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AGGREGATE PLANNING STRATEGIES AT CV SASWCO PERDANA

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Abstract. CV Saswco Perdana is a company engaged in clothing industry that located in Gedebage, Bandung. CV Saswco Perdana is a company with medium-large industrial scale. The current condition of the company, they manufactured product in based on order. Based on interview with General Manager of CV Saswco Perdana. Currently the company has 50 employee that work in production division with total capacity can reach 2.500 dozens per month. Otherwise, based on previous data the average demand for 2014 is 730,76 dozens per month and for 2015 the average of demand is 596,94 dozens per month. According to those situation, there is a high level of idle workers that can be occur. So, the company needs to adjusting their workers in order to optimizing their resources and minimizing the total cost. And one of the operations management's tool that company can use is aggreate planning strategy. Because by using aggregate planning the company can determines the ideal levels of capacity, production, subcontracting, inventory, stockouts, and even pricing over a specified time horizon (for this research, the time horizon is among 12 months). The research aimed to know the best of aggregate planning strategy that can be implemented by CV Saswco Perdana in order to fulfill the forecasted demand in period 2016 from 5 alternative aggregate planning strategies that conducted in this research, which are: pure chase strategy, pure level strategy, overtime strategy, optimization using linear programming, and mix strategy by varying workforce and overtime, by minimizing unmeet demand and the low cost as key performance. The methodology used is quantitative method. Primary data are collected from interview with Operations Director and General Manager at CV Saswco Perdana. And secondary data is collected from company's documents record. Based on all strategies that conducted, the workforce needed is less than 50 workers. Thus, the company needs to adjust their workforce by laying off some workers in order to maximize the resources. The strategy that has the lowest cost is optimization strategy using linear programming with estimation total full costs is Rp.2.407.306.752 and incremental cost is Rp.64.524.912. But, the current work-hour in CV Saswco Perdana is violate the existing of regulations. Especially "pasal 77 and pasal 78 UU no. 13 tahun 2003" about work-hour and overtime of labor. According to those situation, the author providing the alternative optimization strategy using linear programming with changing the variable of work-hour and overtime related to the regulations as a recommendation. The total cost for alternative optimization using linear programming is Rp.2.610.594.007 and the total incremental cost is Rp.69.464.160.

Keywords: Demand, Forecast Demand, Optimization Resources, Aggregate Planning.

Introduction

Today, the competition of business is really tight in Indonesia, including clothing industry. According to towamatano.com (2016), currently in Pontianak and Yogyakarta the clothing industry is growing fast. Yet again with the new players from ASEAN Economic Community (AEC) that are ready to invade Indonesian market (jabar.tribunnews.com, 2016). Strategies have been implemented by the entrepreneurs to increase their profit. Increasing product quality and doing more promotion are one of those. Another strategy is by optimizing their resources, in order to minimize the total costs. By optimizing the resources, the company can matching the available resources (human, machinery, financial) with the need of the company in order to achieve established goal. CV Saswco Perdana is a company engaged in clothing industry that located in Gedebage, Bandung. CV Saswco Perdana is a company with medium-large industrial scale. The current condition of the company, they manufactured product in based on order. Based on interview with Ms. Welisha, General Manager of CV Saswco Perdana. Currently the company has 50 employee that work in production division with total capacity can reach 2.500 dozens per month. Otherwise, based on previous data the average demand for 2014 is 730,76 dozens per month and for 2015 the average of demand is 596,94 dozens per month. According to those situation, there is a high level of idle workers that can be occur. So, the company needs to adjusting their workers in order to optimizing their resources and minimizing the total cost. And one of the operations management's tool that company can use is aggreate planning strategy. Because by using aggregate planning the company can determines the ideal levels of capacity, production, subcontracting, inventory, stockouts, and even pricing over a specified time horizon (for this research, the time horizon is among 12 months).

Literature Review

Operations Management

Operation management is the science and art of ensuring that goods and services are created and delivered successfully to customers. Operation management includes the design of goods, services, and the processes that create them; the day-to-day management of those processes; and the continual improvement of these goods, services, and processes (Collier and Evans, 2013).

Operations is a the technical core or "hub" of the organization, interacting with the other functional areas and suppliers to produce goods and provide services for customers. Activities in operations management include organizing work, selecting processes, arranging layouts, locating facilities, designing jobs, measuring performance, controlling quality, scheduling work, managing inventory, and planning production (Reid and Sunders, 2007).

Aggregate Planning

Aggregate planning is a process by which a company determines ideal levels of capacity, production, subcontracting, inventory, stock outs, and even pricing over a specified time horizon (Chopra and Meindl, 2007). The aggregate planner's main objective is to identify the following operational parameters over the specified time horizon (Chopra and Meindl, 2007):

Production rate: the number of units to be completed per unit time (such as per week or per month).

Workforce: the number of workers/units of capacity needed for production.

Overtime: the amount of overtime production planned.

Machine capacity level: the number of units of machine capacity needed for production.

Subcontracting: the subcontracted capacity required over the planning horizon.

Backlog: demand not satisfied in the period in which it arises but carried over to future periods.

Inventory on hand: the planned inventory carried over the various periods in the planning horizon.

According to Pan, Lin; Kleiner, Brian H., (1995: 4), there are a number of strategies, which aggregate planners might adopt. Some of the more prominent ones are:

maintain a level workforce;

maintain a steady output rate;

match demand period by period;

use a combination of decision variables.

Decision Variable

W_t = workforce size for Month *t*.

H_t= number of employees hired at the beginning of Month *t.*

L_t = number of employees laid off at the beginning of Month *t*.

P_t = number of units produced in Month *t*.

I_t = inventory at the end of Month *t*.

S_t= number of units stocked out/backlogged at the end of Month *t*.

C_t = number of units subcontracted for Month *t.*

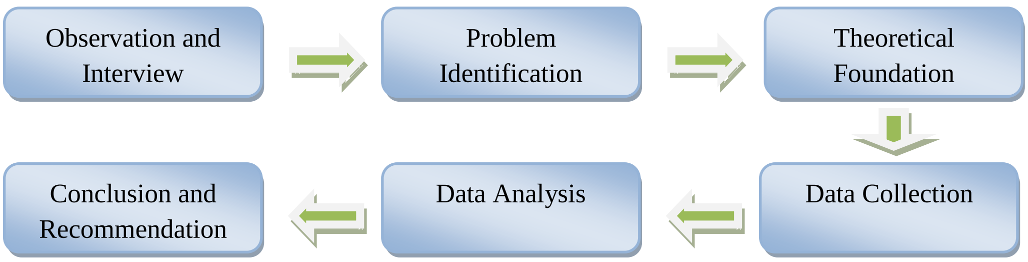
O_t = number of overtime hours worked in Month *t*.

Objective Function and Relevant Cost

Table 2.1 Objective Function

Components	Formulas
Regular-time labor cost. W_t is the number of workers in Period t.	$\sum_{t=1} Rp\ W_t$
Overtime labor cost. Overtime labor cost (Rp) and O_t represents the number of overtime hours worked in period t. FO_t = first hour of O_t, NO_t = Next Hours of O_t.	$\sum_{t=1} Rp\ O_t$
Cost of hiring and layoffs. H_t and L_t represent the number hired and the number laid off, respectively, in Period t.	$\sum_{t=1} Rp\ H_t + \sum_{t=1} Rp\ L_t$
Cost of holding inventory and stockout. I_t and S_t represent the units in inventory and the units stocked out, respectively, in Period t.	$\sum_{t=1} Rp\ I_t + \sum_{t=1} Rp\ S_t$
Cost of materials and subcontracting. P_t represents the quantity produced and C_t represents the quantity subcontracted in Period t.	$\sum_{t=1} Rp\ P_t + \sum_{t=1} Rp\ C_t$
The total cost = $\sum_{t=1} Rp\ W_t + \sum_{t=1} Rp\ O_t + \sum_{t=1} Rp\ H_t + \sum_{t=1} Rp\ L_t + \sum_{t=1} Rp\ I_t + \sum_{t=1} Rp\ S_t + \sum_{t=1} Rp\ P_t + \sum_{t=1} Rp\ C_t$	

Methodology



Grafik 3.1 Flowchart of Methodology

This research conducted for measuring the aggregate planning of CV Saswco Perdana for 2016 forecasted demand, using several strategies as comparison. There are six stages used in this research: Observation and Interview, Problem Identification, Theoretical Foundation, Data Collection, Data Analysis, and Conclusion and recommendation. First step is doing interview and discussion with operations manager to get the company overview and find the general problem that should be discussed in this research. Second step is identify the main problem of this research. Third step is do literature review in order to get theory and tools that will be useful in doing this research. Fourth step is gathering data, the types and techniques of data collection including primary data collected through interview with operations manager and general manager. And the secondary data gain from CV Saswco Perdana business documents and records, also from other research. The data needed to investigate what is the real current condition of the subject. Fifth step is collecting and then analyzing the data that already gathered to investigate what kind of solution that will be fit to solve the problem. Last step is to conclude the data analysis of the best solution that will solve the main problem and give recommendation.

Data Analysis

From data that gathered, the researcher doing aggreate planning measurement using several strategies as comparison to find which strategy that has the lowest costs. The strategies that conducted are: Pure Chase Strategy, Pure Level Stratey, Overtime Strategy, Optimization Strategy Using Linear Programming (using Ms. Excel 2007 solver), and Mix Strategy by Varying Workforce and Overtime. The result of calculation of each strategy can be seen in the tables below:

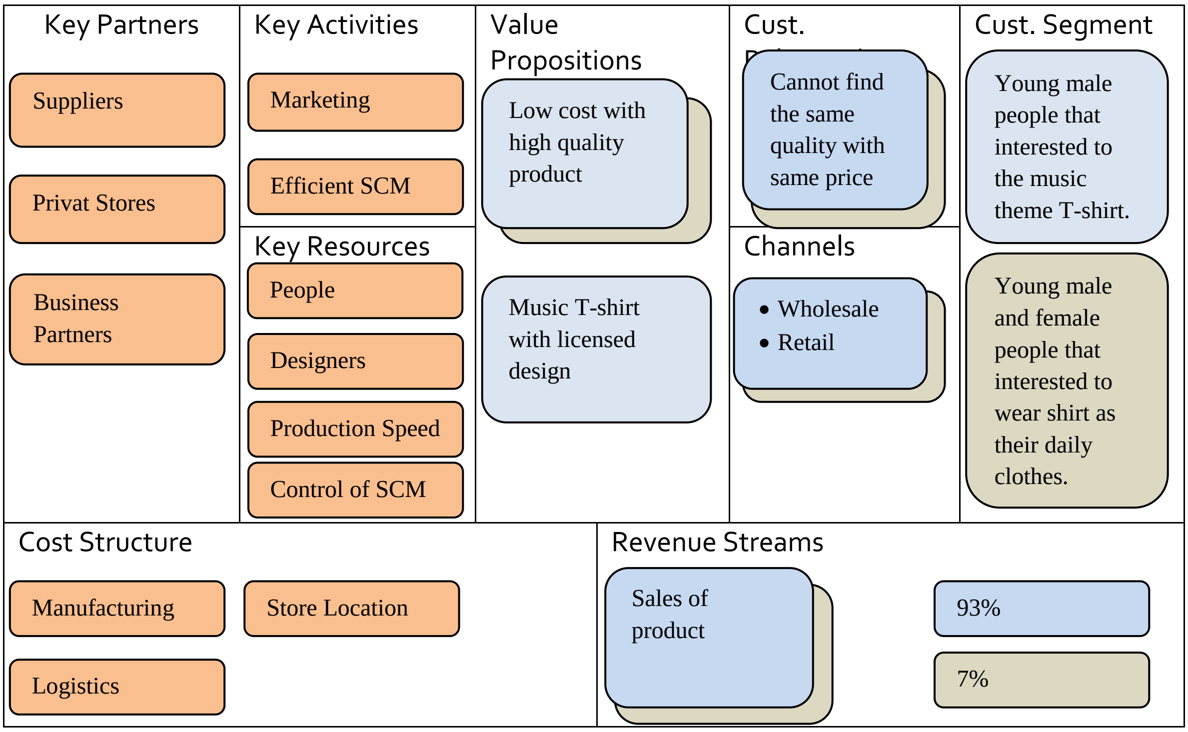


Figure 4.1 CV Saswco Perdana Business Model Canvas

The minimum total cost function

$$\sum_{t=1}^{12} \text{Rp. } 10.635 \,.\, Wt + \text{Rp. } 15.953 \,.\, Ot + \text{Rp. } 21.270 \,.\, Ot + \text{Rp. } 500.000 \,.\, Ht + \text{Rp} 1.000.000 \,.\, Lt$$
$$+ \text{Rp. } 1.500.000 \,.\, It + \text{Rp. } 157.650 \,.\, St + \text{Rp. } 216.000 \,.\, Pt + \text{Rp. } 195.000 \,.\, Ct$$

Constraints

Workforce, hiring, and layoff	Wt = Wt-1 + Ht – Lt	for	t = 1,...,12
Capacity	Pt ≤ 52 Wt + Ot	for	t = 1,...,12
Inventory balance	It-1 - St-1 + Pt - Dt - It + St	for	t = 1,...,12
Overtime limit	Ot ≤ 156 Wt	for	t = 1,...,12
All the variables above are variables with non-negative constraint			

Forecast for 2016 (in dozen)

Table 4.1 Forecast for 2016 (in dozen)

Period	Pesimistic Forecast	Mostlikely Forecast	Optimistic Forecast
1	622,40	816,90	933,60
2	308,80	405,30	463,20
3	483,30	617,55	698,10
4	576,09	756,12	864,13
5	465,60	611,10	698,40
6	486,00	621,00	702,00
7	565,69	742,47	848,53
8	526,40	690,90	789,60
9	592,80	778,05	889,20
10	689,60	905,10	1034,40
11	237,60	311,85	356,40
12	284,00	372,75	426,00
Total	5.730,58	7.521,38	8.595,86

For the aggregate planning research, this data of forecast demand (optimistic) at 2016 are use for the data demand, because the aggregate planning is aggregate planning for 2016.

Pure Chase Strategy

Pure chase strategy is a strategy that the company produce to exact monthly production requirements using a regular ten-hours a day by varying workforce size. Because the company produce exact monthly demand by varying workforce, so there are no overtime, stockout, subcontracting, or inventory occur.

Table 4.2 Pure Chase Strategy Aggregate Plan Decision Variable (in dozen)

The total full costs for pure chase strategy is Rp.2.413.824.124 and the incremental cost is Rp.64.000.000.

Period	Working days	Wt	Ht	Lt	Pt	FOt	NOt	St	Ct	It	Cum.It	Demand
0	0	50	0	0	0	0	0	0	0	0	0	0
1	25	19	0	31	933,60	0	0	0	0	0	0	933,60
2	24	10	0	9	463,20	0	0	0	0	0	0	463,20
3	25	14	4	0	698,10	0	0	0	0	0	0	698,10
4	26	17	3	0	864,13	0	0	0	0	0	0	864,13
5	24	15	0	2	698,40	0	0	0	0	0	0	698,40
6	26	14	0	1	702,00	0	0	0	0	0	0	702,00
7	21	20	6	0	848,53	0	0	0	0	0	0	848,53
8	26	15	0	5	789,60	0	0	0	0	0	0	789,60
9	25	18	3	0	889,20	0	0	0	0	0	0	889,20
10	26	20	2	0	1034,40	0	0	0	0	0	0	1034,40
11	26	7	0	13	356,40	0	0	0	0	0	0	356,40
12	25	9	2	0	426,00	0	0	0	0	0	0	426,00

Pure Level Strategy

Pure level strategy is a strategy that the company produce to meet expected average demand over the next twelve months by maintaining a constant workforce. By using pure level strategy, the company will dealing with inventory and stockouts. And the probability of overtime will occur is very low, because with the constant workforce that finded by the calculation will covering all the demand over the time horizon.

Table 4.3 Pure Level Strategy Decision variable (in dozen)

Period	Working days	Wt	Ht	Lt	Pt	FOt	NOt	St	Ct	It	Cum. It	Demand
0	0	50	0	0	0	0	0	0	0	0	0	0
1	25	15	0	35	750	0	0	0	0	(184)	(184)	933,60
2	24	15	0	0	720	0	0	0	0	257	73	463,20
3	25	15	0	0	750	0	0	0	0	52	125	698,10
4	26	15	0	0	780	0	0	0	0	(84)	41	864,13
5	24	15	0	0	720	0	0	0	0	22	63	698,40
6	26	15	0	0	780	0	0	0	0	78	141	702,00
7	21	15	0	0	630	0	0	0	0	(219)	(78)	848,53
8	26	15	0	0	780	0	0	0	0	(10)	(88)	789,60
9	25	15	0	0	750	0	0	0	0	(139)	(227)	889,20
10	26	15	0	0	780	0	0	0	0	(254)	(481)	1034,40
11	26	15	0	0	780	0	0	0	0	424	(58)	356,40
12	25	15	0	0	484	0	0	0	0	58	0	426,00

The total full costs for pure level strategy is Rp.2.575.263.593 and the incremental cost is Rp.218.219.843.

Overtime Strategy

Overtime strategy is a strategy that the company produce to meet expected demand for all but the first two months using a constant workforce on regular time. And use overtime to meet additional output requirements. By using overtime Strategy, the company will dealing with overtime and inventory. But the company also can avoid the inventory by maximizing the overtime.

Table 4.4 Overtime Strategy Decision variable (in dozen)

Period	Working days	Wt	Ht	Lt	Pt	FOt	NOt	St	Ct	It	Cum. It	Demand
0	0	50	0	0	0	0	0	0	0	0	0	0
1	25	15	0	35	750	75	109	0	0	0	0	933,60
2	24	15	0	0	720	0	0	0	0	256,80	256,80	463,20
3	25	15	0	0	750	0	0	0	0	51,90	308,70	698,10
4	26	15	0	0	780	0	0	0	0	(84,13)	224,57	864,13
5	24	15	0	0	720	0	0	0	0	21,60	246,17	698,40
6	26	15	0	0	780	0	0	0	0	78	324,17	702,00
7	21	15	0	0	630	0	0	0	0	(218,53)	105,64	848,53
8	26	15	0	0	780	0	0	0	0	(9,60)	96,04	789,60
9	25	15	0	0	750	75	0	0	0	(189)	0	889,20
10	26	15	0	0	780	78	176	0	0	(208)	0	1034,40
11	26	15	0	0	356	0	0	0	0	372	0	356,40
12	25	15	0	0	426	0	0	0	0	274	0	426,00

The total full costs forovertime strategy is Rp.2.450.944.880 and the incremental cost will be Rp.93.996.170.

Optimization Strategy Using Linear Programming (Using Ms. Excel 2007)
Optimization using linear programming strategy is a strategy that using solver in Ms. Excel as a tool for calculation (in this research, author using Ms. Excel 2007). While doing calculation using solver, we need to input the decision variables, aggregate plan costs, constraints, subject to the constraints, and also we need to setup the value (in this research, the value that set is minimum cost). After that, by using solver the decision varibles will be fill with the best solution scenario that setting up by program. By using optimization strategy, the company will dealing with all the variables that may be occur in order to get the best scenario. But the company also can setup the constraints according to their policies (in this research, the inventory is setting for 0).

Table 4.5 Optimization Strategy Decision Variable (in dozen)

Period	Working days	Wt	Ht	Lt	Pt	FOt	NOt	St	Ct	It	Cum. It	Demand
0	0	50	0	0	0	0	0	0	0	0	0	0
1	25	19	0	31	933,60	0	0	0	0	0	0	933,60
2	24	10	0	9	463,20	0	0	0	0	0	0	463,20
3	25	14	4	0	698,10	0	0	0	0	0	0	698,10
4	26	17	3	0	864,13	0	0	0	0	0	0	864,13
5	24	15	0	2	698,40	0	0	0	0	0	0	698,40
6	26	14	0	1	702,00	0	0	0	0	0	0	702,00
7	21	20	7	0	848,53	0	0	0	0	0	0	848,53
8	26	15	0	5	789,60	0	0	0	0	0	0	789,60
9	25	18	3	0	889,20	0	0	0	0	0	0	889,20
10	26	20	2	0	1034,40	0	0	0	0	0	0	1034,40
11	26	7	0	13	356,40	0	0	0	0	0	0	356,40
12	25	9	2	0	426,00	0	0	0	0	0	0	426,00

The total full costs forlinear programming strategy is Rp.2.407.306.752 and the incremental cost is Rp.64.524.912.

Mix Strategy (Varying workforce and overtime)
Mix strategy is a strategy that using combination from the other pure strategy (Pure Chase, Pure Level, Optimation, and Overtime strategy). For the mix strategy in this research, the author using variation of workforce and use overtime to meet additional output requirements. The variation of workforce is basicly from the pure chase strategy with adjustment in some period to find the lowest total cost by using trial-and-error. By using mix strategy, the company will dealing with variation of workforce and overtime that occur.

Table 4.6 Mix Strategy Agregate Plan Decision Variable (in dozen)

Period	Working days	Wt	Ht	Lt	Pt	FOt	NOt	St	Ct	It	Cum. It	Demand
0	0	50	0	0	0	0	0	0	0	0	0	0
1	25	18	0	32	900	33,60	0	0	0	0	0	933,60
2	24	9	0	9	432	31,20	0	0	0	0	0	463,20
3	25	14	5	0	698,10	0	0	0	0	0	0	698,10
4	26	16	2	0	832	32,13	0	0	0	0	0	864,13
5	24	14	0	2	672	26,40	0	0	0	0	0	698,40
6	26	14	0	0	702	0	0	0	0	0	0	702,00
7	21	20	6	0	840	8,53	0	0	0	0	0	848,53
8	26	15	0	5	780	9,60	0	0	0	0	0	789,60
9	25	18	3	0	889,20	0	0	0	0	0	0	889,20
10	26	20	2	0	1034,40	0	0	0	0	0	0	1034,40
11	26	7	0	13	356,40	0	0	0	0	0	0	356,40
12	25	8	1	0	400	26	0	0	0	0	0	426,00

The total full costs for mix strategy using varying workforce and overtime is Rp.2.413.994.490 and the incremental cost will be Rp.77.357.766.

Conclusion and Recommendation

Conclusion

Table 5.1 Summary Costs of Alternative Strategies (in Rupiah)

Alternative Strategy	Full Costs	Costs-Incremental
Pure chase	2.413.824.124	64.000.000
Pure level	2.575.263.593	218.219.843
Constant workforce with overtime	2.450.944.880	93.996.170
Optimization using linear programming	2.407.306.752	64.524.912
Mix strategy 1	2.413.994.490	77.357.766

From the table of summary cost, we can find that the lowest cost between those alternative strategies is Optimization Strategy Using Linear Programming. So, from the 5 alternative strategies that has been calculated, optimization strategy using linear programming is can answer the research objective and research question that has been stated in Chapter I, which is Minimizing unmeet demand and the total cost for forecasted demand in 2016 by using aggregate planning strategy. By using optimization strategy using linear programming for forecasted demand in 2016, the company will facing the hirring and laid off the workers in several period in order to meet the resources needed to fulfill the demand in each period as effect of optimizing the resources. The company will has the lowest workforce in period 11, with number of workforce is 7 workers and the highest workforce in period 7 and 10, which is 20 workers. Since the demand for every period is filled by regular production and the company produce exact monthly demand. There are no overtime, stockout, subcontracting, or inventory that occur.

But the negative side from this strategy is the vary of workforce, this situation may potentially can be a problem if there are an issue with labor about the uncertainty of work and the availability of workers for the company. This strategy can still be used if the company and the workers have some agreements.

Recommendation

Based on the five strategies that has been conducted, the current number of workforce in CV Saswco Perdana is considered too much to meet the forecasted demand for 2016. So the company can decreasing the workforce in order to optimize the resources and minimize the total cost.

Beside of that, the work-hour in CV Saswco Perdana is 6 days per week and 10 hours per day. This situation is violate the existing of regulations. Especially "pasal 77 and pasal 78 UU no. 13 tahun 2003" about work-hour and overtime of labor. The regulations that the company violate are regular work-hour and maximum overtime. If we are reffering to the work-hour by regulations it is must be:
7 hours per day and 40 hours per week for 6 days working-day per week. Or
8 hours per day and 40 hours per week for 5 days working-day per week.
And for maximum overtime in CV Saswco Perdana is 6 hours per day. Otherwise the regulation is only allowed 3 hours per day and 14 hours per week.
According to those situation, the author providing the optimization strategy using linear programming with changing the variable of work-hour and overtime related to the regulations as a recommendation. Surely, by changing (cut down) the work-hour, the cost of production will increase. For the decision variable can be seen on the tables below.

Table 5.2 Alternative Optimization Strategy Decision Variable (in Dozen)

Period	Working days	Wt	Ht	Lt	Pt	FOt	NOt	St	Ct	It	Cum. It	Deman d
0	0	50	0	0	0	0	0	0	0	0	0	0
1	25	27	0	23	933,60	0	0	0	0	0	0	933,60
2	24	14	0	13	463,20	0	0	0	0	0	0	463,20
3	25	20	6	0	698,10	0	0	0	0	0	0	698,10
4	26	24	4	0	864,13	0	0	0	0	0	0	864,13
5	24	21	0	3	698,40	0	0	0	0	0	0	698,40
6	26	19	0	2	702,00	0	0	0	0	0	0	702,00
7	21	29	10	0	848,53	0	0	0	0	0	0	848,53
8	26	22	0	7	789,60	0	0	0	0	0	0	789,60
9	25	25	4	0	889,20	0	0	0	0	0	0	889,20
10	26	28	3	0	1034,40	0	0	0	0	0	0	1034,40
11	26	10	0	19	356,40	0	0	0	0	0	0	356,40
12	25	12	2	0	426,00	0	0	0	0	0	0	426,00

The total cost for alternative optimization using linear programming will be Rp.2.610.594.007 and for the total incremental cost will be Rp.69.464.160.

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