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DEMAND FORECAST AND AGGREGATE PLANNING STRATEGY AT PT LABITTA BENDERANG USAHA

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Abstract. PT Labitta Benderang Usaha is a footwear company in Indonesia. On one of the brands, Lamonty, PT LBU often experiences the mismatch between production and demand because the company only uses naive approach to their forecasting method. To deal with high predicted demand, PT LBU uses overtime as their aggregate planning strategy. But the company still experience production shortages. However, the company is required to increase efficiency in production sector. So, the most optimal demand forecasting method and aggregate planning strategy are needed. Forecasting method used is time-series forecasting method that using Simple Moving Average, Single Exponential Smoothing, Holt's model, and Winter's model. The error of these methods will be compared with 3 parameters; Mean Squared Error, Mean Absolute Deviation, and Mean Absolute Percentage Error. From the error evaluation, the Winter's Model has the smallest MAD, MSE, MAPE which is 105.33, 21813.9, and 4.72%. This result can be used to calculate the aggregate planning strategy. There are 4 strategies that were practiced, which are company strategy, chase strategy, level strategy, and linear programming. Linear programming strategy has the smallest production cost which is IDR 463,092,586. This strategy can minimize the cost from company strategy up to IDR 169,147,414.

Keywords: footwear industry; demand forecasting; aggregate planning; production cost

INTRODUCTION

One of the growing industries in Indonesia is the manufacturing industry. Based on Indonesian Ministry of Industry (2018), one of the manufacturing sectors that makes a major contribution to the national economy is the footwear industry for daily use. Historically, every eight years, the export value of the footwear industry rose by two digits. During 2002 to 2010, exports of footwear rose 118% and from 2010 to 2018 rose by 104%. With increasing demand, footwear companies must be able to determine the demand in the market to avoid the supply-demand mismatch. One of the strategies to forecast the demand is to use the demand forecasting method (Junaedi & Suharsono, 2017).

Demand forecasting has always been crucial for the better production process. As the need for more efficient operations in the modern business environment, more effective forecasting methods are needed (Sahin et al, 2013). In operational function, forecasting is used to make periodic decisions involving supplier selection, process selection, capacity planning, and facility layout. Forecasts are also needed to determine how a firm operates processes on a day-to-day basis. (Jacobs & Chase, 2014). To meet the demand, footwear manufacturing companies need to find the most optimal rate of production. In each production activity, the company will always deal with costs including inventory costs, labor costs, and overtime costs, etc (Mariyani, 2014). To optimize production costs, there are several strategies could be done. One of them is by using aggregate planning method. Aggregate planning is an intermediate-range planning technique, usually covering the frame of 2-12 months for the production process, in order to determine the best approach to meet the set objectives and to meet the forecasted demand for its products, varying orders of customers over the period of medium and long-term adjusting overtime and regular rates of production, back ordering and subcontracting rates, level of inventory, level of labor hours, and the other factor which can be controlled (Katie, 2012). Demand forecasting method and aggregate planning strategy are important to use in the production process for footwear companies.

One of the examples of medium and large-sized footwear company in Indonesia is PT Labitta Benderang Usaha or called PT LBU. PT LBU serves medium and large-sized companies both private and government. On one of the brand, Lamonty, the company are often faced the mismatch between demand and production. In targeting the number of shoes to be produced, PT LBU uses the previous month data for production or called the naive approach. The company uses this approach with adjustment based on the trend in Indonesia, like the holiday season, the month of Ramadan, or other trends. In the high predicted demand months, company increase working hours and decides overtime strategy as an aggregate planning strategy. With only overtime strategy, the company continues to experience production shortages in certain months so that sometimes there are stock outs.

With fluctuating demand forecasting for the past 3 years and also with erratic employee overtime, better production planning is needed. PT LBU needs further analysis of other demand forecasting method and aggregate planning strategies to find the most

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optimal production strategy. So, the aims of this research are to identify the most optimal demand forecasting method and the most appropriate aggregate planning to be implemented in PT LBU focusing on Lamonty Brand.

LITERATURE REVIEW

Forecasting

Forecasting is a prediction about what will happen in the future. This prediction is interpreted as a scientific process to estimate future events with calculations based on data in the previous period. The data in the previous period was initially analyzed to determine the underlying trends that characterize the data and information is then used in a predetermined way to obtain future estimates. Forecasts made with the assumption that the characteristics of the trends identified in the previous period data will continue into the future must always be open for dynamic changes in accordance with actual market conditions (Lewis, C. 1997).

Time Series Forecasting Method

Time Series forecasting methods use historical demand to make predictions. This is based on the assumption that previous demand in the past is a good indicator of future demand. This method is considered most appropriate when basic demand patterns do not change significantly from one year to the next and this method is the simplest method to implement and can function as one of the results for the demand forecast. (Chopra and Meindl, 2016)

Simple Moving Average

The simple moving average method is used when demand does not have observable trends or seasons. In this method, the level in the Period is estimated as the average demand during the last N period (Chopra and Meindl, 2016).

Simple Exponential Smoothing

The simple exponential smoothing method is appropriate when the demand has no observable trend or seasonality.

Trend-Corrected Exponential Smoothing (Holt's Model)

This method is said to be appropriate when demand data is assumed to have levels and trends in systematic components, but there is no seasonality. (Chopra and Meindl, 2016).

Trend and Seasonality-Corrected Exponential Smoothing (Winter's Model)

This method is appropriate for the systematic component of demand and has various factors, such as having levels, trends, and seasonal factors (Chopra and Meindl, 2016).

Forecast Error

As told earlier that all estimates will be wrong, estimates of measurement estimates will be needed. this can happen because some estimates will be higher than demand, and some will be lower. Managing the forecast process requires a slight error between the actual demand and the estimated demand. To determine the best forecasting technique for a set of data, estimation errors must be measured. (Coyle et al, 2008)

1. Mean Squared Error (MSE)
2. Mean Absolute Deviation (MAD)
3. Mean Absolute Percentage Error (MAPE)

Aggregate Planning

Aggregate planning is the development of long-term output and resource plans in aggregate units of measure. The aggregate plan determines the level of output during the medium-term planning horizon, usually monthly or quarterly. Aggregate planning is driven by the results of demand forecasting. (Collier & Evans, 2009).

Anggregate Planning Strategies

There are essentially three distinct aggregate planning strategies for achieving balance among these costs. these strategies involve trade-offs among capital investments, workforce size, work hours, inventory, and backlogs/lost sales. The three strategies are as follows (Chopra & Meindl, 2016):

1. Chase Strategy
   With this strategy, the production rate is synchronized with the demand rate by varying machine capacity or hiring and laying off the employee's as the demand rate varies.
2. Level Strategy
   With the strategy, stable machine capacity and workforce are maintained with a constant output rate. shortages and surpluses result in inventory levels fluctuating over time.

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Anggregate Planning Methods

1. Linear Programming
2. Graphical Methods

Decision Variables

In constructing an aggregate planning model, there is need to identify the set of decision variables whose values to be determined as part of the aggregate plan. The predefined decision variables are as follows (Chopra & Meindl, 2016):

W_t : Workforce size for Month *t*
H_t : Number of employee's hired at the beginning of Month *t*
L_t : Number of employee's laid-off at the end of Month *t*
P_t : Number of production in Month *t*
I_t : Inventory number at the end of Month *t*
S_t : Number of units stocked-out or backlogged at the end of Month *t*
C_t : Number of units subcontracted in Month *t*
O_t : Number of overtime hours worked in Month *t*

Objective Function

After constructing the decision variables, in aggregate planning there is need to define the objective function. The objective function is to minimize the totcal cost incurred during the planning horizon. The cost incurred has the following components (Chopra & Meindl, 2016),

METHODOLOGY

Data Collection

At this stage, the data from PT LBU will be collected. There are 2 types of data used in this data collection; Primary data and secondary data. Primary data is data collected directly from observations and interviews with companies. In this study, interview will be conducted with one of the managers at PT Labitta Benderang Usaha and found that there was no demand forecasting method used through operational activities that caused problems in aggregate planning strategies that can increasing production cost. Secondary data is data collected from data available at other companies or sources. In this study, data were collected from one manager at PT Labittta Benderang Usaha focuses on-demand data, sales data, the production cost for Lamonty brands at PT LBU.

Data Analysis

After collecting data, the data will be analyzed to solve the problem based on the theoretical foundation. There are 5 stages to analyze the data:

Measure Demand Forecasting

To find out the appropriate demand forecasting method in PT LBU according to the existing production policies is using time-series methods.

Measure Forecasting Error

After measuring the forecasting of demand through 5 methods, the forecasting error will be calculated from the result in the previous stage. There are 3 types of forecasting error.

Compare Forecasting Error

After measuring the forecasting error, forecasting error will be compared due to finding the smallest error among all method. With the small error, the demand forecasting will be more appropriate to use in the company.

Measure the appropriate aggregate planning strategy

After choosing the best demand forecasting method to use, in this stage, Aggregate Planning will be calculated with 3 methods, which are Chase Strategy, Level Strategy, and using Linear Programming.

Choose the most appropriate method

Choose the most appropriate method that has minimum production cost to the company.

Conclusion and Recommendation

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The conclusion focusing on the most suitable demand forecasting method and aggregate planning strategy to apply according to the data analysis stage. For the recommendation, this is focusing on PT LBU and the other company with a similar problem and production policy.

FINDINGS AND ARGUMENT

Demand Forecasting

In forecasting demand for Lamonty Brand in PT LBU, the calculation will be used the demand and production data from January 2016 until December 2018 due to the available data given by the company. The result of this calculation will be compared with the forecasting method the company already implemented to find the most optimal method. In addition, the demand data of Lamonty shows the tendency of a significant signs of trend and seasonality.

Table 1. Error Evaluation

Forecasting Method	MAD	MSE	MAPE(%)
Company Model	164.47	46195,0	6.66
6-month Moving Average	199.76	57568,4	14.44
Single Exponential Smoothing	182.21	55912,1	12.74
Holt's Model	184.24	55140,1	14.69
Winter's Model	105.33	21813,9	4.72

Reference: author analysis, 2019

Shown in Table 1 the summary of MAD, MSE, and MAPE of the method that company already used and all four methods that had been calculated. MAD expresses accuracy in the same units as the data, which helps conceptualize the amount of error. MSE is average difference in squares between the estimated and observed values. Then MAPE expresses accuracy as a percentage of the error. The most optimal forecasting is the method with the smallest error. From the table, the method with the smallest error is Winter's Model with alpha 0.0003, beta 1, and gamma 1 that has MAD 105.33, MSE 21813,9, and MAPE 4.72%. So the forecasting result of winter's model has the smallest amount of error and the smallest percentage of error between actual demand and forecasted demand. From the Table 1 also could be proven the characteristic of Lamonty demand from 2016 until 2018 that has the trend and seasonality. It is proved by the MAD, MSE, and MAPE of all forecasting methods has significant differences since those methods used different number of coefficient. In this case, the best method is winter's method that used coefficients as the representative of trend and seasonality.

Aggregate Planning Strategy

In measuring aggregate planning for Lamonty Brand in PT LBU, the calculation will use the costs and policies related to the production process due to the available data given by the company and the forecasting result in the previous stage. To find the optimal solution of aggregate planning strategy, the total cost of company model will be compared with other methods which are chase strategy, level strategy, and linear programming strategy to find the smallest total cost as the most appropriate aggregate planning strategy to be implemented in Lamonty Brand.

Table 2 Total Production Cost Comparison

Aggregate Planning Strategy	Total Cost
Company Model	IDR632,240,000
Chase Strategy	IDR479,800,000
Level Strategy	IDR558,200,000
Linear Programming Strategy	IDR463,092,586

Reference: author analysis, 2019

Shown in Table 2 the calculation of total cost of the strategy that company already used and all 3 strategies that had been calculated. The most appropriate aggregate planning strategy is the strategy with the smallest total cost. From the table, the strategy with the smallest total cost is using linear programming strategy with total cost IDR 463,092,586. With Level strategy, PT LBU can minimize the total cost up to IDR 169,147,414 for the Lamonty production.

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CONCLUSIONS

From the analysis, there are 5 analysis of demand forecasting methods that had been calculated. The result of the analysis is the comparison of error of all methods. Error that be compared including Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE). From the error evaluation in previous chapter, the Winter's Model has the smallest MAD, MSE, MAPE which is 105.33, and 21813.9, and 4.72% compared to the other methods which are company method that have 164.47 of MAD, 46,195 of MSE, and 6.66% of MAPE, 6-month moving average with 199.76 of MAD, 57568 of MSE, and 14.44% of MAPE, single exponential smoothing with 182.21 of MAD, 55912 of MSE, and 12.74% of MAPE, and Holt's Model with MAD 105.33, MSE 55140, and MAPE 4.72%. It means that Winter's model is the most optimal demand forecasting method to PT LBU use in Lamonty brand.

In the calculation of previous chapter, there are 4 strategy of aggregate planning that were practiced. The first one is Company Strategy that use overtime strategy with constant workforce so the result is there are some stock outs. The second one is Chase strategy that use the same production unit for 12 periods by varying the workforce. So this strategy does not use overtime, stock out, subcontracting, or inventory strategy. The third one is Level Strategy that uses to produce the the expected demand over the next twelve months by maintaining constant workforce. The last strategy is using linear programming. This strategy using solver function in Microsoft excel with some inputs includes decision variables, aggregate plan costs, constraints, subject to constraints, and needs to set values to minimum costs. Using a solver, the decision variables will be filled with the best scenario set by the program. Each strategy resulted the total cost for production in Lamonty shoes in PT LBU. Based on the calculation, linear programming strategy has the smallest production cost which is IDR 463,092,586. This strategy can minimize the total cost from the strategy that company already used up to IDR 169,147,414. So, the most appropriate aggregate planning strategy for Lamonty Brand in PT LBU is using linear programming strategy.

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