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THE IMPLEMENTATION OF DEMAND FORECASTING AND AGGREGATE PLANNING IN SMALL MEDIUM ENTERPRISES OF FURNITURE PRODUCTS IN JEPARA CITY, CENTRAL JAVA PROVINCE, INDONESIA.

Muhammad Luthfi Mishbah, Yuanita Handayati and Noorhan Firdaus Pambudi
School of Business and Management, Institut Teknologi Bandung, Indonesia
Email: luthfi.mishbah@sbm.itb.ac.id

Abstract. Struggling with the advancement of competition in furniture industry in recent years, local small medium enterprises in Jepara has difficulties in managing demand that cause an oversupply and undersupply condition which influenced directly to its production cost and indirectly to its competitive advantage in a global furniture market. This research aims to find the most suitable demand forecasting and aggregate planning that can give the optimum result to the company's demand forecast and the production planning. Time series forecasting will be used in this research. For the aggregate planning method author compare level strategy, chase strategy, and linear programming strategy to find the optimum production cost. The result of this research shows that the most optimum demand forecast for the company is Winter's Model, this method shows the smallest error among the others method. This method also can decrease the excess stock loss value by IDR 564,487,762. The result from forecasting then used to find the optimum production planning. The result shows that linear programming strategy is the optimum aggregate planning for the company. This strategy can decrease production cost in 2019 to IDR 115,075,000.

Keywords: Furniture Industry; Local; Demand Forecasting; Aggregate Planning; Production Cost

INTRODUCTION

According to AMKRI (2015), furniture industry has already spread out around provinces in Indonesia. One of the cities that is reputable for its furniture industry center is Jepara, Central Java, Indonesia. CV Munawir Furniture was established in 1988 and has been operated only in Jepara. Currently, CV Munawir has 130 employees to run their business. The demand for the products usually came from domestic to overseas. For the domestic market, the demand came from big cities especially Jakarta, Medan, Magelang, Yogyakarta, and Purwokerto, while for the overseas market, the demand came from Malaysia. However, as one of the small medium enterprises (SME) in furniture industries, this company must have competitive advantages to make them become more outstanding among the industries.

With this tight competition, many SMEs furniture industries in Jepara are collapsed due to the production inconsistency on fulfilling the quantity of demand, this problem might be happened because of the limited knowledge the human resources have about demand forecasting and aggregate planning to produce the products. CV Munawir Furniture has a problem with its production cost efficiency where it caused by the mismatch between the actual and the forecasted demand. This was occurred because they have symptoms on setting their forecasting demand; they have no sufficient knowledge about another methods of demand forecasting when they are forecasting the demand. Another symptom is how they fulfill the forecasted demand. CV Munawir Furniture only uses constant workforce method with the total of 130 employees in their company and for the production team is 20 Employees. If the demand is reducing, there will be idle workforce arised, otherwise when the demand is rising, they execute overtime method for their employees and its affecting to the quality of the furniture and the company has to pay three times more than the regular payment due to this method.

This research aims to give the company a suitable aggregate planning based on the optimum future demand forecast; this proposed solution can be done by setting the right demand forecasting with the smallest error value measurement. After the results of the desired demand forecasting are obtained, the process continue to find the optimum production by calculating the aggregate planning with the most minimum production cost. This research aims to answer the following research questions. (1) What is the suitable demand forecast method for the company forecasted demand in the future? and (2) What is the suitable aggregate planning for giving profitable advantages to the company?

LITERATURE REVIEW

Operation Management Strategic Decision

Operation Management has ten strategic decision; there are: Design of goods and services, Managing quality, Process and capacity design, Location strategy, Layout strategy, Human resources, and job design, Supply-chain management, Inventory management,

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Scheduling, and Maintenance. Those are the strategic decision in Operation management, and for an Operation manager, they must successfully address these strategic decisions (Heizer & Render, 2014).

Time Series Demand Forecasting

One of four methods in demand forecasting is Time series method, and one Of the method in time series forecasting method is Adaptive forecasting. This method, the estimates of level, seasonality, and trend are updated after each demand observation. (Chopra & Meindl, 2013). There are four methods in adaptive forecasting, there are Moving Average, simple exponential smoothing, Holt's Model, and the last is Winter's Model. (Chopra & Meindl, 2013). Defining terms in forecasting: Estimate of level at the end of period t (Lt), estimate of trend at the end of period t (Tt), estimate of seasonal factor for period t (St), Forecast of demand for period t (Ft), Actual demand observed in period t (Dt).

Simple Moving Average

This method is used if no trend or seasonality occurs, the formula: $L_t = \frac{D_1+D_{t-1}+\cdots+D_{t-N+1}}{N}$

Simple Exponential Smoothing

This method is used when the demand has no observable trend or seasonality for determining the level in a certain period (Chopra & Meindl, 2013): $L_0 = \frac{1}{n}\sum_{i=1}^{n} Di$, and for the forecast fo future period is: $F_{t+1} = L_t$.

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). For Forecast future period is: $F_{t+n} = L_t + nT_t$, and for estime the levels and trends are: $L_{t+1} = \alpha D_{t+1} + (1-\alpha)(L_t + T_t)$ and $T_{t+1} = \beta(L_{t+1} - L_t) + (1-\beta)T_t$

Winter's Model

This method is suitable if the systematic component of demand has a level, a trend, and a seasonal factor (Chopra and Meindl, 2016). To calculate the future period forecast is: $F_{t+n} = (L_t + T_t)S_{t+1}$ and for the Level estimate (L_{t+1}), Trend (T_{t+1}), and Seasonality (S_{t+p+1}) are: $L_{t+1} = \alpha(\frac{D_{t+1}}{S_{t+1}}) + (1-\alpha)(L_t + T_t)$; $T_{t+1} = \beta(L_{t+1} - L_t) + (1-\beta)T_t$; $S_{t+p+1} = \gamma(\frac{D_{t+1}}{L_{t+1}}) + (1-\gamma)S_{t+1}$.

Forecast Error

As already mentioned, one of the requirements forecasts features is inaccurate so that we can reduce the inaccuracy by measuring the forecast error. To measure the forecast error, three methods can be used to measure the demand forecast error. There are Mean Squared Error, Mean Absolute Deviation, Mean Absolute Percentage Error. Previous study was comparing the appropriate forecasting method by using MAD, MSE (Agung, 2009), and MAPE (Rivandad, et al., 2019).

Mean Squared Error (MSE)

The first method is MSE (mean squared error) the formula is: $En = \frac{1}{n}\sum_{t=1}^{n} E_t^2$, MSE can be related to the variance of the forecast error (Chopra & Meindl, 2013), the less score of MSE the better the forecast method.

Mean Absolute Deviation (MAD)

The second method is MAD (mean absolute deviation) the formula is: $Dn = \frac{1}{n}\sum_{t=1}^{n} A_t$, MAD can be used to estimate the random component's standard deviation if the random component is normally distributed (Chopra & Meindl, 2013), the less score of MAD the better the forecast method.

Mean Absolute Percentage Error (MAPE)

The third method is MASPE (Mean Absolute Percentage Error) the formula is: $MAPEn = \sum_{t=1}^{n} |\frac{E_t}{D_t}|100/n$, This method is a good measure of forecast error when the underlying forecast has considerable seasonality and demand varies significantly from period to period (Chopra & Meindl, 2013), the less score of MAPE the better the forecast method.

Aggregate Planning

Aggregate planning is a process through which a company determines its planned capacity levels, production, subcontracting, inventory, inventories, and even pricing over a given time horizon (Chopra & Meindl, 2013). The aim of overall planning is to create a plan that meets demand while maximizing profit. The main objective of the aggregate planner is to identify the following operational parameters over the specified time horizon: production rate, workforce, overtime, capacity level of the machine, subcontracting, backlog, stock (Chopra & Meindl, 2013).

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Anggregate Planning Strategies

In general, a company tries to make the best possible use of a combination of three costs. These strategies include trade-offs between investment capital, the size of the workforce, working hours, inventory, and backlog. The following three strategies are:

1. *Level Strategy*

This strategy maintains a stable machine capacity and workforce at a constant rate of output. Shortages and surpluses lead to fluctuating inventory levels over time (Chopra & Meindl, 2013). Production is not synchronized with demand in this case. Either inventory is built in anticipation of future demand or delays from high to low demand periods are carried over. This strategy maintains relatively low capacity and cost for changing capacity (Chopra & Meindl, 2013). Level strategy had the cheapest cost among other aggregate planning method in previous case study in similar small medium enterprise (Rivandad, et al., 2019).

2. *Chase Strategy*

In this strategy, the production rate is synchronized with the demand rate by changing the capacity of the machine or by hiring and employing staff, as the demand rate changes (Chopra & Meindl, 2013). This strategy can be costly to implement if the cost of a different machine or work capacity is high over time. It can also have a major negative effect on the morality of the workforce (Chopra & Meindl, 2013).

3. *Linear Programming Strategy*

According to (Chopra & Meindl, 2013), Linear Programming can find the optimum solution by creating high profit with satisfying the constraints that faces by the company. To maximize its profit the company can use This strategy because Linear Programming is a tool that highly effective to increase the profit while still subjected to the constraints of the company. This strategy uses Solver function add-ins in Microsoft Excel Software. This method had been used in other case study of furniture company in deciding production plan for several type of furniture product, the optimal profit can be obtained in linear programming using simplex method (Prananda, Suhartono, & Mastika, 2013). According to (Chopra & Meindl, 2013) there are variables values to be determined as part of the aggregate planning using linear programming. The following decision variables are:

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

There are other aggregate planning methods also had been used by previous research such as transportation method, trial and error method, and permanent labor. Transportation method showed the cheapest cost among three of them in previous research (Kusumaningrum, Rachmadita, & Sandora, 2018). This research had limited the aggregate planning into level, chase, and linear programming strategy due to limited option for production plan available for the company.

METHODOLOGY

Data Collection

The author has chosen an interview as one of the tools used to gain data. The reason is that first, the respondent is not that many people. It consists only of several people as an employee or staff in CV Munawir Furniture. Second, the author wishes to gain in-deep information regarding the production activity in CV Munawir Furniture. In contrary to a questionnaire, the interview can provide it. After that observation is done by the author to gain full experience and involve firsthand in the production activity of CV Munawir Furniture. The observation will also be the clarification of whether the information gained from the interview is true or not. Finally, the author will use secondary data as one of the sources of data. It consists of written reports regarding the production activity. The reports will be obtained through interviews. It also represents the information which the author requires.

Data Analysis

Data analysis are divided into three steps as the general view of the data analysis process; first is choosing the demand forecasting methods and aggregate planning methods that will be compared. In this case, the forecast method will be using four methods of forecast methods; there are Moving Average, Exponential Smoothing, Holt model, and winter model. For the aggregate planning method, this research will use Level Strategy (Overtime) and Chase Strategy (Hiring/Layoff) and Linear Programming Strategy. The second step is choosing the best Aggregate planning method and Forecast method based on the smallest production cost and smallest error and finally use these methods to forecast and set the aggregate planning for year 2019. After all the research steps are conducted, the author will produce a conclusion in answer to the research question and fulfilling the research objectives. And the solution will become a recommendation for the company; the recommendation is to help the company to find the best aggregate planning and demand forecast method that can satisfy the needs of the company.

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FINDINGS AND ARGUMENT

Company Demand Forecasting

In forecasting demand for CV Munawir Furniture, the data is taken quarterly from 2015 to 2018. It is because the data limitation availability from the company, CV Munawir Furniture use previous actual demand data with subjective adjustment for the forecast demand in the current year. The result for the forecast shown below:

Table 1 Company's Demand Forecasting Current Condition

Year	Quarter	Actual	Forecast	Error	Absolute Error	Squared Error	% Error
2015	1	195	220	-25	25	625	0.13
	2	135	145	-10	10	100	0.07
	3	235	265	-30	30	900	0.13
	4	125	155	-30	30	900	0.24
2016	1	165	195	-30	30	900	0.18
	2	120	130	-10	10	100	0.08
	3	200	230	-30	30	900	0.15
	4	105	135	-30	30	900	0.29
2017	1	130	160	-30	30	900	0.23
	2	95	105	-10	10	100	0.11
	3	155	185	-30	30	900	0.19
	4	50	90	-40	40	1600	0.80
2018	1	92	130	-38	38	1444	0.41
	2	80	90	-10	10	100	0.13
	3	110	150	-40	40	1600	0.36
	4	65	70	-5	5	25	0.08
ERROR MEASUREMENT =					**24.88**	**749.63**	**0.22**
					MAD	**MSE**	**MAPE**

The current condition of demand forecast in CV Munawir Furniture shows that there are many margins is excess stock, it becomes the main problem because the company produce the whole forecasted demand.

Error Evaluation

Table 1. Error Evaluation

Method	Parameter			Error Measurement		
	Alpha (α)	Beta (β)	Gamma (γ)	MAD	MSE	MAPE
Company Model	N/A	N/A	N/A	24.875	749.625	0.223687
Moving Average	N/A	N/A	N/A	30	1231.54	0.33
Exponential Smoothing	0.35	N/A	N/A	41.38	2243.41	0.41
Holts Model	0.11	1	N/A	34.92	1686.16	0.31
Winter Model	0.51	0.24	0.61	**12.37***	**233.254***	**0.13***

According to Table 1, the smallest error between the four methods of demand forecasting is Winter model. The error value of this method is MAD = 12.37, MSE = 233.23, and MAPE = 0.13. It happens because Winter Model are considering the Level, Trend, and Season for the demand forecasting, with the optimum alpha, beta, and gamma this method can decrease the error from the company model significantly. The optimum forecast parameters value used is alpha 0.51, beta 0.24, gamma 0.61. This condition of forecast parameters shows that this demand characteristic is have base level, trend, and season and the amount of each characteristic shown in the forecast parameter's alpha, beta, and gamma. This winter's model can decrease the error half from the current condition error measurement, which is MAD 24.88, MSE 749.63, MAPE 0.22

Aggregate Planning Strategy

Before measuring the aggregate planning for CV Munawir Furniture, the author collects essentials data of the production cost for calculating the aggregate planning. In other hand, the author also collects the policies as the constraints for the aggregate planning, the result of the data is shown in these tables below:

Table 2. Production Costs for Lamonty in CV Munawir Furniture

Cost Item	Value
Material	IDR 2,000,000 per set
Inventory Holding	IDR 125,000 per unit
Stockout	IDR 1,420,000 per unit
Hiring and training	IDR 350,000 per worker

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Layoff	IDR 600,000 per worker
Regular time	IDR 10,000 per hour
Overtime	IDR 15,000 per hour
Subcontracting	IDR 3,000,000 per unit

Reference: CV Munawir Furniture, 2019

Table 3. Production Policies for Lamonty in CV Munawir Furniture

Constraints	Value
Labor hours required	80 hours per unit
Production time	8 hours per day
Production time	60 days per quarter
Regular time a month	480 hours per quarter
Production Capacity per Labor	6 Units/Labour
Cost of Regular time labor a month	IDR 4,800,000 per quarter

Reference: CV Munawir Furniture, 2019

For the sequence for calculating the aggregate planning the author will calculate the company aggregate planning as the current condition, after that the author will calculate the level, chase, and linear programming strategy as the proposed aggregate planning

Production Cost Comparison

Table 4 Toal Production Cost Comparison

Aggregate Planning Strategy	Total Cost
Company Model	IDR 1,078,000,000
Chase Strategy	IDR 1,033,505,000
Level Strategy	IDR 993,550,000
Linear Programming Strategy	IDR 980,800,000

According Table 9, the company model was the most expensive cost among the others, the total cost of company model aggregate planning is IDR 1,078,000,000 it happens because the company model keeps using constant workforce while some of the worker is idle and overtime when the production is exceed the capacity. For the Level strategy the total cost is IDR 993,550,000. Level strategy cost can decrease the cost to IDR 84,450,000 because in level strategy the company already adjust the workforce and varying inventory, and backorder to produce the furniture. In chase strategy the total cost is IDR 1,033,505,000, it can decrease the cost from the company model to IDR 44,495,000 because in chase strategy the company need to adjust the workforce and varying the workforce by hiring and layoff the workforce each period if needed. And for the last strategy is Optimization using Linear Programming, this strategy total cost is IDR 980,800,000. This strategy can decrease the cost to IDR 97,200,000 because this strategy considers the level and chase strategy to find the most production method with the most optimum production cost.

CONCLUSIONS

The best method for demand forecasting for CV Munawir Furniture is Winter's Model because the error is the smallest among the other methods with the forecast parameters Alpha 0.51, Beta 0.24, Gamma 0.61. This method is chosen to forecast the demand of CV Munawir Furniture in 2019, the result for the demand forecast in 2019 is in quarter 1 is 91 sets, quarter 2 is 71 sets, quarter 3 is 107 sets with the total mismatch value is IDR 291,5125,238. Based on the result of proposed solution in demand forecasting, the author already calculates the best proposed solution method for the company. According to the analysis result this proposed solution method can decrease the loss of excess stock value

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by IDR 564,487,762. But forecasted demand are not always accurate, and this demand forecasting only using previous actual demand data and time series as the variable of the forecasting. So, this proposed solution can be author's recommendation for the owner of the company to become the base line in taking the decision of the forecasted demand in 2019. Because the owner still can consider the macroeconomics factors or another factor that can affect the forecasted demand.

For the aggregate planning, according to the result in Linear Programming Strategy with the demand data in 2019 author recommend the owner to varying the workforce and the production level based on the proposed solution strategy. Once again this recommendation is become the base line for the owner of the company there will be another external or internal factor that can affect the aggregate planning for the company such as government policy, labour union, and the linear programming strategy shows that the company need to lay off some of their workforce, this might be become dilemma for the owner because there will be a negative effect to the employee life and based on the interview with the owner for hiring a good and highly skilled employee for furniture industries is not easy. In 2019 if the company still use the current aggregate planning the cost will be IDR 1,026,000 and if the company choose the proposed solution the production cost will be reduce to IDR 910,925,000

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