

ANALYSIS OF AGGREGATE PRODUCTION PLAN FOR MINIMIZING COST OF COAL PRODUCTION AT PT XYZ

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Abstract

To be able to increase profits, one way that companies can do is to consider the number of product requests. As a form of way to control this, companies need to plan and control the amount of production well to be able to minimize the occurrence of excess product inventory. The purpose of this study is to determine an aggregate production plan that can minimize production costs at PT XYZ. The research was conducted by taking coal products which are the main commodity of the company. The data used in this study is sales data for 2019. The use of the chase strategy in the production plan resulted in a lower total cost of 18.85% compared to the initial cost, and 3.80% lower than using the level strategy.

Keywords: *Aggregate Production Plan, Level Strategy, Chase Strategy*

Preliminary

One of the main commodities from Indonesia is the product of natural resources and minerals which are quite abundant. One of the commodities that have a significant impact on state revenues is coal. PT XYZ is a company engaged in the production and management of natural and mineral resources, especially coal. The company, which is located in East Kalimantan, Indonesia, markets its products widely for export and domestic markets. The land area managed by PT XYZ reaches approximately 70,000 hectares, with 3,000 employees working both in the mine and office areas and the support of around 15,000 personnel from related companies. Currently, PT XYZ's production capacity can reach 40 million tons of coal per year [1-4].

In 2019, the company recorded a 13.5% increase in coal demand compared to the previous period. The increase in demand for coal also increased the company's revenue with an average increase of 12.2%. In 2020 the company has a target to increase the company's revenue. One of the efforts that the company can do is to

increase productivity with good aggregate production costs with the aim of meeting consumer demand. To support this, it is necessary to plan and control good production for a smooth production process. With a good planning and control process, it is expected to increase the company's productivity with the ultimate goal of increasing profits with minimal costs and being able to face competition with competitors.

This research focuses on scheduling aggregate production to meet product demand with minimum production costs. The aggregate production plan is a medium-term plan related to determining production, inventory, and labor to meet consumer demand [5, 6]. In the aggregate production plan, it is determined how to fulfill consumer demand within the next 3-18 periods by adjusting several factors including labor schedules, inventory levels, and several other variables [7-10].

Studi Literatur

Forecasting

Forecasting is an art and science to predicts future events by involving historical data to project that data into the future with a mathematical model approach [11]. Companies engaged in production are required to meet consumer demand in the future, where the amount of consumer demand is something that cannot be predicted. Production forecasting approaches using historical data to forecast future demand. It is hoped that with the forecasting process, the company can predict how much consumer demand will come. This is done to reduce risks that occur such as excess or shortage of products to meet consumer demand. By forecasting product demand, the company determines how much inventory is needed, how much production must be carried out, and how much material needs to be prepared and ordered through suppliers to meet the predicted consumer demand [12, 13]. Without forecasting, companies need to prepare large amounts of inventory, this has an impact on the costs that need to be incurred to be large as well. With large costs, the company also has a great risk of experiencing losses due to products that are not successfully sold due to lack of demand, or are damaged because they are not used. Russell & Taylor further stated that accurate forecasting is almost impossible to do, but good forecasting can reduce uncertainty in the future.

Aggregate Planning

The aggregate production plan begins with an imbalance between demand and production capacity in each planning period. This is due to fluctuations in demand from one period to another. The purpose of the aggregate production plan is to achieve a balance between demand and production capacity to produce minimum costs [14, 15].

Aggregate product planning is a production planning process carried out by adjusting production capacity and resources to meet demand with minimal total production costs [16]. This production plan is made at a strategic level to focus on the level of production expressed in the form of aggregate data (family). The units used are usually expressed in currency so that all units of the product need to be converted into a uniform form. Uniformity in the form of units used is done to simplify the planning process with many products and many units.

The concept of aggregate planning is to choose the strategy that the company will use in the production process to absorb fluctuations in demand economically [17]. The input of aggregate planning consists of 4 main components, namely human resources, demand forecasting, company policies, and production costs. In terms of resources, labor and facilities are the main concerns in this planning process. Demand forecasting is obtained from past demand data which is projected with a certain method to produce predictions of future demand. Company policies related to

hours worked, overtime, subcontracting, and inventory levels. While the costs in question are components of production costs incurred by the company such as storage costs, inventory costs, and company production operational costs.

Apart from the low cost, other factors need to be considered, such as the smoothness of the work, the level of inventory, and the fulfillment of consumer demand.

Aggregate Production Plan Strategy

There are 3 (three) strategies that can be used in the aggregate production planning process, namely chase strategy, level strategy, and mixed strategy [12, 18]. Chase strategy varies production capacity by using regular time, overtime, and subcontracting. The level strategy of excess production is kept as inventory when the amount of demand increases so that variations in demand are suppressed by increasing inventory, while the mixed strategy is a combination of the two strategies previously mentioned.

Problems in the aggregate production plan can be solved by considering the various decisions available, namely demand modification or capacity modification. The choice of capacity is the company's choice not to change demand, but to change the company's capacity to anticipate fluctuations in demand. Changing inventory levels is also a strategy that can be carried out by companies, the consequences that arise from using this strategy are the emergence of inventory costs or storage costs.

Chase strategy is a strategy that tries to achieve a level of output each period that meets the amount of demand for that period. In this strategy, the number of workers is adjusted to the needs of customer requests every month. The consequence of using this strategy is the emergence of hire (employee recruitment) and layoff (employee termination). In addition, the consequence of using this strategy is the morale of workers who will be affected due to the uncertainty of work and the emergence of recruitment and training costs.

Level strategy is an aggregate plan in which the production level for each period is fixed. In this strategy, the number of workers is maintained as much as possible by utilizing overtime or by utilizing subcontracting to other companies. Companies work overtime when demand is high, and reduce working hours when demand is low. In selecting overtime, companies also need to consider the maximum limit for workers to work overtime. Each worker will have a maximum workload limit per day, where if the workload is violated it can cause fatigue which can affect production results.

Basically, the purpose of the aggregate production plan is to develop a comprehensive production plan that can meet market demand by following the available capacity to produce minimal production costs. To get the results from the goals, the company needs to establish an appropriate plan from several strategies that have been mentioned previously.

Research Methods

Identification of Problems

This stage is the initial stage in the research, where observations and interviews with PT XYZ are carried out to find out the problems faced by the company, especially in the field of production. Based on observations and interviews, it is known that fluctuating demand from PT XYZ is an obstacle for the company in determining the right amount of production demand. To overcome these problems, it is necessary to plan production at the aggregate level by using a chase strategy and a level strategy to see what strategies are suitable to be applied to overcome problems at PT XYZ.

Research Purposes

Determination of the objectives of the research is done so that the research can be right on target. The purpose of this research is to minimize the production costs of PT XYZ to be able to meet consumer demand for coal products.

Data

The data used in this study is primary data obtained directly from the results of observations of the company. The data used in this study include the following:

Monthly data on demand for coal products in 2019. The data shown in Table 1 is data on demand for coal products for PT XYZ in 2019, this data will be used as historical data to forecast product demand in the following year.

Table 1

PT XYZ Coal Demand Data for 2019

Month	Request (hundreds of thousands of tons)	Month	Request (hundreds of thousands of tons)
January 2019	270	July 2019	300
February 2019	260	August 2019	260
March 2019	380	September 2019	340
April 2019	200	October 2019	210
Mey 2019	440	November 2019	380
June 2019	330	December 2019	410

Data Processing

Based on the data that has been obtained in the previous step, the researchers then carried out the data processing process to solve problems at PT XYZ. The stages carried out in data processing in this study include:

Forecasting calculations using the method of the double moving average, Single Exponential Smoothing Brown, Double Exponential Smoothing Holt, and Linear Regression. The results of forecasting using the four methods are shown in

Table 2

Results of Forecasting PT XYZ's Coal Demand

Period	DMA	Brown	Holt	RL
1	392	333	347	351
2	420	336	357	356
3	449	338	367	362
4	478	341	377	367
5	507	344	388	373
6	536	346	398	378
7	565	349	408	384
8	594	351	418	389
9	623	354	428	395
10	652	356	438	400
11	680	359	448	405
12	709	361	458	411
Average	550,42	347,33	402,67	380,91

Figure 1 shows the results of the demand data plot during the 2019 period and the results of demand forecasting during 2020 using 4 methods, namely Double Moving Average, Brown, Holt, and Linear Regression.

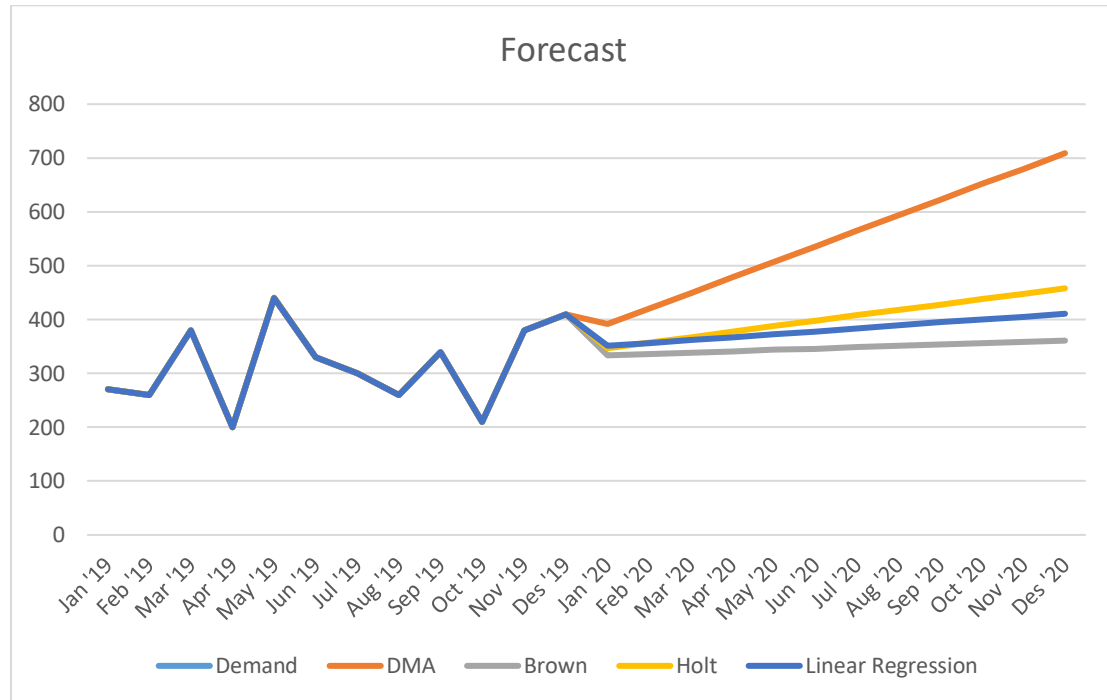


Figure 1 Plot of Data Demand and Forecasting Results

Calculate the Mean Square Error (MSE) value of each forecast and look for the forecasting method that produces the smallest error value. The results of the MSE values of the four methods used for forecasting demand are shown in Table 3.

Table 3

Calculation of Error Value (MSE) for Forecasting

Method	DMA	Brown	Holt	RL
Error Value	9068,57	8082	9006,8	5217,92

Based on the results of calculations without using an aggregate production plan with the assumption that in 2020 the company's condition will not change the number of workers, the company needs to spend \$ 696,925,000.00/year to meet demand based on forecasting results using the linear regression method.

The next step is to calculate the aggregate production schedule using the chase strategy and level strategy. Costs are calculated based on 2 strategies by calculating the total costs incurred for 12 months, and the average cost each month is shown in

Table 4

Cost Calculation Result of Aggregate Production Plan

Method	Total Cost	Average Cost/Month
Level Strategy	\$ 587,933,800.00	\$ 48,994,483.33
Chase Strategy	\$ 565,568,400.00	\$ 47,130,700.00

Analysis and Discussion

The next step in this research is to analyze and discuss the results of data processing. Analysis and discussion were conducted to see the results of data processing and its impact on the company's production plan. After conducting the analysis and discussion, the last step is to draw conclusions about the results of the study and make suggestions for further research.

Based on the forecasting results, it was found that the most appropriate method used by PT XYZ is to use the linear regression method. This is based on the calculation of the error value (MSE) obtained showing that the linear regression method produces an error value of 5217.92. This value is better than forecasting using the DMA, Brown, and Holt methods. Based on the forecasting results, it was found that the average demand during 2020 was 380.91 hundred thousand tons of coal per month. This value increased by 20.93% compared to the number of requests in the previous year. Compared to 2019 which experienced an increase in the number of requests by 13.5%, the forecasting results showed an increase of 6.43%.

Based on the results of forecasting calculations using the linear regression method, the company needs to prepare a production capacity of 411 thousand tons per month to meet demand at the end of 2020. This is a challenge for the company considering that the company currently has a capacity of around 330 thousand tons of coal per month. To anticipate a large number of requests, the company can choose a production plan by using overtime and also subcontracting to related companies.

The results of the calculation of the company's aggregate production plan using the level strategy produce a total production cost of \$ 587,933,800.00 per year or an average of \$ 48,994,483.33 per month. Meanwhile, by using the chase strategy, the company needs to incur production costs of \$565,568,400.00 per year or \$47,130,700.000 per month. This means that by using a chase strategy, the company can save production costs of \$ 22,365,400.00 per year or a savings of 3.80%.

Conclusion

Based on the results of the analysis and discussion of the calculation results, it can be concluded that using the linear regression forecasting method the company needs to produce an average of 380.91 thousand tons per month in 2020. The results of the calculation of the aggregate production plan using the chase strategy result that the cost the company needs to spend for a year in 2020 is \$565,568,400.00 or better by 18.85% compared to without doing an aggregate production plan.

Based on the results of this study, the advice that can be given to PT XYZ is to apply a chase strategy to its aggregate production plan for the period 2020. To overcome the shortage or excess that is too large for the number of requests, the company is advised to forecast demand needs using the regression method. linear. This is expected to provide an optimal amount of production for the company.

Suggestion for Furthur Research

For the next research, the author hopes to be able to perform calculations using other methods to compare with the currently used method. In addition, the author also hopes to compare the results of the aggregate production plan using a mixed strategy and transportation.

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