Analysis of Aggregate Planning with a Chase Strategy Approach to Reduce Production Costs

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Article Info	A B S T R A C T
	Manufacturing companies are companies that spend a lot of production costs. Therefore, the company expects a planning method that can minimize production costs and can also maximize the existing workforce. The purpose of this study is to minimize production costs. The method used is the aggregate chase strategy method. The results showed that planning using the aggregate chase strategy method can minimize production costs. After comparing the company's total production cost in 2020 amounted to Rp. 8,952,896,124 with the results of planning using the aggregate method of chase strategy in 2021 amounting to Rp. 8,428,458,444, obtained a gap of Rp. 524,437,680. By planning production costs using the aggregate method, the company can reduce the amount of labor and utilize the amount of labor available as much as possible without incurring workers' overtime costs. Then the company can save on production costs.

1. Introduction

In Indonesia, there are already many established companies. Starting from a more focused industry/manufacturing, services, and trade. Industrialization is already very rapid in Indonesia, thus increasing competition in the industrial world. Many companies are starting to look for ways to increase the company's profits. The manufacturing industry sector itself certainly spends a lot on production. Therefore, the company began to determine or look for a method that can increase its profits of the company so that the company can minimize production costs. Production costs are the costs attached to a product, including costs either directly or indirectly used to process raw materials into finished products (Harnanto, 2017).

One method that can minimize or streamline production costs of them is by using the Aggregate Method. Aggregate planning is a way to estimate the amount of output to be produced to meet demand over the next 3 to 18 months and is adjusted to the company's production capacity. Aggregate planning allows companies to set up a way of utilizing the company's resources to the maximum, to achieve effective and efficient results, made based on future demand forecasts (Atika, Khoirun & Yonathan,

Trio, 2017). The purpose of this study is to reduce and minimize the cost of production to save the expenses of companies.

2. Literature Review
a. Manufacturing Company
A manufacturing company is a company that processes raw materials into finished goods. Business processes that occur in manufacturing companies are more complex than in service or trade companies.

b. Production Costs
Production costs are direct costs, which depend on the production process of products produced by the company. Production costs are the source of the economy sacrificed to produce output, the value of output is expected to be greater than the input sacrificed to produce the output so that the organization's activities can generate profits (Felicia & Gultom, 2018).

c. Forecasting
Forecasting is defined as the process of forecasting a variable (event) in the future based on variable data in the past (Nugroho, 2016). While prediction is the process of forecasting a variable in the future based more on consideration of intuition than on the past (Nugroho, Yudha & Sulhan, n.d.).

Forecasting is estimating future demand associated with aspects of quantity, the timing of occurrence, and locations that require the production of goods or services in question (Ningsih et al., 2019). In a company, forecasting is needed to provide information to the leadership as a basis for determining a decision in various activities, such as sales, demand for financial supplies, and so on (Sanjaya et al., 2016).

d. Aggregate Planning
Aggregate planning is the planning of operational activities to provide the level of output that a facility must generate for 3 to 18 months, in order t certain levels of demand in the future while taking into account the minimization of total operating costs (Juliantara & Mandala, 2020). Aggregate Planning is a production planning strategy to achieve efficiency but can meet customer demand (Putra et al., 2019).

e. Chase Strategy
Strategies are used to achieve an output level for each period that meets demand forecasting for that period. Strategies are used to minimize and stabilize the level of a supply. Chase strategy itself brings together production-level data with demand levels, increasing/reducing working hours by adjusting demand and the number of workers with fixed, but non-fixed working hours (Reicita, 2019).

3. Research Method
The method used in this study is the aggregate chase strategy method, carried out to minimize production costs. The data collection technique consists of observation, by looking and observing directly the research and interviewing place, by collecting data by asking directly to the worker concerned.

The research stage starts by forecasting the amount of production in the next 1 year then doing a measure of the forecasting results to ensure that the forecasting data is worth using, and the last one is the planning calculation using the chase strategy aggregate method.

a. Forecasting
  1. Least square method
     The least-square method is the most widely used method for forecasting big data for a given time (Setiawan & Wulanningrum, 2017). The least-square method calculation formula is:

$$Y = a + b(x)$$

Where Y = periodic data trend value, a = constant value, b = slope, x = time period le time.

2. Size of forecasting results
- MAD (Mean Absolute Deviation)

   Look for absolute error averages that occur in a given period regardless of whether the results of forecasting are smaller or even larger than the previous data. Mathematically, the MAD formula is expressed as follows:

   $$MAD = \sum \left| \frac{A_t - F_t}{n} \right|$$

   Where = actual request, = request value, n = the number of forecasting periods involved.

- MSE (Mean Square error)

   The second way to measure the whole in forecasting errors is MSE. MSE can be mathematically formulated as follows:

   $$MSE = \sum \frac{(A_t - F_t)^2}{n}$$

   Where = actual request, = request value, n = number of forecasting periods.

- MAPE (Mean Percentage Error)

   MAPE generates a percentage of errors from the results of predictions of real requests at a given time that provide error percentage information. MAPE formula is as follows:

   $$MAPE = \left(\frac{100}{n} \right) \sum \left| A_t - \frac{F_t}{A_t} \right|$$

   Where = actual request, = request value, n = the number of forecasting periods involved. The lower the mape percentage value, the forecasting value can be said to be feasible (Maricar, 2019). Mape's range or average percentage will be said to be very good if it is below 10%.

b. Aggregate planning
   1. Chase strategy

   Chase strategy is a production capacity that can be varied in this strategy by using overtime hours, regular working hours (regular time), and subcontracting.

   Formulas used to calculate or search for Chase strategies:

   Chase strategy = Raw material cost + production overhead + Labor cost + inventory (storage) cost + hiring cost + firing cost.

   The data needed to analyze include demand and production data for 1 the year of 2020 period, working day data in 2021, production cost data, and production capacity data.

   Request data can be seen in Table 1. There are data on demand and production from January to December in 0 with a total demand and production of 236.

Table 1. Demand and production data during January – December Period 2020

No	Month	Production	Demand
1	January	22	22
2	February	36	36
3	March	26	26
4	April	7	7
5	May	10	10

6	June	15	15
7	July	8	8
8	August	15	15
9	September	22	22
10	October	28	28
11	November	15	15
12	December	32	32
	Total	236	236

Table 2. Weekday data for 2021

No	Month	Number of working days
1	January	25
2	February	24
3	March	26
4	April	25
5	May	21
6	June	25
7	July	26
8	August	24
9	September	26
10	October	25
11	November	26
12	December	26
	Total	299 Hari

Table 3. Production cost data

Cost	Sum
Cost of raw materials/unit	Rp. 29.411.250
Labor costs/month	Rp. 4.594.324
Overtime cost/hour	Rp. 15.000/ hour
Overhead costs/month	Rp. 10.233.975
Inventory costs/month	Rp. 35.750.000
hiring costs/workforce	Rp. 0
firing costs/workforce	Rp. 4.594.324

Table 4. Production capacity data

Description	Number of Units	Unit
workforces	23	Person
Amount of initial inventory	0	Pcs
Number of hours worked/day	8	Hour
Number of overtime days/month	25	Day
Number of overtime hours/day	6	Hour
Number of overtime hours/month	150	Hour
Average monthly production capacity (average production in 2020)	21	Pcs
Production capacity/day (production in 2020)	1	Pcs
Production capacity/person per hour	0.005	Pcs

Production capacity/ person per day	0.04	Pcs
Overtime capacity/hour (23 Workforce)	0.13	Pcs
Overtime capacity/person/hour	0.01	Pcs

4. Results and Discussion

Forecasting

1. Find values a and b by using formulas

$$a = \frac{(\sum Y)}{n}$$

$$b = \frac{(\sum XY)}{(\sum X^2)}$$

Before searching for values a and b, it is required to look for the values X, XY, and X^2. As follows:

- Specify the value of X

   The way to find the value of X is with the distance between the two times given a value of two units, then the upper part is given a negative sign and the bottom is given a positive sign. Can be seen in Table 5.

- Search for XY values

   Multiply the value of X by the value of Y (many requests). Obtained results are in Table 5.

- Search for X^2 values

   Find the value of X^2 by multiplying the value of X by the value of X also or squaring the value of X. Results can be seen in Table 5.

Table 5. X, XY, and X^2

Month	X	XY	X^2
January	-11	-242	121
February	-9	-324	81
March	-7	-182	49
April	-5	-35	25
May	-3	-30	9
June	-1	-15	1
July	1	8	1
August	3	45	9
September	5	110	25
October	7	196	49
November	9	135	81
December	11	352	121

Least Square Method

Looking for trend equations for January – December for 2021. Using the formula Yt = a + bX. X above is a continuation of the value X. The last X value of the positive bottom is worth 11, then to then use the value of X of 13, 15, 17, and so on with a value of two units.

The results of the trend equation for January – December for 2021 are as follows:

Yt (Januari) = 19,67 + 18 (13)

= 20,1 ≈ 20

Likewise with the next month until December. The result of the trend equation is demand forecasting data for 2021. The results of forecasting in 2021 using the least square method can be seen in Table 6.

Table 6. Forecasting calculation results

Month	Demand for 2020 (Y)	Demand for 2021 (Yt)	(Y - Yt)	| Y - Yt |
January	22	20	2	2
February	36	20	16	16
March	26	20	6	6
April	7	20	-13	13
May	10	20	-10	10
June	15	20	-5	5
July	8	20	-12	12
August	15	21	-6	6
September	22	21	1	1
October	28	21	7	7
November	15	21	-6	6
December	32	21	11	11
Total	236	245		95

As seen in Table 5. The total demand in 2020 (Y) amounted to 236, the total demand in 2021 (Yt) amounted to 245, and the total | Y-Yt| It's 95. Value (Y-Yt) is useful to know how much the difference in demand between demand in 2020 (Y) and demand in 2021 (Yt). Then the value of Y-Yt is absolutes so that there is no negative result.

Forecasting Results Size

1. Mean Absolute Deviation (MAD)

   Absolute error average by using the MAD formula.

   $$\text{MAD} = \frac{95}{12}$$

   $$= 7{,}916 \approx 8$$

   So, the result of Mean Absolute Deviation (MAD) or the average absolute error is 8.

2. Mean Square Error (MSE)

   Average squared errors. Obtained results from calculations using the MSE formula as follows:

   $$\text{MSE} = \frac{95^2}{12}$$

   $$= \frac{9025}{12}$$

   $$= 752{,}083 \approx 752{,}1$$

   So, the result of Mean Square Error (MSE) or the average squared error is 752.1.

3. Mean Absolute Percentage Error (MAPE)

   The average percentage of errors is relative. Obtained results from calculations using mape formula as follows:

   $$\text{MAPE} = \frac{\frac{95}{236}}{12} \times 100\%$$

   $$= \frac{0{,}402542373}{12} \times 100\%$$

$= 0,033545198 \times 100\%$

$= 3,354519774\% \approx 3\%$

Thus, the result of Mean Absolute Percentage Error (MAPE), or the average percentage of relative errors is 3%. The percentage value is a very accurate percentage because it is <10%.

The results of the calculation of error forecasting using Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE) can be seen in Table 7.

Table 7. Results of Forecasting Results Size

	MAD	MSE	MAPE
Forecasting Results Size	8	752.1	3%

Aggregate Planning

1. Chase Strategy

In this strategy, the set rate of production is by existing demand. Production shortages will be overcome by adding labor (Hiring) and overproduction will be overcome by reducing labor (Firing). Calculations with Chase Strategy can be seen in the following Table 4.8:

Table 8. Chase strategy calculation results

Month	D	PC	LPC	LN	R	H	F	Total Firing Cost
January	20	20	1.1	18.5	19	-	4	Rp. 18,377,296
February	20	20	1.0	19.3	19	-	-	-
March	20	20	1.1	17.9	18	-	1	Rp. 4,594,324
April	20	20	1.1	18.6	19	1	-	-
May	20	20	0.9	22.3	22	3	-	-
June	20	20	1.1	18.8	19	-	3	Rp. 13,782,972
July	20	20	1.1	18.1	18	-	1	Rp. 4,594,324
August	21	21	1.0	19.7	20	2	-	-
September	21	21	1.1	18.2	18	-	2	Rp. 9,188,648
October	21	21	1.1	19.0	19	1	-	-
November	21	21	1.1	18.3	18	-	1	Rp. 4,594,324
December	21	21	1.1	18.4	18	-	-	-
Total	245	245	13		227	7	12	Rp. 55,131,888

Can be seen in Table 8. Above is the result of calculating aggregate costs using the Chase Strategy. Where D = demand, PC = Production Capacity, LPC = Labor Production Capacity, LN = Labor Needs, R = Rounding, H = Hiring, and F = Firing. The total cost of firing from January to December amounted to Rp. 55,131,888.

After obtaining the results of calculations using the aggregate chase strategy method in the form of a total of 1 year of firing, the comparison between the company's expenditure without using the aggregate method in 2020 with those that already use the aggregate method in 2021. You can see the comparison in Table 8.

Table 9. Comparison between the company's production costs in 2020 and the results of the chase strategy in 2021

	Company Production Costs in 2020		Chase Strategy in 2021	
Number of production units		236		335
Cost of raw materials	Rp	6,941,055,000	Rp	7,207,607,308
Overhead costs	Rp	122,807,700	Rp	122,807,700
Labor costs	Rp	1,268,033,424	Rp	1,042,911,548
Cost of supply	Rp	-	Rp	-
Hiring costs	Rp	-	Rp	-
Firing costs	Rp	-	Rp	55,131,888
Overtime costs	Rp	621,000,000	Rp	-
Total	Rp	8,952,896,124	Rp	8,428,458,444

As can be seen from the comparison in Table 9. above the company's total production cost in 2020 amounted to Rp. 8,952,896,124 and the total production cost using the chase strategy in 2021 amounted to Rp. 8,428,458,444 there was a considerable cost difference of Rp. 524,437,680.

Thus, planning using the chase strategy is declared successful or Worth It because the results of the total production are smaller than the company's initial strategy in 2020.

5. Conclusion

Based on the results of the study, there was a considerable difference in Rp. 524,437,680 from the comparison of the company's total production cost in 2020 amounting to Rp. 8,952,896,124 and the total production cost using the chase strategy in 2021 amounted to Rp. 8,428,458,444. It can be concluded that using the aggregate chase strategy method can minimize production costs by reducing the number of workers and maximizing the existing workforce, without the cost of overtime workers.

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