

## PRODUCTION PLANNING CONTROL TO MINIMIZE PRODUCTION COST

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### ABSTRACT

Urea demand has been fluctuated from year to year. It has reached 5.9 million tons in 2010, and it has been estimated for 2011 will be reached about 5.1 million tons. The results of production planning are generated much different from the reality. This leads to PT. Pusri must changes their production planning to customize with the changing of internal and external environment, through the preparation of master production schedule, for a planning horizon, the period July 2011-June 2012. The results of forecasting methods (forecast) that is used is a linear trend analysis with the total amount of urea to be produced is 1.95 million tons. Aggregate planning strategies, there is an election to be used i.e. overtime strategies, regular working day, subcontract, and mix between regular weekday and subcontracting. Production planning cost by company calculation is Rp.2.69 billion. While overtime strategy costs Rp.2.74 billion, regular working day strategy costs Rp.2.73 billion, subcontract strategy costs Rp.2.71 billion and mixed strategies costs Rp.611 million. The selected alternative strategy is a mix strategy. The difference is Rp.87 billion compared to company strategy, or reduce for about 3,25%.

**Key words:** Production planning, forecasting, aggregate planning, master production schedule, the total cost of production planning

### 1. INTRODUCTION

Urea demand has been fluctuated from year to year, such as it was reached 5.9 million tons in 2010. It has been estimated it will reached about 5.1 million tons in 2011. The fluctuated demand make the company must be adapted to change the internal and external environments. There for, one of the company goal is to maximize value or increase the prosperity of stakeholders (Weston&Copeland, 1995).

PT Pusri Palembang is one company that produced urea in Indonesia. Production planning processes by using the company's budget work plan (RKAP). Production planning results produced much different with the reality of the production. It leads company to make changes to the production planning, to balancing the appropriate internal and external company environmental conditions. One approach to production planning can be done is preparation of the Master Production Schedule (MPS).

### 2. THEORETICAL BACKGROUND

#### 2.1. Forecasting

Forecasting is a method to estimate a value in the future by using past data. Forecasting can also be defined as the art and science to predict future events. Forecasting activities constitute a business function that attempted to predict the sales, thus products can be made in accurate quantity (Gaspersz, 2002).

#### 2.2. Aggregate Planning

Aggregate planning is used to determine how the unit volume of products to be produced each period by using the maximum capacity available (Hakim, 2006)

Aggregate planning would be compiled in a single unit of measurement that represents the entire product to be produced. The purpose of aggregate planning is to develop an overall plan of production are feasible and optimal.

According to Eddy Herjanto (2004) feasible means it suits the demand of the market and compliance with existing capacity, whereas the optimal means to use the resources to

process the possible with the lowest possible cost expenditure.

### 2.3. Master Production Schedule

MPS is a statement about the final production (including component replacement and spare parts) of an industrial manufacture produces output that is planning with regard to quantity and time period. In other words the parent schedule is a set of production planning identifies the quantity of a specific item which can and will be made by a manufacturing company (in a unit of time) (Gaspersz, 2002).

### 2.4. Rough Cut Capacity Planning

According to Toomey (1996) RCCP is defined as capacity to validate the technique of the MPS. According to Gaspersz (2002), RCCP is defined as the process of converting from the plan of production or MPS into capacity needs related to critical resources, such as manpower, machines and equipment, the capacity of the warehouse, suppliers of materials and parts capabilities, and financial resources. RCCP is similar to resource requirements planning (RRP), except RCCP is more detailed than the RRP in some ways.

## 3. RESEARCH METHOD

Based on Figure 1, this research initiation by study literature to identify the main parameters in production planning, and direct observation. Observation has done to learn about urea production processes directly, storage processing in warehouse and processing the waste.

The next step is gathering data: production quantity and costs of urea. Production quantity is used to forecast demand of urea.

This research is using 4 forecasting methods: (1) Linear, quadratic and the growth curve trend analysis, (2) Moving average length of 1, 2, and 3, (3) Single exponential smoothing, and (4) Double exponential smoothing.

Aggregate planning is using four strategies: (1) The strategy on overtime, (2) A fix regular day 22 days, (3) Subcontracting, and

(4) A mix of the fix regular day 21 days and subcontracting.

Best strategies were choosing by the least cost of production planning. The next process is preparing MPS, followed by validation using RCCP. Then, conducted data analysis and logical inference conclusions.

## 4. RESULT AND DISCUSSION

### 4.1. Historical Data Production

Historical data production is the data results of realization of production in certain periods. This research used 42 production periods, from January 2008 to July 2011.

### 4.2. Components of Cost

The following are the costs necessary in this study, they are:

- a. Cost of regular production is Rp.1.372.372,56 /ton.
- b. Inventory cost: Rp.15.144.06 / ton.
- c. Backorder cost: Rp.22.716.09 / ton.
- d. Subcontracting cost is Rp.1.500.000/ton.

### 4.3. Forecasting

Based on figure 2, it can be seen that there is no data that is out of control limits, so there is no data that must be eliminated.

In addition, it is also known that the urea production history data pattern is stationer. Forecasting is done by using the time series models. Table 1. represented the accuracy of forecasting.

Trend analysis of linear method has been chosen because it has the smallest error when compared to the three other methods. Thus, the results of the forecasting of urea is considered to be representative enough to be used as the value of the amount that should be produced during planning horizon. Where specified on the horizon planning research is one year or can be said urea production forecasting expected for the coming 12 period i.e. July 2011 to June 2012.

Table 1 shown the urea forecasting for 12 periods ahead.

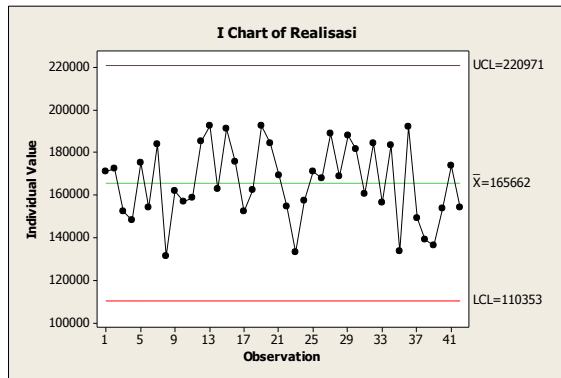


Figure 2. Control Chart of Urea Production PT. Pusri

Table 1. Forecasting

Period	Forecast
Jul'11	162.939
Aug	162.812
Sept	162.686
Oct	162.559
Nov	162.432
Dec	162.306
Jan'12	162.179
Feb'	162.053
Mar	161.926
Apr	161.799
May	161.673
Jun	161.546
<b>Total</b>	<b>1.946.910</b>

#### 4.4. Aggregate Planning

##### 4.4.1. PT. Pusri Strategy

Aggregate planning using employed methods by PT. Pusri generates production planning cost is Rp.2.699.201.396.567. Details are shown in the Table 3.

##### 4.4.2. Overtime Strategy

There are four periods of this production that less than the number of specified period, i.e July 2011, October 2011, June 2012, and April 2012, so it needs to be added one day working overtime. The total cost that should be pay if company uses this method is Rp.2.743.206.584.159. Details are shown in Table 4.

##### 4.4.3. Strategy of Fix Regular Working Day

Aggregate planning strategies with a regular day that is considered to be fixed, in each period, the amount of which is set is fixed that is 22 days. In addition, in this strategy,

the amount of labor that was used was not heeded. The Total cost to be incurred if using this method is Rp. 2.731.960.222.681. Details are shown in Table 5.

##### 4.4.4. Subcontract Strategy

Aggregate planning strategies with subcontracting, labor day is a regular work day that is five working days in each week. In the use of this strategy, the amount of labor that is used does not note in the calculation.

Assumptions used in this strategy, namely subcontracting would do if the amount of urea production in the current period and inventory in the previous period did not meet the amount of urea to be produced in the current period. Based on the results of the calculations are already done the total cost that should be pay if company use this method is Rp. 2.707.104.033.115. Details are shown in Table 6.

##### 4.4.5. Mix Strategy between Fix Regular Working Day and Subcontract

Aggregate planning strategies with a mix between the fix regular day 21 days and subcontracting, regular work day used fixed in every month that is 21 days and the lack of production of urea is overcome with the use of subcontracting in other fertilizer companies.

Determination of the amount of the regular working day remains should not be less than the minimum level the number of regular working day of each month, with the number of regular working day five working days in one week, the number of working days in the regular minimum is 21 days. so that the number of regular working day remains determined should not be less than 21 days. In this strategy is the amount of labor used is considered to have no effect on the results of the production of urea that are not listed in the calculation. Based on the results of the calculations are already done, the total cost of the aggregate planning is needed if using this strategy is Rp. 2.611.397.617.363. Details are shown in Table 7.

##### 4.4.6. Comparison

Aggregate planning by using the strategy overtime (overtime), a regular working day

strategy remains 22 days, subcontracting strategies, and a regular work day of mixed strategies remain 21 days and subcontracting, the total cost of production planning issued relatively large. On the strategy of overtime the total cost of production planning of must be issued is Rp. 2.743.206.5845. On the strategy of the regular working day fixed 22 days in every production planning at costs that must be incurred is Rp. 2.731.960.222.681. Aggregate planning fee required on subcontracting strategies is Rp. 2.707.104.033.115. While the strategy mix between the regular weekday stays 21 days and subcontracting, the total cost of production planning must be issued is Rp.2.611.397.617.363. Details of each strategy can be seen in Table 8.

The selected strategy based on the results of a comparison of the total cost of production planning strategy is a mixture between the fix regular day 21 days and subcontracting. Whereas the methods used PT Pusri's current cost of production planning is Rp.2.699.201.396.567.

Thus the difference is Rp.87.803.779.203 lower than using company's strategy currently cost reductions or production planning around 3,25%. Details of the results of a comparison of the total cost of production planning using the company's method, and method of aggregate planning strategies with a number of labor still can be seen in Table 9.

#### 4.5. Master Production Schedule

MPS should be done in the disaggregation of the aggregate planning. Disaggregation process which is not a process of disaggregation performed by using a specific method.

Percentage of products based on history is IB 26.47%, II 22.02%, III 24.52% and IV 26.99%. Percentage of each production plant used to make disaggregation of the results of forecasting the amount of urea to be produced, in order to obtain the master production schedule as shown in Table 10.

The next step is to validate the master production schedule by way of making a

rough cut capacity planning or capacity planning on the brute as indicated Figure 3.

## 5. CONCLUSION

Based on the results of the processing and data analysis that has been done, then it can be inferred that:

- The method of forecasting to determine the amount of urea to be produced from July 2011 to June 2012 is trend analysis of linear. Forecasting results for one year is equal to 1946910 Tons
- Alternative production planning strategies chosen in aggregate planning strategies is a mixture between the regular weekday stay 21 days and subcontracting.
- The Total cost of production planning using the strategy mix between the fix regular day 21 days and subcontracting is valued at Rp. 2.611.397.617.363, 64.
- The percentage reduction in costs is equal to 3.25% of the total cost of production planning using company the method today.

The amount that should be produced PT Pusri to each plant in the period July 2011 until June 2012 period can be filled with a capacity that is owned by the respective manufacturers either factory IB, II, III and IV.

## 6. REFERENCES

- Eddy Herjanto. 2004. *Manajemen Produksi dan Operasi, Edisi Kedua*. Grasindo. Jakarta.
- Gaspersz, Vincent. 2002. *Production Planning and inventory Control*. PT. Gramedia Pustaka Utama. Jakarta.
- Nasution, Arman Hakim. 2006. *Manajemen Industri*. Penerbit Andi. Yogyakarta.
- W. Toomey.1996. *MRP II Planning For Manufacturing Excellene*. Printed in the United State Of America.
- Weston, J.Fred, Thomas E. Copeland. 1995. *Manajemen Keuangan*. Erlangga. Jakarta.
- <http://economy.okezone.com/read/2011/01/03/320/409682/produksi-pupuk-urea-naik-6> [downloaded at February 8, 2012]

- (g) [http://economy.okezone.com/read/2011/01/03/320/409682/produksi-pupuk-urea-naik-\[downloaded at October 6, 2012\]](http://economy.okezone.com/read/2011/01/03/320/409682/produksi-pupuk-urea-naik-[downloaded%20at%20October%206,%202012])
- (h) <http://www.pusri.co.id/50profil01.php> [downloaded at July 14, 2011]
- (i) <http://www.pusri.co.id/50profil02.php> [downloaded at July 14, 2011]
- (j) <http://www.pusri.co.id/50profil03.php> [downloaded at July 14, 2011]
- (k) <http://www.pusri.co.id/50profil04.php> [downloaded at July 14, 2011]
- (l) <http://www.pusri.co.id/50profil09.php> [downloaded at July 14, 2011]

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Table 2. Testing The Accuracy of Forecasting

Minitab 15	Metode		MAPE	Delta	Normalisasi			
					Residual		MR Chart	
					Normal	No	Out	No
<i>Trend Analysis</i>	<i>Linear</i>		9	-1	√	-	-	√
	<i>Quadratic</i>		9	88	√	-	-	√
	<i>Growth Curve</i>		9	39294	√	-	-	√
<i>Moving Average</i>	<i>Length 1</i>		13	-16857	√	-	-	√
	<i>Length 2</i>		11	-16840	√	-	-	√
	<i>Length 3</i>		11	-3066,3	√	-	-	√
	<i>Single Exponential Smoothing (SES)</i>		9	-74416	√	-	-	√
	<i>Double Exponential Smoothing (DES)</i>		11	-87160	√	-	-	√

Table 3. Aggregate planning by using methods employed PT Pusri Palembang (million Rp.)

Period	Forecast (ton)	Regular Workday (days)	Total Production (ton)	Inventory (ton)	Total production cost (Rp)	Inventory & Backorder cost (Rp)	Total cost (Rp)
Jul	162.939	21	158.131,66	-4.807,34	217.015,55	109,20	217.124,75
Aug	162.812	23	173.191,82	5.572,48	237.683,70	84,39	237.768,09
Sept	162.686	22	165.661,74	8.548,21	227.349,62	129,45	227.479,08
Oct	162.559	21	158.131,66	4.120,87	217.015,55	62,41	217.077,96
Nov	162.432	22	165.661,74	7.350,61	227.349,62	111,32	227.460,94
Dec	162.306	22	165.661,74	10.706,35	227.349,62	162,14	227.511,76
Jan	162.179	22	165.661,74	14.189,09	227.349,62	214,88	227.564,50
Feb	162.053	21	158.131,66	10.267,75	217.015,55	155,50	217.171,05
Mar	161.926	22	165.661,74	14.003,48	227.349,62	212,07	227.561,69
Apr	161.799	21	158.131,66	10.336,14	217.015,55	156,53	217.172,08
May	161.673	23	173.191,82	21.854,96	237.683,70	330,97	238.014,67
Jun	161.546	21	158.131,66	18.440,62	217.015,55	279,27	217.294,82
						Total	2.699.201,40

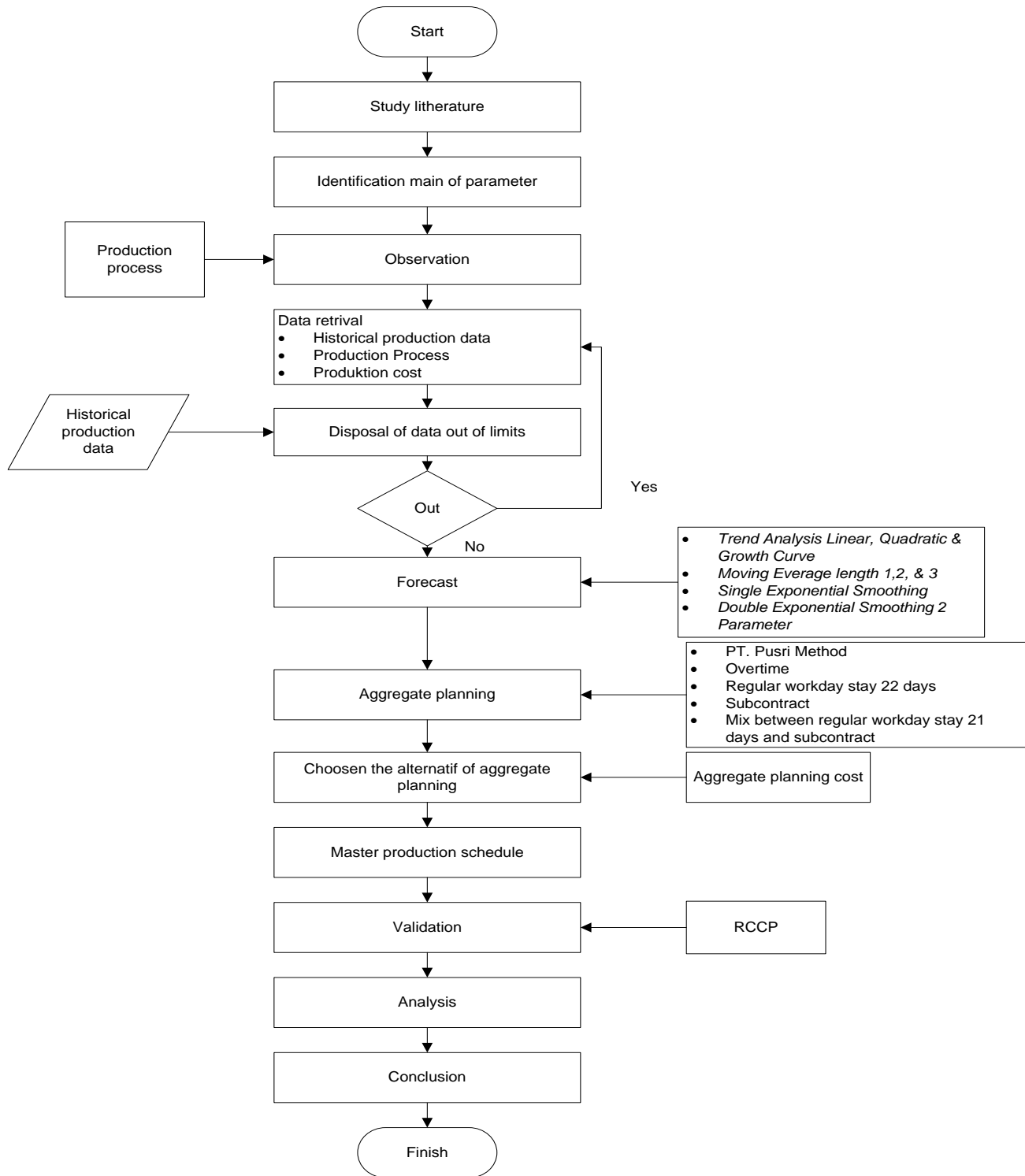


Figure 1. Research Metodology

Table 4. Alternatives of aggregate planning with strategic overtime

Period	Forecast (ton)	Regular Day (days)	Over time (day)	Regular Production (ton)	Overtime production (ton)	Total Production (ton)	Inventory (ton)	Total Production Cost (Rp)	Inventory & Backorder Cost (Rp)	Total cost (Rp)
Jul	162.939	21	1	158131,66	7530,08	165661,74	2722,74	227.349,62	41,23	227.390,86
Aug	162.812	23	0	173191,82	0	173191,82	13102,56	237.683,70	198,43	237.882,12
Sept	162.686	22	0	165661,74	0	165661,74	16078,29	227.349,62	243,49	227.593,11
Oct	162.559	21	1	158131,66	7530,08	165661,74	19181,03	227.349,62	290,48	227.640,10
Nov	162.432	22	0	165661,74	0	165661,74	22410,77	227.349,62	339,39	227.689,01
Dec	162.306	22	0	165661,74	0	165661,74	25766,51	227.349,62	390,21	227.739,83
Jan	162.179	22	0	165661,74	0	165661,74	29249,25	227.349,62	442,95	227.792,58
Feb	162.053	21	0	158131,66	0	158131,66	25327,90	217.015,55	383,57	217.399,12
Mar	161.926	22	0	165661,74	0	165661,74	29063,64	227.349,62	440,14	227.789,77
Apr	161.799	21	1	158131,66	7530,08	165661,74	32926,38	227.349,62	498,64	227.848,26
May	161.673	23	0	173191,82	0	173191,82	44445,20	237.683,70	673,08	238.356,78
Jun	161.546	21	1	158131,66	7530,08	165661,74	48560,94	227.349,62	735,41	228.085,03
Total										2.743.206,58

Table 5. Alternative aggregate planning strategies with fix regular working day 22 days

Period	Forecast (ton)	Regular Workday (day)	Total Production (ton)	Inventory (ton)	Total Production Cost (Rp)	Inventory & Backorder Cost (Rp)	Total cost (Rp)
Jul	162.939	22	165661,74	2.722,74	227.349,62	41,23	227.390,86
Aug	162.812	22	165661,74	5.572,48	227.349,62	84,39	227.434,01
Sept	162.686	22	165661,74	8.548,21	227.349,62	129,45	227.479,08
Oct	162.559	22	165661,74	11.650,95	227.349,62	176,44	227.526,07
Nov	162.432	22	165661,74	14.880,69	227.349,62	225,35	227.574,98
Dec	162.306	22	165661,74	18.236,43	227.349,62	276,17	227.625,80
Jan	162.179	22	165661,74	21.719,17	227.349,62	328,92	227.678,54
Feb	162.053	22	165661,74	25.327,90	227.349,62	383,57	227.733,19
Mar	161.926	22	165661,74	29.063,64	227.349,62	440,14	227.789,77
Apr	161.799	22	165661,74	32.926,38	227.349,62	498,64	227.848,26
May	161.673	22	165661,74	36.915,12	227.349,62	559,04	227.908,67
Jun	161.546	22	165661,74	41.030,86	227.349,62	621,37	227.971,00
Total							2.731.960,22

Table 6. Alternative aggregate planning strategies with subcontracting (million Rp.)

Period	Forecast (ton)	Regular (day)	Total Production (ton)	Sub contract (ton)	Inventory (ton)	Total Production Cost (Rp)	Sub contract Cost (Rp)	Inventory & Backorder cost (Rp)	Total cost (Rp)
Jul	162.939	21	158.131,66	4.807,34	0,00	217.015,55	7.211,01	0	224.226,56
Aug	162.812	23	173.191,82	0,00	10.379,82	237.683,69	0	157,19	237.840,89
Sept	162.686	22	165.661,74	0,00	13.355,56	227.349,62	0	202,25	227.551,88
Oct	162.559	21	158.131,66	0,00	8.928,21	217.015,55	0	135,21	217.150,79
Nov	162.432	22	165.661,74	0,00	12.157,95	227.349,62	0	184,12	227.533,75
Dec	162.306	22	165.661,74	0,00	15.513,69	227.349,62	0	234,94	227.584,56
Jan	162.179	22	165.661,74	0,00	18.996,43	227.349,62	0	287,68	227.637,31
Feb	162.053	21	158.131,66	0,00	15.075,09	217.015,55	0	228,30	217.243,85
Mar	161.926	22	165.661,74	0,00	18.810,83	227.349,62	0	284,87	227.634,50
Apr	161.799	21	158.131,66	0,00	15.143,48	217.015,55	0	229,33	217.244,88
May	161.673	23	173.191,82	0,00	26.662,30	237.683,69	0	403,78	238.087,4
Jun	161.546	21	158.131,66	0,00	23.247,96	217.015,55	0	352,07	217.367,62
Total									2.707.104,03

Table 7. Alternative Aggregate Planning Strategies with a mix of fix regular day 21 days and subcontracting (million Rp.)

Period	Forecast (ton)	Regular (days)	Total Production (ton)	Subcontract (ton)	Inventory (ton)	Total Production cost (Rp)	Subcontract (Rp)	Inventory & Backorder Cost (Rp)	Total Cost (Rp)
Jul	162.939	21	158.131,66	4.807,34	0,00	217.015,55	7.211	-	224.226,56
Aug	162.812	21	158.131,66	4.680,34	0,00	217.015,55	7.021	-	217.015,55
Sept	162.686	21	158.131,66	4.554,34	0,00	217.015,55	6.832	-	217.015,55
Oct	162.559	21	158.131,66	4.427,34	0,00	217.015,55	6.641	-	217.015,55
Nov	162.432	21	158.131,66	4.300,34	0,00	217.015,55	6.451	-	217.015,55
Dec	162.306	21	158.131,66	4.174,34	0,00	217.015,55	6.262	-	217.015,55
Jan	162.179	21	158.131,66	4.047,34	0,00	217.015,55	6.071	-	217.015,55
Feb	162.053	21	158.131,66	3.921,34	0,00	217.015,55	5.882	-	217.015,55
Mar	161.926	21	158.131,66	3.794,34	0,00	217.015,55	5.692	-	217.015,55
Apr	161.799	21	158.131,66	3.667,34	0,00	217.015,55	5.501	-	217.015,55
May	161.673	21	158.131,66	3.541,34	0,00	217.015,55	5.312	-	217.015,55
Jun	161.546	21	158.131,66	3.414,34	0,00	217.015,55	5.122	-	217.015,55
Total									2.611.397,62

Table 8. Total production planning cost

Strategy Alternatives	Cost (Rp.)
Overtime	2.743.206.584.158,67
Regular workday fixed (22 hari)	2.731.960.222.681,97
Subcontract	2.707.104.033.115,21
Mix between the regular workday stays 21 days and subcontract	2.611.397.617.363,64

Table 9. Total cost comparison with aggregate planning method of PT Pusri and aggregate planning methods with mixed strategies between the fix regular day 21 days and subcontracting

Alternatives	Cost (Rp.)
Mix between the regular workday stays 21 days and subcontract	2.611.397.617.363,64
RKAP	2.699.201.396.567,27
Difference	87.803.779.203,63
Percentage	3,25%

Table 10 Master production schedule

Periode		1	2	3	4	5	6
Pabrik	IB	43132,76	43099,14	43065,79	43032,17	42998,55	42965,19
	II	35875,73	35847,77	35820,03	35792,06	35764,10	35736,36
	III	39955,88	39924,73	39893,83	39862,69	39831,55	39800,65
	IV	43974,63	43940,36	43906,35	43872,08	43837,80	43803,80
Periode		7	8	9	10	11	12
Pabrik	IB	42931,57	42898,22	42864,60	42830,98	42797,63	42764,01
	II	35708,40	35680,65	35652,69	35624,73	35596,99	35569,02
	III	39769,51	39738,61	39707,47	39676,32	39645,43	39614,28
	IV	43769,52	43735,52	43701,24	43666,97	43632,96	43598,69

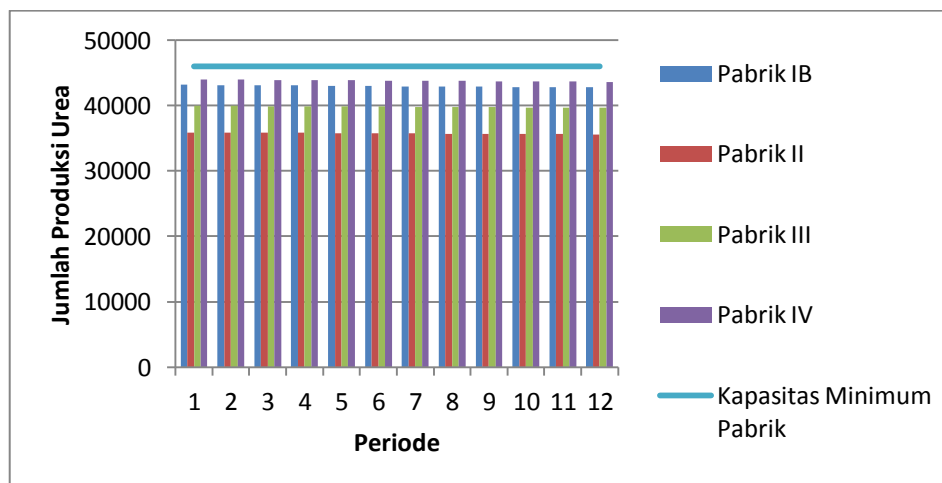


Figure 3. Rough cut capacity planning