Production Planning and Capacity Control with Demand Forecasting Using Artificial Neural Network (Case Study PT. Dynaplast) for Industry 4.0

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Abstract

PT. Dynaplast is a manufacturing company engaged in the production of plastic packaging. There are problems with fulfilling demands and overproduction. This research was conducted at the Blow 1 Department for Arrow, Morning fresh, ZWT, and BBF products using demand data from January 2017 to December 2019. Other than that, it takes some additional data to do disaggregated aggregate planning, rough-cut capacity planning, material requirement planning, and capacity requirement planning. Based on the analysis used, used forecasting methods SMA, DMA, WMA, SES, DES, Linear Regression, Cyclic, Quadratic, Decomposition, and ANN, the method chosen for PT. Dynaplast is an (ANN) with the smallest error value, disaggregate aggregate planning using mixed scheduling with a total cost of Rp 4.311.305.125. The results of rough-cut capacity planning using CPOF, BOLA, and RPA methods, all of these RCCP methods have sufficient resources. Based on lot sizing calculations using the LFL, EOQ, POQ, PPB, Silver Meal, AWW, and LUC techniques, the best results are the Algoritma Wagner Within (AWW) method optimal total cost for raw materials of Rp 10.633.664.526 and capacity requirement planning. There are deficiencies in the mixing machine, which can be resolved by adding overtime in January.

Keywords
Forecast, Aggregate Disaggregate, RCCP, MRP, CRP

1. Introduction
In this era of globalization, industrial development is increasing for customer's satisfaction. Competition for improving productivity is always demanded. Production planning and control is defined as a process for planning and controlling the flow of material into, flowing and out of the production or operation system so the market demand can be fulfilled with the right quantity, delivery time, and the minimum cost of production (I. Rus, 2008).

Production planning is the planning of production and manufacturing modules in the company or industry, which utilizes the activities of employees, materials, and production capacity resources allocation to satisfy customer's needs (Fargher, 1996).

PT. Dynaplast is a plastics manufacturing company founded in 1959 and engaged in producing plastic packaging (rigid packaging). Based on the observations that have been done, the problems that come about are the production results don't match the production demand, and overproduction for some products type, and do data collection manually for the production results every day. In this study, the products that were examined are in the Blow 1 Department, namely Arrow, Morning Fresh, Zwitsal (ZWT), and Biore Body Foam (BBF).

1.1 Objectives
Based on the problems above, this research aims to minimize losses to the company by carrying out appropriate production planning with forecasting to find out the demand for the coming period. The cost analysis with the Lot Sizing technique has the lowest cost by calculating the cost of the raw materials and finding out the capacity available at the company to satisfy the demand.

2. Literature Review

The production processes must be manufactured at some specified steps to satisfy the demand for the products.

2.1 Forecasting

Forecasting is the art and science of predicting future events by taking historical data and projecting it into the future using a systematic approach model (Heizer, Jay and Barry 2011). Qualitative Inventory planning was replaced by forecasting and determining the smallest error (Gozali, Samuel, Lefta, and Indahsari 2020). The forecasting process is done with Single Moving Average (SMA), Double Moving Average (DMA), Weighted Moving Average (WMA), Single Exponential Smoothing (SES), Double Exponential Smoothing (DES), Linear Regression, Cyclic, Quadratic, Decomposition, and Artificial Neural Network (ANN).

2.2 Verification of The Forecasting Model

Forecasting results will be followed by validation and verification by calculating the smallest error by several methods (Heizer, Jay, and Barry 2009):

a. *Mean Absolute Percentage Error* (MAPE)

$$\text{MAPE} = \frac{100\,\frac{|Xi-Fi|}{Xi}}{n} \quad (1)$$

b. *Mean Absolute Deviation* (MAD)

$$\text{MAD} = \frac{|Xi-Fi|}{n} \quad (2)$$

c. *Mean Squared Error* (MSE)

$$\text{MSE} = \frac{(Xi-Fi)^2}{n} \quad (3)$$

2.3 Aggregate Planning

Aggregate planning is a medium-term production plan made by adjusting the demand for forecasting results in a certain period (Teguh 2002). Aggregate planning has various types of techniques, but the mixed strategy is the technique that is generally used because the application of a mixed strategy requires lower cost when compared to implementing the pure strategy (Gozali, Marie, and Fransiska 2020).

2.4 Disaggregate Planning

Disaggregate planning is the next step after aggregate planning to break down the aggregate units in each product item. The steps in the disaggregation process are determining the value of the expected quantity. Disaggregate planning in this research uses the percentage disaggregate technique.

2.5 Master Production Schedule (MPS)

MPS is the result of the activation of master production scheduling. The master production schedule is a statement about manufacturing industrial companies' final product that planning and producing output relates to quantity and period of time (Vincent 2021). There are some inputs for the primary input production scheduling:

a. The data of total demand is a demand that is related to sales forecasts and orders.
b. Inventory status is related to information about on-hand inventory, stocks allocated for specific uses, issued production dan purchase orders.
c. The production plan provides a set of limits to the master production schedule.

2.6 Rough Cut Capacity Planning (RCCP)

RCCP is the second order of the capacity priority planning hierarchy that plays a role in developing MPS. RCCP is used to determine specific sources to provide information about the level of production in the future to satisfy the total demand (Vincent 2012). There are three techniques to make rough-cut capacity planning, such as Capacity Planning Using Overall Factors (CPOF), Bill of Labor Approach (BOLA), and Resources Profile Approach.

2.7 Material Requirement Planning (MRP)

Material Requirement Planning is an information system that translates the Indusk Production Schedule (Master Production Planning) for finished goods into several stages of component and raw material requirements (Gozali, Jap, and Irena 2020). The purpose of MRP is to produce the right information to take the right action (order cancellation, re-order, and reschedule). There are 7 MRP techniques used in this study, such as LFL, EOQ, POQ, PPB, LUC, AWW, and Silver Meal. The best method chosen is the one that produces the minimum cost.

2.8 Capacity Requirement Planning (CRP)

CRP or capacity design is a system for planning and controlling agro-industrial production. Production must pay attention to the characteristics of the typical raw material. Seasonal factors necessitate the importance of production scheduling (Hani Hadoko 2001). The purpose of making capacity requirement planning is to know which workstation is overloaded and underloaded.

3. Methods

Data used in this research are demand data from January 2017 until December 2019, the company's cost component, and the capacity of each machine used in the production process. Data collection was carried out by conducting direct surveys on the production process, seeing the factory's conditions, and taking interviews with the company or the PPIC Manager. After that, searches for some references or information to determine which methods can be used to solve the company's problems. Dynaplast. The results of field studies and literature studies on the company analyze the problems and obstacles. An identification of the problems at PT. Dynaplast is about the production process, controlling raw material inventory, minimizing excess costs, and determining production capacity. The problems that occurred at PT.

Dynaplast is how to determine the right forecast planning to optimize the production process, steps in determining the method of controlling raw material inventories, minimizing excess costs, and determining the right production capacity. The purpose of this research at PT. Dynaplast is solved that problems occur due to overloaded and underloaded production results. The method used to solve this problem is forecasting with the MATLAB R2017b application to verifies the smallest error value. The forecasting results that have been done will be used to calculate the aggregate, disaggregate planning using the amount that must be produced in the coming year. Making disaggregate planning will calculate RCCP with three methods, such as CPOF, BOLA, and RPA. The process of calculating material requirements is carried out using seven techniques of MRP. The final step is calculating the CRP to determine the availability of a more detailed machine using the data that has been collected. Based on the calculations results, the researcher made an analysis and a conclusion that could be given to the company as a solution to solve the problems. The research methodology flow chart can be seen in Figure 1 below.

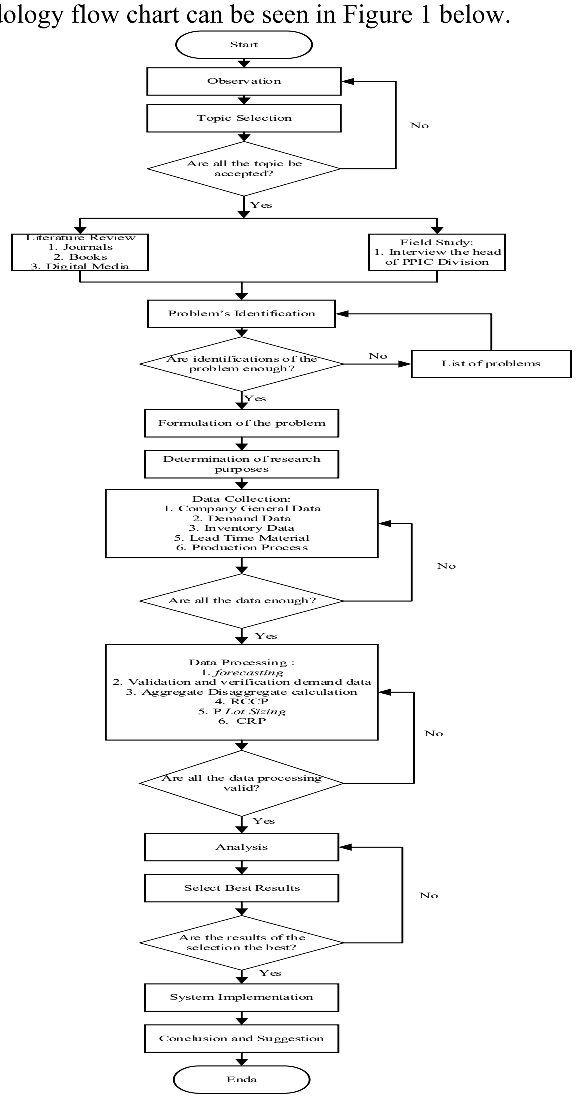

Figure 1. Research Methodology Flow Chart

4. Data Collection

Data used in this research are demand data from January 2017 until December 2019 at PT. Dynaplast for Arrow, Morning Fresh, ZWT, and BBF. Operation time used for each type of product, the company's cost component, each machine's capacity used in the production process, and Bill of Material (BOM) for each product.

5. Results and Discussion

5.1 Numerical Results

5.1.1. Forecast

Forecast results can be done by calculating each technique's error using demand data from January 2017 until December 2019. The forecasting chosen is an Artificial Neural Network (ANN) technique with the smallest error value. Artificial Neural Network for each item are summarized and can be seen in Table 1.

Table 1. Artificial Neural Network for The Smallest Error Results

Product	MAD	MSE	SDE	MAPE	MPE
Arrow	123,80958	25871,97	167,99992	0,033923	0,03392
Morning fresh	121,03333	28155,91	175,2585	0,025229	0,00046
ZWT	187,82035	78374,01	292,4019	0,035339	0,01451
BBF	150,24069	94923,49	321,7964	0,019373	0,01641

Based on the table above, the results have shown that the Artificial Neural Network forecast error is the smallest, which proves the forecast to make the demand projection for the upcoming year. The results for forecasting using the Artificial Neural Network can be seen in Table 2.

Table 2. Forecast Result Using Artificial Neural Network

No	Arrow	Morning Fresh	ZWT	BBF
1	213236	137020	130633	548053
2	189279	347083	155422	653259
3	148979	231412	559995	502162
4	162106	485442	210048	467055
5	161975	427730	381120	485641
6	798897	419699	190921	370453
7	163550	393037	129103	413591
8	801785	534377	124359	188723
9	171295	463169	554487	265935
10	544233	414091	584542	174612
11	235289	315371	355223	547365
12	163878	307543	302623	462236

5.1.2. Aggregate Disaggregate Planning

Aggregate planning used in this research is mixed planning because it implements a combination of shift and overtime to produce the minimum cost. Aggregate planning can be seen in Table 3.

Table 3. Aggregate Planning Result

Period	Avg Production/ Hour	Working Days (Mon-Fri)	Working Days (Sat)	Total Working Hour	Demand Forecast (Unit)	Reguler Time Production (Unit)	Initial Inventory	Overtime	Overtime Production (Unit)	Initial Inventory	RT+OT Production (Unit)	Overtime Cost	Salary	Inventory Cost	Total Cost
Jan-20	3498	22	4	372	1.028.942	1.301.256	272.314	0,0	0	272314	1301256	Rp -	Rp 246.989.979	Rp 34.039.278	Rp 281.029.257
Feb-20	3498	21	5	374	1.345.043	1.308.252	235.523	0,0	0	235523	1308252	Rp -	Rp 246.989.979	Rp 29.440.368	Rp 276.430.346
Mar-20	3498	23	4	386	1.442.548	1.350.228	143.203	0,0	0	143203	1350228	Rp -	Rp 246.989.979	Rp 17.900.367	Rp 264.890.346
Apr-20	3498	21	4	358	1.324.651	1.252.284	70.836	0,0	0	70836	1252284	Rp -	Rp 246.989.979	Rp 8.854.453	Rp 255.844.431
May-20	3498	20	5	360	1.456.466	1.259.280	-126.351	55,6	136069,794	9719	1395350	Rp 105.040.893	Rp 246.989.979	Rp 1.214.909	Rp 353.245.780
Jun-20	3498	22	4	372	1.779.970	1.301.256	-468.995	206,3	505071,710	36077	1806328	Rp 389.896.844	Rp 246.989.979	Rp 4.509.569	Rp 641.396.391
Jul-20	3498	20	4	344	1.099.282	1.203.312	140.107	0,0	0	140107	1203312	Rp -	Rp 246.989.979	Rp 17.513.369	Rp264.503.347
Aug-20	3498	21	5	374	1.649.244	1.308.252	-200.885	88,4	216338,17	15453	1524590	Rp 167.005.138	Rp 246.989.979	Rp 1.931.591	Rp 415.926.708
Sep-20	3498	22	4	372	1.454.886	1.301.256	-138.178	60,8	148806,668	10629	1450063	Rp 114.873.292	Rp 246.989.979	Rp 1.328.631	Rp 363.191.902
Oct-20	3498	23	5	402	1.717.478	1.406.196	-300.652	132,2	323779,598	23127	1729976	Rp 249.945.980	Rp 246.989.979	Rp 2.890.889	Rp 499.826.848
Nov-20	3498	20	4	344	1.453.248	1.203.312	-226.808	99,8	244255,293	17447	1447567	Rp 188.556.132	Rp 246.989.979	Rp 2.180.851	Rp 437.726.961
Dec-20	3498	22	4	372	1.236.280	1.301.256	82.423	0,0	0	82423	1301256	Rp -	Rp 246.989.979	Rp 10.302.823	Rp 257.292.802
						TOTAL						Rp 1.215.318.279	Rp 2.963.879.748	Rp 132.107.098	Rp 4.311.305.125

The result of aggregate planning was then added to the calculation disaggregate planning using the percentage technique. The disaggregate planning result can be seen in Table 4.

Table 4. Disaggregate Planning Result

No	Arrow	Morning Fresh	ZWT	BBF
1	269670	173283	165206	693098
2	184102	337590	151171	635391
3	139445	216602	524157	470025
4	153251	458922	198574	441539
5	154098	406928	362585	462022
6	798898	419699	190922	370454
7	179028	430233	141321	452732
8	751211	500670	116516	176819
9	171296	463169	554487	265936
10	544234	414091	584542	174612
11	235290	315371	355223	547365
12	172492	323707	318528	486531

Based on the table above, the production amount calculation is calculated until 12 months for all products. An example of disaggregate planning for the first period Arrow product can be seen below.

Production Amount = Percentage All Demand Products x Previous Total Aggregate Planning Production Results
= 0, 2072% x 1301256 Pcs
= 269670 Pcs

5.1.3. Master Production Schedule (MPS)

The calculation for the master production schedule uses the data disaggregated results that have been determined. The master production schedule for the upcoming period of PT. Dynaplast can be seen in Table 4.

5.1.4. Rough Cut Capacity Planning (RCCP)

Rough cut capacity used operation time in the production process for all products. The results of the calculation of rough-cut capacity planning can be seen in Table 5.

Table 5. Available Working Time (Minutes)

Machine	Penimbangan	Mixing	Blow Molding	Leak Tester	Labeling	Packing	Total
Jan	1112826,6	11621058,2	2720680,8	1380442,4	619063,7	166418,3	17620490,1
Feb	1184921,4	12421420,0	2883669,6	1455950,6	658706,7	178573,3	18783241,5
Mar	1400421,5	14580654,5	3330708,0	2034120,8	774710,2	206086,0	22326700,9
Apr	1287330,2	13543649,1	3205488,8	1622910,0	714630,6	196571,4	20570580,2
May	1415369,2	14832313,6	3466879,4	1905355,6	784402,4	213158,6	22617478,7
Jun	1728601,1	18210402,4	4911175,6	2104907,0	962682,8	273758,9	28191527,8
Jul	1067620,1	11237476,3	2681064,0	1310287,5	593226,6	163594,4	17053269,0
Aug	1604638,7	16979216,6	4722501,6	1907774,8	893980,3	259031,9	26367143,8
Sept	1417599,2	14857594,6	3545999,4	2043143,9	783812,7	214379,7	22862529,4
Oct	1672568,6	17547196,1	4540222,7	2354171,3	926761,5	258821,3	27299741,5
Nov	1410020,7	14747336,7	3474956,7	1880680,8	782169,0	211757,0	22506920,8
Des	1459019,8	15220719,2	3521670,0	2105170,1	807139,8	216463,1	23330182,0

Rough cut capacity planning calculation used three techniques, such as CPOF, BOLA, and RPA, that have the same results, which show the available working time to do the production. The results of the rough-cut capacity planning calculation can be seen in Table 6.

Table. 6. Rough Cut Capacity Planning Result (Minutes)

Penimbangan	Mixing	Blow Molding	Leak Tester	Labeling	Packing	Total
1	1	1	1	1	1	6
10713600,0	10713600,0	10713600,0	10713600,0	10713600,0	10713600,0	64281600,0
28315663,5	28315663,5	28315663,5	28315663,5	28315663,5	28315663,5	169893980,7
32131156,7	32131156,7	32131156,7	32131156,7	32131156,7	32131156,7	192786940,1
27200755,0	27200755,0	27200755,0	27200755,0	27200755,0	27200755,0	163204530,1
26124441,0	26124441,0	26124441,0	26124441,0	26124441,0	26124441,0	156746646,2
29875250,3	29875250,3	29875250,3	29875250,3	29875250,3	29875250,3	179251501,7
24788851,6	24788851,6	24788851,6	24788851,6	24788851,6	24788851,6	148733109,8
28582704,6	28582704,6	28582704,6	28582704,6	28582704,6	28582704,6	171496227,6
29661879,0	29661879,0	29661879,0	29661879,0	29661879,0	29661879,0	177971274,0
33610641,8	33610641,8	33610641,8	33610641,8	33610641,8	33610641,8	201663850,8
25000059,0	25000059,0	25000059,0	25000059,0	25000059,0	25000059,0	150000354,2
29518395,3	29518395,3	29518395,3	29518395,3	29518395,3	29518395,3	177110371,7

Based on RCCP calculation results using CPOF, BOLA, RPA, there are mixing machines that can't satisfy production needs in January.

5.1.5. Material Requirement Planning (MRP)

MRP calculations are using seven techniques, such as Lot for Lor (LFL), Economic Order Quantity (EOQ), Period Order Quantity (POQ), Part Period Balancing (PPB), Wagner-Within Algorithm (AWW), Silver Meal, and Least Unit Cost (LUC) to get the lowest total cost. The MRP calculation is carried out using the safety stock for each raw with the safety level of 95%. The results of raw material safety stock can be seen in Table 7.

Table 7. Raw Material Safety Stock

Marlex HDPE	**Masterbatches**	**Additive Hidrocerol**
14222314 gr	468037 gr	32592 gr

MRP calculation's primary focus is to minimize the combined total shipping costs of the set-up costs and the storage costs and try to have the set-up costs and the storage costs add the same value to the number of orders placed. The calculation result of MRP can be seen in Table 8.

Table 8. MRP Calculation Result

No	**Metode**	**Produk**		
		Marlex HDPE	**Masterbatches**	**Additive Hidrocerol**
1	*Lot for Lot* (LFL)	Rp 9.876.115.637	Rp 730.132.587	Rp 59.584.135
2	*Economic Order Quantity* (EOQ)	Rp 27.454.308.608	Rp 1.685.632.771	Rp 134.869.924
3	*Period Order Quantity* (POQ)	Rp 41.175.897.388	Rp 1.068.872.783	Rp 86.115.880
4	*Part Period Balancing* (PPB)	Rp 9.876.115.637	Rp 1.453.480.142	Rp 60.905.458
5	*Algoritma Wagner Within* (AWW)	**Rp 9.876.115.637**	**Rp 698.737.235**	**Rp 58.804.958**
6	*Silver Meal*	Rp 9.876.115.637	Rp 1.391.813.243	Rp 58.804.958
7	*Least Unit Cost (LUC)*	Rp 10.415.378.376	Rp 746.270.727	Rp 61.423.060

Based on the results of the MRP calculation above, it can be seen that the optimal cost of raw materials has more than one technique. The calculation with the selected technique for one of the raw materials that provide optimal costs for all raw materials is to use the Algoritma Wagner Within (AWW). And the costs for Marlex HDPE is Rp. 9.876.115.637, the cost for Masterbatches is Rp. 698.737.235, and the cost for additive hydrosol is Rp. 58.804.958. The total amount of raw materials that have been calculated using the AWW method is Rp 10.633.657.829.

5.1.6. Capacity Requirement Planning (CRP)

Calculations using the CRP method are carried out by comparing the capacity needed to meet the ordering requirements that will be generated by the MRP. The capacity calculation is used to determine the amount of production capacity that the company has. The first step that needs to be done to calculate the CRP is to calculate the total production time of each product type and calculate the CRP of each existing process machine. Comparison of available working time and capacity needed by considering the utilization and efficiency available is 96% can be seen in Table 9.

Table 9. Comparison Capacity Requirement Planning (Minutes)

Recap		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Des
Penimbangan machine	A	9873653,76	26057687,04	29455073,28	24942919,68	23887872,00	27152547,84	22826188,80	26057687,04	27152547,84	30676008,96	22826188,80	27152547,84
	R	1258133,10	1267501,25	1445960,70	1365548,40	1495900,21	2502972,89	1342185,42	2231571,23	1583636,37	2200094,57	1638087,27	1430321,72
Mixing Machine	A	9873653,76	26057687,04	29455073,28	24942919,68	23887872,00	27152547,84	22826188,80	26057687,04	27152547,84	30676008,96	22826188,80	27152547,84
	R	13138468,54	13287097,33	13647514,72	12803747,37	14110947,01	18210402,38	12300927,29	15908213,47	14857594,55	17547196,14	14747336,67	13220367,20
Blow Molding Machine	A	9873653,76	26057687,04	29455073,28	24942919,68	23887872,00	27152547,84	22826188,80	26057687,04	27152547,84	30676008,96	22826188,80	27152547,84
	R	3075931,14	3084638,66	3117547,03	3030370,27	3298267,96	4911175,64	2934784,18	4424619,58	3545999,43	4540222,70	3474956,68	3088624,89
Leak Tester Machine	A	9873653,76	26057687,04	29455073,28	24942919,68	23887872,00	27152547,84	22826188,80	26057687,04	27152547,84	30676008,96	22826188,80	27152547,84
	R	1560692,34	1557419,14	1903940,05	1534249,09	1812689,57	2104906,97	1434286,07	1787437,70	2043143,88	2354171,32	1880680,76	1684506,36
Labeling Machine	A	9873653,76	26057687,04	29455073,28	24942919,68	23887872,00	27152547,84	22826188,80	26057687,04	27152547,84	30676008,96	22826188,80	27152547,84
	R	699897,48	704613,44	725129,94	675589,66	746253,13	962682,81	649366,22	837590,43	783812,65	926761,51	782169,02	700471,51
Packing Machine	A	9873653,76	26057687,04	29455073,28	24942919,68	23887872,00	27152547,84	22826188,80	26057687,04	27152547,84	30676008,96	22826188,80	27152547,84
	R	188148,26	191018,44	192896,78	185832,56	202791,62	273758,93	179075,99	242692,86	214379,72	258821,25	211756,96	189646,16

Information:
A: Available Time
R: Requirement Time

5.2 Graphical Results

Comparison Capacity of RCCP and CRP can show that CRP calculation results have a smaller average capacity than RCCP because CRP uses the machines' efficiency and utilization. The comparison of RCCP and CRP can be seen in Figure 2.

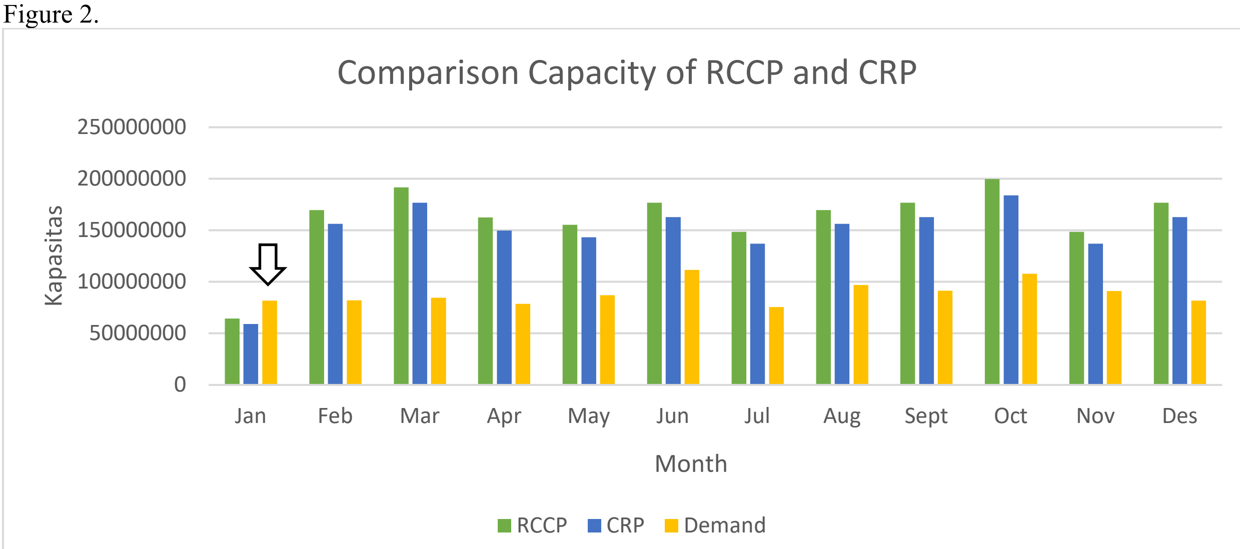

Figure 2. Comparison Capacity of RCCP and CRP

From Figure 2, we can see that RCCP and CRP's capacity doesn't meet the demand for January. After being traced, it was found that the mixing machine is having lacks capacity because the available timeless than the available time. The capacity of the January period can be seen in Figure 3.

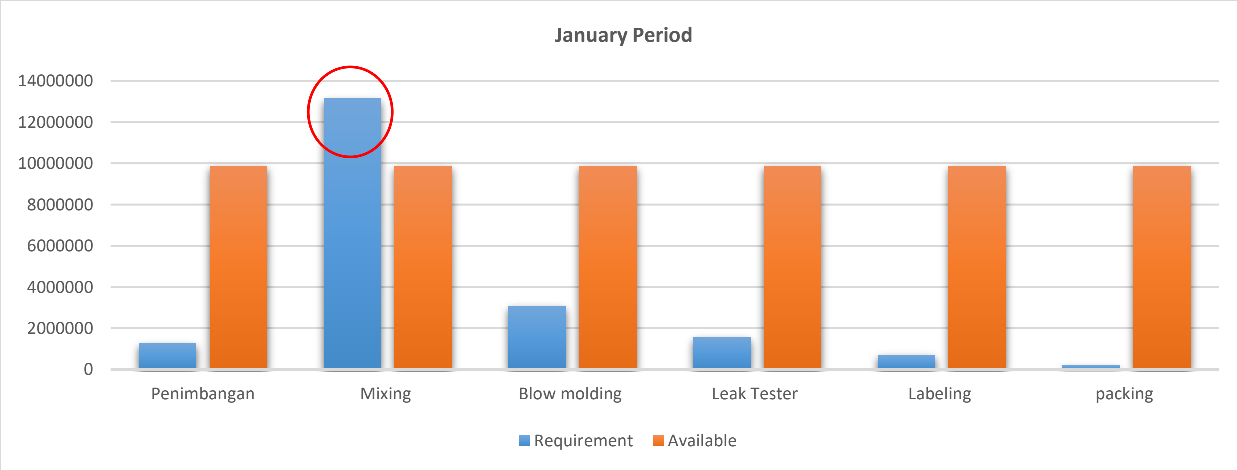

Figure 3. The Capacity of January Period

5.3 Proposed Improvements

Based on the capacity requirement calculation result, it can be seen that the mixing machine was lacking the capacity for January. The solution for the capacity problems and the cost needed for each alternative are summarized and seen in Table 10.

Table 10. Solution Cost Needed for Capacity Problem

Machine	Solution	Total Cost	
Penimbangan	Reduce Work Shift	Rp	10.918.559.310
Mixing	Overtime	Rp	73.741.880.310
Blow Molding	Reduce Work Shift	Rp	10.915.510.051
Leak Tester	Overtime replacement	Rp	7.373.695.898
Labeling	Overtime replacement	Rp	459.141.521
Packing	Overtime replacement	Rp	487.403.231

The solution to the capacity problem found that the mixing machine's lack of capacity can be overcome by considering the work overtime in January. The cost given is Rp 73.741.880.310. For machines that have more capacity can consider several solutions. Penimbangan machines and blow molding machines can reduce shifts for every month so that the cost given is Rp 10.915.510.051. Leak tester machines, labeling, and packing can be done by replacing work shifts with overtime to reduce the total cost.

5.3.1 Software Improvements

The implementation of this research is designing software that can help companies perform production planning calculations using the methods discussed before. In this design, the software uses the calculation methods that have been done, such as forecasting, aggregate disaggregated, RCCP, MRP, and CRP.

The first screen page of the software can be seen in Figure 4.

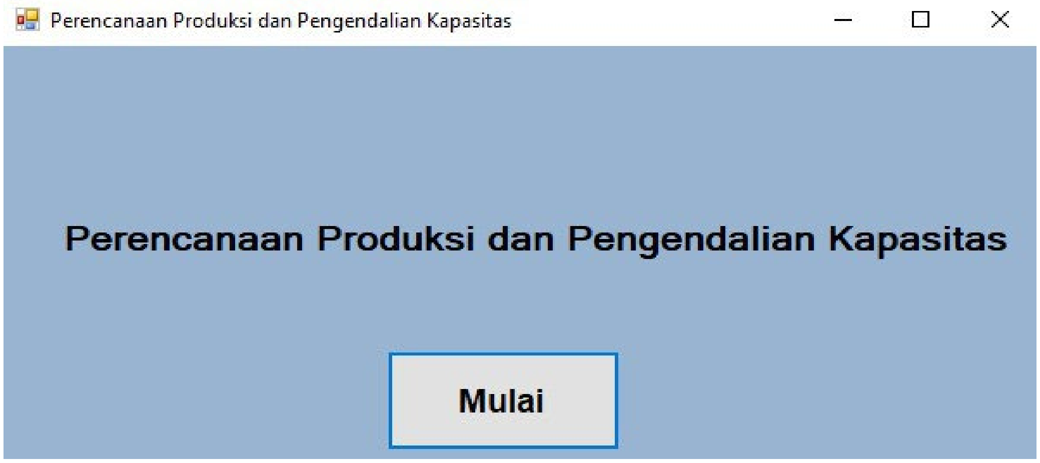

Figure 4. The Screen Page

There is a 'mulai' button to perform calculations on the front page, and the software starts to calculate using methods such as forecasting, aggregate, disaggregate, RCCP, MRP, and CRP. An example of the software calculation for forecasting used the MATLAB R2017b application to get the smallest normalization value. The MATLAB R2017b application can be seen in Figure 5.

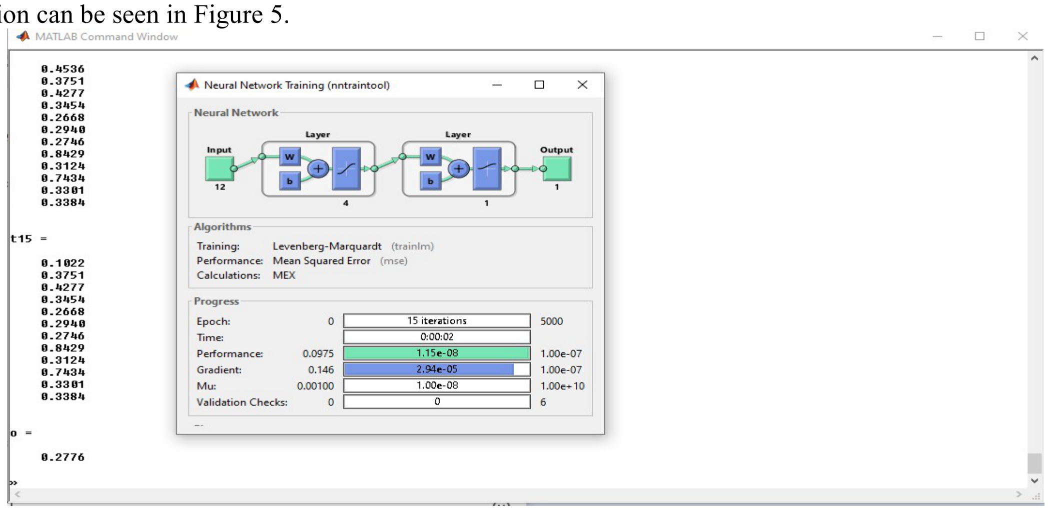

Figure 5. MATLAB R2017b Application

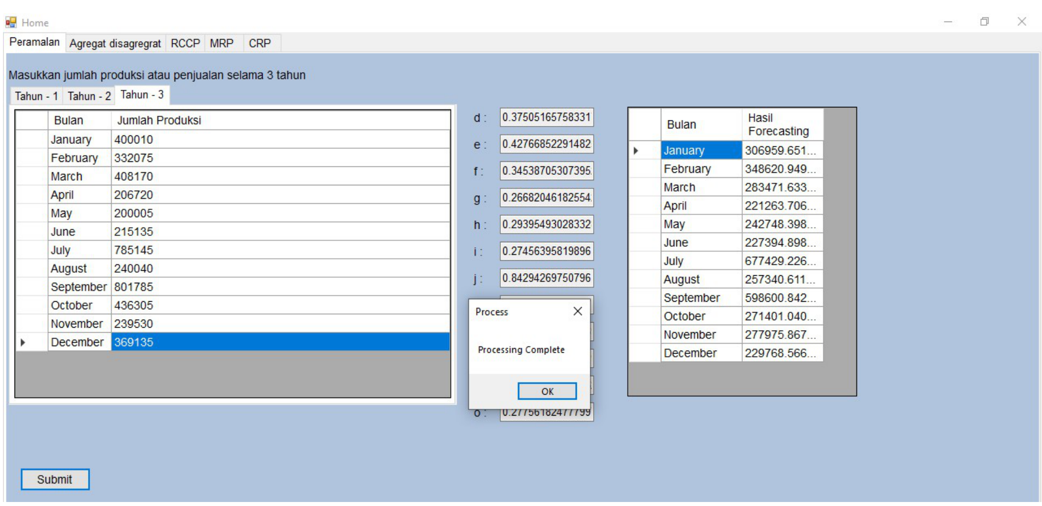

Figure 6. The Result of Forecasting Method

6. Conclusion

The conclusion of the analysis for PT. Dynaplast used the artificial neural network method as the best forecasting method with the MATLAB R2017b application, which has the smallest error. The forecasting results are used for normalization data, then calculate aggregate and disaggregate planning by mixed strategy method with a total cost of Rp 4.311.305.125. Calculations of the rough-cut capacity using three techniques, such as CPOF, BOLA, and RPA are known that the total production time capacity needs can be fulfilled for each period. The calculation of material requirements carried out showed Algoritma Wagner Within has a minimum cost of Rp. 10.633.657.829 for the total raw material cost.

Based on the analysis that has been done, there are differences in RCCP and CRP capacity because the CRP method uses the efficiency and utilization of the machine for calculations. The capacity machine problem always affects production. This is happened because of an inaccurate scheduling system. Mixing machines is lack of capacity to fulfill all of the demand. Companies need to pay attention to some machines that have the excess capacity to reduce and replace shifts into overtime because the costs given are smaller, and excessive production results can be reduced.

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Biography

Priskila Abigail Gunawan was born in Indonesia in 1999. She is a final year student at Universitas Tarumanagara. She had been given a scholarship from Adaro Foundation in her college years. She is a member of BEM Universitas Tarumanagara. She was an assistant lecturer for some subjects. In 2020, she had an internship at PT. Asri Pancawarna at Production Planning and Inventory Control division.

Lina Gozali is a lecturer in the Industrial Engineering Department at Universitas Tarumangara since 2006 and a free-lance lecturer at Universitas Trisakti since 1995. She got her Bachelor's degree at Trisakti University, Jakarta - Indonesia, then she graduated Master's Degree at STIE IBII, Jakarta – Indonesia, and graduated with her Ph.D. at Universiti Teknologi Malaysia, Kuala Lumpur – Malaysia in 2018. Her apprentice college experience was in paper at Kertas Bekasi Teguh, shoe at PT Jaya Harapan Barutama, automotive chain drive industry at Federal Superior Chain Manufacturing. She teaches Production System and Supply Chain Management Subjects and her Ph.D. research about Indonesian Business Incubator. She actively writes for almost 70 publications since 2008 in the Industrial Engineering research sector, such as Production Scheduling, Plant Layout, Maintenance, Line Balancing, Supply Chain Management, Production Planning, and Inventory Control. She had been worked at PT. Astra Otoparts Tbk as International.

Lamto Widodo is a lecturer at Tarumanagara University Jakarta since 1994, joining the Mechanical Engineering Department.; he is involved as a team for the Industrial Engineering Department opening in 2004-2005. He was starting in 2005 as a lecturer in the Industrial Engineering Department. Obtained a Bachelor's degree at the Sepuluh

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Frans Jusuf Daywin was born in Makasar, Indonesia on 24th November 1942. is a lecturer in the Department of Agricultural Engineering at Faculty of Agricultural Technology Bogor Agricultural University since 1964 conducted teaching, research, and extension work in the field of farm power and machinery and become a professor in Internal Combustion Engine and Farm Power directing and supervising undergraduate and graduate students thesis and dissertation and retired as a professor in 2007. In 1994 up to present as a professor in Internal Combustion Engine and Farm Power at Mechanical Engineering Program Study and Industrial Engineering Program Study Universitas Tarumanagara, directing and supervising undergraduate student's theses in Agricultural Engineering and Food Engineering Desain. In 2016 up to present teaching undergraduate courses of the introduction of concept technology, research methodology, and seminar, writing a scientific paper and scientific communication, and directing and supervising undergraduate student's theses in Industrial Engineering Program Study at the Faculty of Engineering Universitas Tarumanagara. He got his Ir degree in Agricultural Engineering, Bogor Agricultural University Indonesia in 1966, and finished the Master of Science in Agricultural Engineering at the University of Philippines, Los Banos, the Philippines 1981, and got the Doctor in Agricultural Engineering, Bogor Agricultural University Indonesia in 1991. He joined 4-month farm machinery training at ISEKI CO, AOTS, Japan in 1969 and 14 days agricultural engineering training at IRRI, Los Banos the Philippines, in March 1980. He received the honors "SATYA LANCANA KARYA SATYA XXX TAHUN" from the President of the Republic of Indonesia, April 22nd, 2006, and received appreciation as Team Jury from the Government of Indonesia Minister of Industry in Industry Start-Up 2008. He did several research and survey in the field of farm machinery, farm mechanization, agricultural engineering feasibility study in-field performance and cost analysis, land clearing and soil preparation in secondary forest and alang-alang field farm 1966 up to 1998. Up till now he is still doing research in designing food processing engineering in agriculture products. Up to the present he already elaborated as a conceptor of about 20 Indonesia National Standard (SNI) in the field of machinery and equipment. He joins the Professional Societies as a member: Indonesia Society of Agricultural Engineers (PERTETA); Indonesia Society of Engineers (PII); member of BKM-PII, and member of Majelis Penilai Insinyur Profesional BKM-PII.

Carla Olyvia Doaly is a lecturer in the Industrial Engineering Department at Universitas Tarumanagara graduated with my bachelor's degree from Institut Teknologi Nasional Malang, which study the Industrial Engineering program, then continued my Master Degree at Institut Teknologi Bandung majoring in Industrial engineering and management and a special field of Enterprise Engineering. I am very interested in studying industrial engineering by doing research related to System Design and Engineering, Supply Chain Management, Operations Research and Analysis, Information System Management, Occupational Health and Safety, Facilities Engineering, Quality and Reliability Engineering