

Production Planning and Control at PT XYZ Using Manufacturing Resources Planning Method

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Article Info

Article history

Received : May 27, 2021

Revised : June 05, 2021

Accepted : June 11, 2021

Published : June 30, 2021

Keywords:

Production Planning;

Raw Materials;

Time Capacity;

Lot Sizing.

A B S T R A K

PT XYZ is an industrial manufacturing company which produces egg trays. Since this company started operating, it never applied any systems in production planning and controlling which now causes many problems. This resulted in the production cost increasing rapidly. Not only that, management also has issues controlling what's going on in the company, because their lack of knowledge. Therefore in this study, the researchers conducted a research to solve and prevent the problems from resurfacing again. The method chosen by the researchers is Manufacturing Resources Planning, for this method is very complex and detailed, therefore, more aspects will be covered. This method is also expected to help the company in the future.



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DOI: <https://doi.org/10.35891/jkie.v8i2.2530>

1. Introduction

PT XYZ located in Percut Sei Tuan, Medan, is an industrial manufacturing company which produces egg trays. PT XYZ was established in 2020, since there was a high demand for the products that were offered by this company at the time. Since the company started operating, there was no system applied, causing many problems to surface, relating to production, raw material control, inventory control, etc (Junaidi & Mas'ud, 2018). This is certainly very unfortunate, considering production planning and raw material control are some of the most important aspects that can affect the quality of a company (Novitasari & Mas'ud, 2020). The company could suffer huge losses if these problems are not solved immediately. The production cost will keep increasing even more and will not be commensurate with the profits received from sales (Hanik & Mas'ud, 2019).

Therefore, the researchers decided to apply a system that could help this company solve its problems. In this research, Manufacturing Resources Planning will be applied because it covers almost all important aspects, not only production planning and control, but management and marketing as well (Novitasari & Mas'ud, 2020). By applying this system, it is expected to help the company overcome existing problems and creating the right solution to further prevent the problems from resurfacing, in order to minimize losses and increase profits (Fauzi & Mas'ud, 2019).

2. Literature Review

Production Planning

Production planning is an activity to analyze and compare data from the past and present in order to make a forecast on production schedule in the future. This is done for the purpose of being able to meet consumer needs effectively and efficiently. Production planning contains of the number of items to be produced, the amount of time needed to finish the production and materials needed to produce the products.

Production Control

Production control is an activity to screen and guarantee the series of activities that have been arranged is running smoothly and accordingly to reach the target, in spite of the fact that a few changes and altercations might happen.

Manufacturing Resources Planning (MRP II)

Manufacturing Resources Planning is an evolution to Material Requirement Planning, which is more complex, for there are extra variables such as, long term planning, master scheduling and rough cut capacity planning. This system is developed after many companies came to the realization that there are still many aspects needed to be integrated consisting of, finance, forecasting, sales order, sales analysis, distribution, quality control, as well as further reporting and monitoring systems.

Master Production Schedule (MPS)

Master Production Schedule is one of the functions of management. Master production schedule has the purpose to create a good work plan to achieve the target that has been set.. MPS determines the final statement of the number of products that have to be produced and the amount of time it takes to finish the production process. In general, MPS is applied in a weekly period of about six (6) to twelve (12) weeks ahead. In order to determine the MPS, an accurate forecasting is needed to obtain a production plan that is in accordance with consumer needs and to prevent production shortage or overproduction.

Material Requirement Planning (MRP)

Material Requirement Planning (MRP) is a system that is used to calculate the number of raw materials needed in order to fulfill the production process. This system is frequently used by manufacturing industry for its capability to give solution regarding the amount, type and time of goods required. MRP has a strong relation to inventory.

Besides inventory, MRP has a strong relation to scheduling priorities as well, because this system is able to predict when goods are needed to prevent the shortage of raw materials.

Rough Cut Capacity Planning (RCCP)

Rough Cut Capacity Planning (RCCP) is the assurance of the level of ampleness of the planned resources to execute master production schedule.

3. Methodology

Type of Research

This research is categorized as descriptive, for there are numerous description of occation that are portrayed clearly for the reason of giving a solution by collecting and analyzing datas. Based on the analysis and type of data used, this study includes quantitative research method, for the data collected can be calculated, measured and described using numbers.

Data Collecting Method

Data used in this study are primary data collected by direct observations in the field and brief interviews with the company employees, whereas secondary data are collected from internet and research papers.

Research Location

Our research is conducted at PT XYZ, located in Jalan Medan – Sampali No.418, Percut Sei Tuan, Medan. The time range of this research being conducted is between December 2020 – January 2021.

Research Object

The object of this research is improving the quality of work system at PT XYZ, focusing on minimizing production cost and creating a feasible production capacity.

4. Results and Discussion

Based on the data collected, a demand forecast is created for a period of 3 months using forecasting method called Moving Average. In order to get the most accurate result, the percentage of MAPE value must be in between 10% to 20%. Below is the result of the calculation.

Forecasting using Moving Average method with $n = 3$

$$\begin{aligned} \text{Dec Moving Average} &= \frac{\text{Demand on Sep, Oct, Nov}}{3} \\ &= \frac{19830 + 19810 + 19850}{3} = 19830 \end{aligned}$$

The forecasting demand for December 2020 is 19830.

Table 1. The results of forecasting demand calculation

Moving Average Method		
Period	Sales (bundle)	Forecast (bundle)
September-2020	19830	
October-2020	19810	19837
November-2020	19850	19813
December-2020	19820	19830
January-2021	19860	19827
February-2021	19810	19843

The forecasting demand for January and February are 19827, 19843.

From the forecasting above, MAPE calculation will proceed with the formula below.

$$MAPE = \frac{1}{N} \sum_{t=1}^N \left| \frac{e_t}{D_t} \times 100\% \right|$$

$$e_t = \text{actual request} - \text{actual period}(t)$$

$$D_t = \text{actual demand period}(t)$$

$$MAPE = \frac{\left(\frac{19820-19830}{19820}\right) + \left(\frac{19860-19827}{19860}\right) + \left(\frac{19810-19843}{19810}\right)}{3} \times 100\%$$

$$= 13\%$$

MAPE value of 13% indicates that the forecasting results are at a good level. Based on the forecasting results, these results are used as guidelines to create the monthly master production schedule. The results have to be added to the defect percentage tolerance set by the company which is 2%. Monthly master production schedule can be calculated with the formula below.

$$MPS_t = (\text{forecasting result} \times 2\%) + \text{forecasting result on } t \text{ period}$$

Table 2. Monthly Master Production Schedule

Master Production Schedule	
Period	Number of Products (Bundle)
December 2020	20227
January 2021	20223
February 2021	20240

The monthly master production schedule, then have to be converted into daily master production schedule.

$$\text{Daily MPS} = \frac{\text{Monthly MPS}}{\text{Effective working days in a month}}$$

Table 3. Daily Master Production Schedule

Master Production Schedule		
Period	Monthly MPS	Daily MPS
Desember 2020	20227	879
Januari 2021	20223	809
Februari 2021	20240	880

*Effective working days on December 2020 are 23 days

*Effective working days on January 2021 are 25 days

*Effective working days on February 2021 are 23 days

After the master production schedule is made, the next step is to conduct a feasibility test of the master production schedule using Rough Cut Capacity Planning method.

The monthly and daily master production schedule can be seen on Table 4 below.

Table 4. Monthly and daily master production schedule

Period	Monthly MPS	Effective working days	Daily MPS
Desember 2020	20227	23	879
Januari 2021	20223	25	809
Februari 2021	20240	23	880

Stated below are some additional information :

Number of shifts/day = 3

Number of hours/shift = 8 hours

Number of man = 37 people (13 people working 1st shift, 12 people working 2nd shift, 12 people working 3rd shift)

The feasibility test will be conducted using Capacity Planning Using Overall Factor technique, using the formula below.

$$\text{available capacity} = \text{total workforce} \times \text{number of shifts} \times \text{working hours} \times \text{number of working days}$$

$$\text{capacity required} = \text{production plan} \times \text{total working time}$$

After being calculated, both the results can be compared to find out if the master production schedule is feasible. The comparison is declared in %LC. If the %LC has a negative value, it means there's a shortage on the time capacity and vice versa.

$$\%LC = \frac{\text{available capacity} - \text{capacity required}}{\text{available capacity}} \times 100\%$$

Below is the results of the calculation using the formula above.

Table 5. Results of %LC.

Period	Required Time	Available Time	Results	%LC
Desember 2020	6742	6364	-378	-6%
Januari 2021	6741	6845	104	2%
Februari 2021	6747	6364	-383	-6%

From the results, it can be seen on the month December and February, that there's a shortage of time capacity. This shows that the master production schedule on both periods are not feasible. One of the ways that can be done to cover the time shortage is to apply overtime. The maximum overtime hours that is permitted by the company is 3 hours/day. The required overtime hours can be calculated using the formula below.

$$\text{Overtime requirement} = \frac{\text{Lack of time}}{\text{Effective overtime working hours}}$$

$$\text{december overtime requirement} = \frac{378}{(19 \times 3) + (4 \times 3)} = 5,4 \approx 5 \text{ people}$$

The result from the calculation shows that on December, there are 5 men required to do overtime, as well as on February. The master production schedule is now feasible, since the time shortage has been covered, which means the production plan and time are now coordinated.

The raw materials used by PT.XYZ to produce eggtrays are paperboards and duplex. Before calculating the raw materials requirements, information about the Bill Of Materials must be obtained, which can be seen on the table below.

Table 2. Bill Of Materials

Bill Of Materials			
Materials	Price/kg	Ordering cost (per one order)	Storage cost/kg
Paperboard	Rp 3,700.00	Rp 150,000.00	Rp 8.00
Duplex	Rp 2,500.00	Rp 100,000.00	Rp 5.00

*Ordering cost consists of all fees included in the process of ordering raw materials such as, admin fee, handling fee, transportation cost, etc.

*Assuming 1 year = 48 weeks

*Storage cost is 10% per year

*Storage cost can be calculated using the formula below

$$H = \frac{\text{Raw material price/kg}}{48} \times \text{percentage of storage costs}$$

The raw materials requirement per period can be seen on the table below.

Table 7. Raw Materials Requirement

Raw Materials Requirement			
Period	Jenis	Quantity (month)(kg)	Quantity (week)(kg)
December 2020	Paperboard	129300	32325
	Duplex	25860	6465
January 2021	Paperboard	138000	34500
	Duplex	27600	6900
February 2021	Paperboard	129300	32325
	Duplex	25860	6465

After calculating the raw materials requirement for each period, the next step is to calculate the number of planned order and ordering frequency, using LFL, EOQ and POQ techniques.

Table 8. Lot For Lot Calculation

lead time	2	DAYS						lot size	LFL					PAPERBOARD	TOTAL	ADMIN FEE	Rp150,000.00		
on hand	4140							safety stock	0										
		DEC				JAN				FEB									
PERIOD	PAST DUE	1	2	3	4	1	2	3	4	1	2	3	4						
GROSS REQUIREMENTS		32325	32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325	396600					
SCHEDULED RECEIPTS		28185	32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325	392460					
PROJECTED ON HAND	4140	0	0	0	0	0	0	0	0	0	0	0	0	0	STORAGE				
NET REQUIREMENTS		28185	32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325	364275	COST	Rp 8.00			
ORDER RECEIPTS PLANNED	28185	32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325		364275	(KG)				
ORDER RELEASE		32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325		364275					

lead time	2	DAYS						lot size	LFL					DUPLEX	TOTAL	ADMIN FEE	Rp100,000.00		
on hand	750							safety stock	0										
		DEC				JAN				FEB									
PERIOD	PAST DUE	1	2	3	4	1	2	3	4	1	2	3	4						
GROSS REQUIREMENTS		6465	6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465	79320					
SCHEDULED RECEIPTS		5715	6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465	78570					
PROJECTED ON HAND	750	0	0	0	0	0	0	0	0	0	0	0	0	0	STORAGE				
NET REQUIREMENTS		5715	6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465	78570	COST	Rp 5.00			
ORDER RECEIPTS PLANNED	5715	6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465		72855	(KG)				
ORDER RELEASE		6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465		72855					

The total of ordering cost can be calculated using the formula below.

$$\text{total order cost} = \text{planned orders} \times \text{order cost}$$

$$\text{Total order cost of paperboard material} = 12 \times \text{Rp.150.000} = \text{Rp.1.800.000}$$

$$\text{Total storage cost of paperboard} = 0$$

*The formula for total of ordering cost can also be used to calculate the total of storage cost.

The results show that the total of ordering cost and storage cost for duplex material for a 3 month period using LFL technique is Rp. 1.200.000, Rp. 0.

Table 9. Economic Order Quantity

lead time	3	DAYS				lot size				EOQ				TOTAL	ADMIN FEE	Rp100,000.00
on hand	750	DEC				JAN				FEB						
PERIOD	PAST DUE	1	2	3	4	1	2	3	4	1	2	3	4	TOTAL	ADMIN FEE	Rp100,000.00
GROSS REQUIREMENTS																
SCHEDULED RECEIPTS		6465	6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465	79320		
PROJECTED ON HAND		16300	0	16300	0	16300	0	16300	0	13370	0	750	0	79320		
NET REQUIREMENTS	750	10585	4120	13955	7490	16890	9990	19390	12490	19395	12930	7215	750	135200	STORAGE	
ORDER RECEIPTS PLANNED		5715	-4120	2345	-7490	-590	-9990	-3090	-12490	-6025	-12930	-6465	-750	-55880	COST	Rp 5.00
ORDER RELEASE	16300		16300		16300		16300		13370		750			63020	(KG)	
RELEASE		6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465		72855		

lead time	2	DAYS				lot size				EOQ				TOTAL	ADMIN FEE	Rp150,000.00
on hand	4140	DEC				JAN				FEB						
PERIOD	PAST DUE	1	2	3	4	1	2	3	4	1	2	3	4	TOTAL	ADMIN FEE	Rp150,000.00
GROSS REQUIREMENTS		32325	32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325			
SCHEDULED RECEIPTS		35200	35200	35200	35200	35200	35200	35200	35200	35200	35200	35200	9400	396600		
PROJECTED ON HAND	4140	7015	9890	12765	15640	16340	17040	17740	18440	21315	24190	27065	4140	191580	STORAGE	
NET REQUIREMENTS		28185	25310	22435	19560	18860	18160	17460	16760	13885	11010	8135	5260	205020	COST	Rp 8.00
ORDER RECEIPTS PLANNED	35200	35200	35200	35200	35200	35200	35200	35200	35200	35200	35200	9400		361400	(KG)	
ORDER RELEASE		32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325		364275		

$$EOQ = \sqrt{\frac{2 \times \text{average raw material requirement per period} \times \text{order cost}}{\text{storage cost}}}$$

$$EOQ = \sqrt{\frac{2 \times 33050 \times \text{Rp.150.000}}{\text{Rp.8}}} = 35200$$

From the calculation above, the results for ordering cost and storage cost for paperboard material is Rp. 1.800.000, Rp. 1.532.640, therefore the grand total is Rp. 3.332.640. The results for ordering cost and storage cost for duplex material is Rp. 1.200.000, Rp. 676.000, therefore the grand total is Rp. 1.876.000.

Table 10. Periodic Order Quantity

lead time	3	DAYS				lot size				POQ				TOTAL	ADMIN FEE	Rp150,000.00
on hand	4140	DEC				JAN				FEB						
PERIOD	PAST DUE	1	2	3	4	1	2	3	4	1	2	3	4	TOTAL	ADMIN FEE	Rp150,000.00
GROSS REQUIREMENTS		32325	32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325			
SCHEDULED RECEIPTS		32325	32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325	396600		
PROJECTED ON HAND	4140	4140	4140	4140	4140	4140	4140	4140	4140	4140	4140	4140	4140	49680	STORAGE	
NET REQUIREMENTS		28185	28185	28185	28185	30360	30360	30360	30360	28185	28185	28185	28185	346920	COST	Rp 8.00
ORDER RECEIPTS PLANNED	32325	32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325		364275	(KG)	
ORDER RELEASE		32325	32325	32325	34500	34500	34500	34500	32325	32325	32325	32325		364275		

lead time	3	DAYS				lot size				POQ				TOTAL	ADMIN FEE	Rp100,000.00
on hand	750	DEC				JAN				FEB						
PERIOD	PAST DUE	1	2	3	4	1	2	3	4	1	2	3	4	TOTAL	ADMIN FEE	Rp100,000.00
GROSS REQUIREMENTS		6465	6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465			
SCHEDULED RECEIPTS		6465	6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465	79320		
PROJECTED ON HAND	750	750	750	750	750	750	750	750	750	750	750	750	750	9000	STORAGE	
NET REQUIREMENTS		5715	5715	5715	5715	6150	6150	6150	6150	5715	5715	5715	5715	70320	COST	Rp 5.00
ORDER RECEIPTS PLANNED	6465	6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465		72855	(KG)	
ORDER RELEASE		6465	6465	6465	6900	6900	6900	6900	6465	6465	6465	6465		72855		

$$POQ = \frac{\text{average raw material requirement per period}}{EOQ}$$

$$POQ = \frac{33050}{35200} = 0,9 \approx 1$$

From the calculation above, the results for ordering cost and storage cost for paperboard material is Rp. 1.800.000, Rp. 397.440, therefore the grand total is Rp. 2.197.440. The results for ordering cost and storage cost for duplex material is Rp. 1.200.000, Rp. 45.000, therefore the grand total is Rp. 1.245.000. After calculating all ordering cost and storage cost using three different lot sizing techniques, a comparison of the results between those techniques is made to find out which technique has the lowest costs.

Table 11. Comparison Of Total Cost

Type	Lot Sizing Method		
	LFL	EOQ	POQ
PAPERBOARD	Rp 1,800,000.00	Rp 3,332,640.00	Rp 2,197,440.00
DUPLEX	Rp 1,200,000.00	Rp 1,876,000.00	Rp 1,245,000.00
TOTAL	Rp 3,000,000.00	Rp 5,208,640.00	Rp 3,442,440.00

As can be seen from the table above, the technique that has the lowest grand total cost is the lot for lot technique, therefore it is the most efficient and suitable technique to be used at PT XYZ regarding ordering and storage cost.

5. Conclusion

In this research, it can be concluded that on certain periods, there was a shortage of available time capacity that resulted in the master production schedule being infeasible meaning the production process is not efficient nor effective and it needs to be revised to find a solution to the problem. The researchers also concluded that MRP method that is applied to this research does help in controlling raw materials and minimizing the costs related to it. Overall, the Manufacturing Resources Planning method is very suitable to be applied to PT.XYZ as this method is very complex, therefore it is able to cover almost every important aspect.

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