t+1} = \beta(L_{t+1} - L_t) + (1-\beta)\,T_t \tag{11}$$

$$S_{t+p+1} = (D_{t+1}/L_{t+1}) + (1-)\,S_{t+1} \tag{12}$$

Where:

$\alpha$ = Smoothing constant for level (o<$\alpha$<1)

$\beta$ = Smoothing constant for trend (o<β<1)

γ = Smoothing constant for seasonality factor

n = Number of periods in forecast lead period

p = Number of periods in seasonal cycle

$F_{t+n}$ = Winter's forecast for period t+n

## 2.3. Measure demand forecast error

To find out the most accurate demand forecasting method, it can be determined by comparing the smallest error. To get the error value, here are the three most popular steps, they are mean squared error (MSE), mean absolute deviation (MAD), and mean absolute percent error (MAPE) [2].

Mean Squared Error measures the average of the squared differences between the forecasted and observed values. This method is appropriate when forecast error has a distribution that is symmetric about zero and if the cost of large error is much larger than the gains from very accurate forecast [1]. The formula is:

$$\text{MSE} = \frac{\sum (\text{Forecast Errors})^2}{n} \tag{13}$$

Where:

$F_e$= Forecast error of demand value at time t

n = Number of time period

Mean Absolute Deviation is done by using the absolute value of the estimated error divided by the number of periods. This method is appropriate if the forecast error does not have a symmetric distribution and if the cost of a forecast error is proportional to the size of the error [1]. It is expressed as shown as below:

$$\text{MAD} = \frac{\sum |\text{Actual-Forecast}|}{n} \tag{14}$$

Where:

$F_t$= Forecast demand value at time t

$D_t$ = Actual demand at time t

$A_t$ = Absolute value of forecast error at time t

n = Number of time period

Mean Absolute Percent Error is useful to avoid the large number of MSE and MAD when the forecast item is measured in thousands. This method is appropriate when forecast has significant seasonality and demand varies considerably from one period to the next [1]. This MAPE is calculated as:

$$\text{MAPE} = \frac{\int_{i=1}^{n} 100 \left|\text{Actual-Forecast}\right| / \text{Actual}}{n} \tag{15}$$

Where:

$F_t$= Forecast demand value at time t

$D_t$ = Actual demand at time t

$A_t$ = Absolute value of forecast error at time t

n = Number of time period

### 2.4. Tracking signal

The tracking signal (TS) is the ratio between bias and MAD. This method is use to track and control the forecasting method. If the TS is outside the range ±6, so the forecast is biased and is either underforecasting (TS<-6) or even overforecasting (TS>6) [1]. The TS is calculated as:

$$\text{TS} = \frac{\text{bias}_t}{\text{MAD}_t} \text{ and } \text{bias}_n = \sum_{t=1}^{n} E_t \quad (16)$$

## 3. Methodology

The research design for this study are derived from background, problem identification, objectives, data collection, data analysis and conclusion and recommendation.

### 3.1. Background

The result of interview that researcher took with the director of XYZ to seeks current problems the company faced is the company had a problem with their inventory, which caused XYZ to have high trade debt with RPG.

### 3.2. Problem identification

Researcher did observation and depth-interview to get a qualitative data of their company conducted with the director of XYZ directly. The purpose of this stage is to narrowing the problem that company had which is their demand are often different from the actual so the error forecasting affects the high cost of overstocking and understocking.

### 3.3. Objectives

The objectives of this research are to find out the appropriate demand forecasting method for PT XYZ.

### 3.4. Data collection

Primary data is a data obtained directly from interview. In this research, the effectiveness of current system for demand forecasting will be obtained by analyzing the situation and problem they faced from interview. Secondary data is a data that company or other sources already have and readily available to be collected. These data will obtain from the director of PT XYZ. The data that will be obtain is the sales data of PT XYZ (included branches) from May 2015 until April 2018.

### 3.5. Data analysis

After the researcher collect the data, researcher will analyze the problem to solve company's problems to find out which one is the best solution for company to reduce their problems. There are 4 stages that researcher do:

1. Calculate the number of demand forecasting using time series forecasting there are Simple Moving Average, Simple Exponential Smoothing, Holt's Model and Winter's Model.
2. Calculate the error on those demand forecasting method and calculate the tracking signal.
3. Choose the best demand forecasting method by comparing the smallest MAD and TS value.
4. Choose the best demand forecasting method to apply.

### 3.6. Conclusion and recommendation

The final step of this research is to summarize by making a conclusion and give a best solution as recommendation that can solving the problems based on the analysis.

## 4. Result and Discussion

### 4.1. Result

In this research, demand forecasting is made based on historical data from May 2015 to April 2018. Researcher choose MAD as a method of measuring forecast error due

to the characteristics possessed by the seven articles; 704BW-XL, 704BW-L, 704BW-M, 302B(S)-36, 302B(S)-34, 708-L and 708-M which has forecast errors that are not symmetric distribution.

Table 1: MAD Comparison Result.

| MAD | 704BW-XL | 704BW-L | 704BW-M | 302B(S)-36 | 302B(S)-34 | 708-L | 708-M |
|---|---|---|---|---|---|---|---|
| **Simple Moving Average** | 2,905.44 | 2931.70 | 2015.52 | 790.09 | 907.85 | 827.5 | 811.53 |
| **Simple Exponential Smoothing** | 4973 | 4385.83 | 3029.46 | 1385.29 | 1409.33 | 1589.66 | 1591.24 |
| **Holt's Model** | 4916.192 | 4297.389 | 2978.848 | 1424.58 | 1421.189 | 1459.755 | 1470.673 |
| **Winter's Model** | 8535.71 | 7775.98 | 5082.97 | 2248.39 | 2403.82 | 2446.93 | 2190.882 |

Source: Author's own work

Based on forecast results using MAD, Simple Moving Average method is the best method compared to the other three methods as we can see in Table 1. The purpose of this comparison is to find the most suitable method for each of the seven selected articles. The lowest the MAD is the better the forecasting method accuracy is. The small error means there is only a small difference between the actual demand and predicted demand.

Table 2: Track Signal Result.

| | 704BW-XL | 704BW-L | 704BW-M | 302B(S)-36 | 302B(S)-34 | 708-L | 708-M |
|---|---|---|---|---|---|---|---|
| **MAD** | 2905.44 | 2931.7 | 2015.52 | 790.09 | 907.85 | 827.5 | 811.53 |
| **TS** | 3 | 2.63 | 4.51 | 3.08 | 1.99 | 17 | 18 |

Source: Author's own work

Based on the table above, it also can be seen the error measurement and the tracking signal of simple moving average method that used to track and control the forecasting method. It useful to measure whether the forecasting method was either under forecasting (TS<-6) or over forecasting (TS>6) (Chopra & Meindl, 2016).This simple moving average method generates TS value of 704BW-XL is 3, 704BW-L is 2.63, 704BW-M is 4.51, 302B(S)-36 is 3.08, 302B(S)-34 is 1.99, so we can conclude if these are still in the coverage of its rule thumb.

However, the TS value of 708-L is17 and 708-M is 18 which means these values are crossed the limit value of 6. Therefore, the current 12-period simple moving average method cannot be continued. To overcome this problem, researcher replace the current t period into nine periods where it produces a second smallest MAD, i.e. TS value of 708-L is 3.4 and TS value of 708-M is 5.5 which they are still within the limit or even

barely crossed the limit value of 6. However, when the new demand has arrived, it will adapt with demand pattern where the number will change.

Below is the result of Simple Moving Average method that applied to predict the demand forecast in May 2018 (in pieces).

Table 3: Demand Forecasting for May 2018.

| 704BW-XL | 704BW-L | 704BW-M | 302BS(S)-36 | 302B(S)-34 | 708-L | 708-M |
|---|---|---|---|---|---|---|
| 12,824 | 11,025 | 6593 | 4876 | 4836 | 4892 | 3725 |

Source: Author's own work

Demand forecasting should be re-estimated each month while using a moving average. In accordance with the principle of moving on this method, that the new demand is calculated for the upcoming period, then to forecast the demand in the next period, the oldest number is dropped and the demand for the latest period is added to determine the new average to be used as an estimate. But, it does not mean if all the calculation results of this method are perfect, it needs a combination by using expert judgment, so that the bias between actual and forecast is small.

## 4.2. Discussion

The company can accept well about the method of calculation of demand forecasting because as a company that provides stocks, this forecast is one of important indicator for company that deal directly with the amount of inventory. Afterwards, the advantages of this method are the simplicity of its use, easy to understand, easy to implement and cheap. To apply this method, the company only needs Microsoft Excel spreadsheets and simple excel functions which the following equations can be found in the given literature.

However, the results of each of these demand forecasting calculations will continue to be combined with the judgement of the sales and finance divisions to measure the capabilities in terms of previous sales as well as in terms of finance. The company is also considering the growth sales, which means the demand forecasting calculations must have a higher amount than in the previous year in the same month. If the calculation result is lower, the company will combine it by using expert judgment. Whereas, if the number of forecasting demand is higher than the previous year in the same month and capable for the company, then the company will take the results of the calculation.

# 5. Conclusion and Recommendation

## 5.1. Conclusion

The aim of this research is to determine the appropriate of demand forecasting method which gives a best performance and compatible for the company by comparing four forecasting methods. Based on the data analysis using simple moving average, simple exponential smoothing, holt's model and winter's model, the best demand forecasting method that compatible for PT XYZ is simple moving average. The 12-period simple moving average has the lowest number of MAD and the TS value are still within the limit in all articles that has been analyzed which are 704BW-XL, 704BW-L, 704BW-M, 302B(S)-36, 302B(S)-34, and nine period simple moving average for 708-L and 708-M.

Table 4: New Track Signal Result.

| | 704BW-XL | 704BW-L | 704BW-M | 302B(S)-36 | 302B(S)-34 | 708-L | 708-M |
|---|---|---|---|---|---|---|---|
| **MAD** | 2905.44 | 2931.7 | 2015.52 | 790.09 | 907.85 | 1204.2 | 1129.33 |
| **TS** | 3 | 2.63 | 4.51 | 3.08 | 1.99 | 3.4 | 5.5 |

Source: Author's own work

According to the results, the method will be proposed for PT XYZ to assist the sales division in overcoming uncertain demand forecasting problems. The method is expected to be a solution to get better results than the methods used before. So, it is expected to reduce the overstock, understock and maximize profitability at XYZ.

## 5.2. Recommendation

It is recommended that XYZ considers to apply the demand forecasting method based on simple moving average. To apply the method in a proper way, make sure if the sales division record the demand data systematically and use Microsoft Excel spreadsheet well. Moreover, sales division should have a proper training to understand the concept of demand forecasting and to learn how to use the proposed method. To improve the accuracy of the forecast, sales division can use the calculation results combine with expert judgement. Sales division have to re-estimate the demand forecasting monthly when there is a new demand to calculated for the upcoming period. Every three months, sales division have to calculate the demand forecasting using all the methods that analyzed in this study to see the changing pattern on demand and to calculate the tracking signal in every demand forecasting to know whether the demand forecasting method is still appropriate or not.

The demand forecasting studied in this research can be applied for other PT XYZ's products. Due to the limitation of time and data, this research only focused on demand forecasting. However, many studies with other topics can be done at PT XYZ. Future research can be conducted in the same topic or it can be expanded into other topics such as inventory management and distribution resource planning that is also important for this company in the future.

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