

Optimization of Human Resources and Machines to Fulfill Customer Orders at PT XYZ

Hasan As'ari¹, Tukhas Shilul Imaroh²

^{1,2}Master of Management Study Program, Faculty of Economics and Business,
Universitas Mercu Buana, Indonesia

Email: hsn.ari76@gmail.com, ts_imaroh@yahoo.com

Abstract

This study explores the challenges faced by the plastic manufacturing company PT XYZ, which produces make-to-order masterbatch. The primary issue is the untimely distribution schedule, which results in an inability to meet production targets. The unknown production capacity leads to bottlenecks in the production process. The study employs the Rough Cut Capacity Planning (RCCP) method to calculate the production capacity of each work station. The analysis results reveal that work stations SK1, SK2, SK3, SK4, and SK5 experience bottlenecks due to capacity demands exceeding available capacity. Suggested solutions include increasing working hours for SK1 (36 hours), SK2 (19 hours), SK3 (5 hours), SK4 (111 hours), and SK5 (45 hours) to address these bottlenecks. Further optimization using Linear Programming POM-QM shows that the RCCP method has achieved optimal results, with the company required to produce 12.95 units of product A, 7.27 units of product B, 4.12 units of product C, and 3.75 units of product D. The combination of RCCP and Linear Programming methods enables the company to efficiently determine the required capacity, address bottlenecks, and ensure optimal fulfillment of customer orders.

Keywords: Capacity, Linear Programming, Rough Cut Capacity Planning (RCCP).

INTRODUCTION

Production capacity determines the course of a production process in producing output in accordance with consumer demand. Thus, to produce appropriate production

321

IJEBIR, Volume 03 Issue 05, 2024



Copyright at authors some right reserved this work is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/).

output requires effective capacity planning supported by the availability of human resources and optimal machine availability in order to meet the set production schedule. Related to meeting current needs and anticipating things that happen in the future, capacity planning is needed (Irensy, 2018). By fulfilling customer needs through effective capacity planning supported by the availability of resources, it can encourage industrial sustainability. This is in line with the 9th goal of SDGs (Industry, Innovation and Infrastructure), namely Building Resilient Infrastructure, Increasing Inclusive and Sustainable Industries, and Encouraging Innovation.

PT. XYZ, is a plastic manufacturing company that produces Color Plastic Seeds (Masterbatch) such as products with certain mechanical / chemical / weather resistant properties for the automotive industry, electronics, household applications, etc. Where its sales are based on orders (make-to-order). Where sales are based on make-to-order. This causes the previously scheduled distribution schedule to not reach the right time, making the production target unattainable (Rasbina et al., 2013). Production capacity in companies that have not been able to meet the production load and complete it on time, due to unknown production capacity which results in bottlenecks, so that the fulfillment of customer orders is not achieved. This can make the potential for switching customers to competitors.

The company's planned and actual production capacity from January to August 2023 shows that there is an actual problem with production capacity that does not match expectations, resulting in product shortages. Therefore, the company's production capacity needs to be assessed first to determine whether additional working hours (overtime) and additional machines are needed to complete the production process on time using Rough Cut Capacity Planning (RCCP) (PT. XYZ, 2023).

RCCP is one of the capacity planning methods (Irawan et al., 2020). RCCP is an analysis used to test the availability of production capacity in meeting the Production Master Schedule (Christanty, et al., 2014). The RCCP method can compare the actual available capacity with the required capacity, allowing companies to make accurate production capacity planning to meet consumer demand (Sugaringra & Nurdiansyah, 2020). Therefore, production capacity optimization is very important to meet consumer demand and achieve maximum profit.

With the non-achievement of customer orders that occur every month, it is necessary to follow up to solve this problem by conducting research entitled "Optimization of human resources and machines to fulfill customer orders at PT XYZ".



LITERATURE REVIEW

Work Stations

A workstation is a combination of machines, tools, and equipment, as well as the people required to complete a task. These workstations are sometimes also referred to as work areas or production centers. Furthermore, a department basically consists of a group or collection of several work stations, and the grouping or merging of these departments will form an entire factory.

Human Resources

Human resources (HR) are productive individuals who function as the driving force of an organization, both in institutions and companies, who act as assets that need to be trained and developed. Human resources are very important and must exist to achieve organizational or company goals. HR is a key element of an organization compared to other resources such as capital and technology, because it is humans who manage other factors. Human resources (HR) are very important in various activities carried out. Even with sophisticated equipment, without human resources, it will be meaningless. This is because intellectual capacity is the basic capital brought from birth, while skills are acquired through effort (learning and training). Intelligence can be measured through Intelligence Quotient (IQ) and Emotional Quotient (EQ).

Capacity

Capacity Putra & Furqon, (2015) is the maximum flow rate that can be achieved by a production process in a certain unit of time. In general, capacity can be seen as a measure that shows the amount of throughput (raw materials or products) that can be produced by a production process, not the amount actually produced. Capacity planning Bachtiar (2018) is a systematic process to determine the optimal level of capacity based on estimated market demand. Thus, if consumer demand increases, production will automatically increase its output. Capacity (Bachtiar, 2018) is defined as the maximum amount of output (product) that a production facility can produce in a certain period. Based on the definition that has been given, it can be said that capacity is the number of products that can be produced or made in a certain time and amount.

Theory of Constraints (TOC)

Theory of Constraints (TOC) is a method for process improvement that can help companies in making decisions for resource management. This method can also help in

323

IJEBIR, Volume 03 Issue 05, 2024



Copyright at authors some right reserved this work is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/).

designing production volumes that match production capacity and optimal profits. TOC focuses on improving a system defined as a series of independent processes. TOC can be applied to production, logistics, supply chain, project management, research and development, and other problems. The TOC method is particularly useful for optimizing production capacity by analyzing and minimizing bottlenecks that impede production flow. A system constraint limits the performance of the system, so all efforts are directed towards maximizing the performance of this constraint.

Rough Cut Capacity Planning (RCCP)

Rough Cut Capacity Planning (RCCP) is a method to estimate capacity requirements and compare them with available capacity. RCCP can also be defined as the process of converting a Production Plan and/or Master Production Schedule (MPS) into capacity requirements related to critical resources, such as labor, machinery and equipment, warehouse capacity, supplier capabilities for materials and components, and financial resources.

Work Time Measurement

A job is considered to be completed efficiently if the completion time is the shortest. To calculate the standard time to complete a job in order to choose the best alternative work method, it is necessary to apply the principles and techniques of work measurement (work measurement or time study). This time measurement is related to efforts to determine the standard time required to complete a job (Ramadhani, 2020).

METHODS

This research design is a type of quantitative descriptive research that uses the Rough Cut Capacity Planning (RCCP) method, which involves measuring Capacity Requirements (CR), Capacity Available (CA), and Linear Programming. According to Syahril Iskandar (2020), descriptive research is conducted to analyze one or more individuals without making comparisons or connecting one individual with another. A quantitative approach is the process of obtaining knowledge that uses numerical data as a tool for analysis. In this study, the population is all products at Work Station (SK) on production line No.17 at PT XYZ. The number of Work Stations on production line No.17 in PT XYZ is 5 units. The sample method used in this research is purposive sampling method. This method is a sample method with certain criteria which in this study the criteria are Work Stations that produce Color Masterbatch on production line No.17 at PT

324



XYZ. The samples used in this study are Color Masterbatch A, B, C and D in the Master Production Schedule (MPS) data and cycle time measurement data.

In this study, data analysis was carried out using the Theory of Constraints (TOC) approach to planning and controlling production capacity at PT XYZ. TOC helps in identifying and dealing with constraints that can hinder the achievement of goals. These constraints are not just any constraints, but constraints that have a significant impact on the production process. In the application of TOC, we will conduct an analysis to find out the work stations that experience constraints (bottlenecks) and carry out capacity planning with RCCP which is continued with optimization with linear programming software POM-QM.

RESULTS AND DISCUSSION

In this study, data collection was conducted with a focus on determining the production process time at each workstation in masterbatch manufacturing. This data collection approach utilizes the secondary data available at each workstation, allowing researchers to gain an in-depth understanding of the complete work process time. The secondary data used covers the entire spectrum of the production process, from the machine cleaning stage which involves preparing the machine before production, weighing the raw materials to ensure the right proportions, the mixing stage which is the process of mixing the raw materials, extruding which is the extrusion process to form the masterbatch, to the product testing stage to verify its quality. By utilizing secondary data from each stage of the production process, this research can provide a holistic picture of the time required for each stage, which will then become the basis for more in-depth RCCP and Linear Programming analysis.

In the period January - August 2023, the company experienced delays in fulfilling customer orders as follows:

Table 1. Number of forecast and non-forecast products

Machine	FC	Non FC	Total	Acc	% Acc
LP17	17	127	144	144	26
LP07	16	87	103	247	45
LP23	14	52	66	313	57
LP21	18	22	40	353	64
LP25	14	26	40	393	71



LP04	8	31	39	432	78
LP15	21	17	38	470	85
LP06	13	16	29	499	90
LP18	2	27	29	528	96
LP10	0	10	10	538	97
LP13	7	3	10	548	99
LP08	3	1	4	552	100
Total	133	419	552		

Table 1 presents the number of anticipated products (forecast) and non-anticipated products (non-forecast) that were not fulfilled during the period January to August 2023. The explanation of this table provides an overview of production performance in meeting market demand or planned production estimates. The largest number of unfulfilled products in Production Line No.17 is mainly in February 2023 according to Figure 1, so the researcher focuses on the analysis of Production Line No.17 in February 2023.

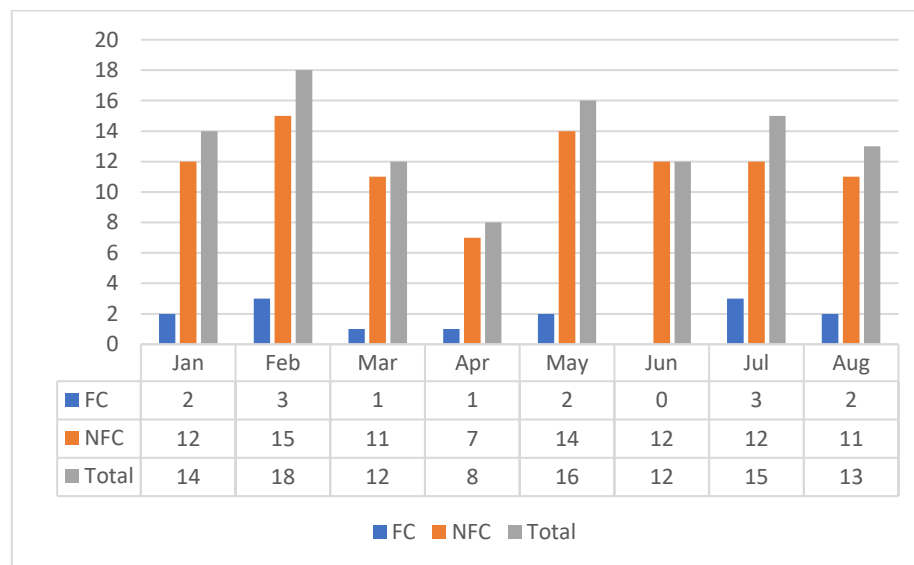


Figure 1. Number of Products Not Fulfilled Production Line 17

Labor and Working Hours

Labor and working hours are important concepts in human resource management and workplace productivity. Labor refers to the number and type of people available to work in a place or in an economy at a given time. To determine the labor requirements and working hours, PT XYZ manages the arrangement of labor and working hours at each work station, as shown in Table 2.

Table 2. Labor and Working Hours

Workforce	Sum	Number of Decreases	Business Hours	Working hours/Decree	SK1 working hours	SK4 working hours
Machine Cleaning Process (SK1) and Extruding (SK4)	1	2	8	-	2,5	5,5
Raw Material Weighing Process (SK2)	1	5	8	1,6	-	-
Mixing Process (SK3)	1	2	5,5	2,8	-	-
Product Testing Process (SK5)	1	5	8	1,6	-	-

Table 2 shows that one worker handles two workstations of SK1 and SK4 machine cleaning processes with a division of SK1 working hours of 2.5 hours and SK4 as much as 5.5 hours in one shift. One worker in the raw material weighing process SK2 handles a total of 5 raw material weighing workstations so that each SK2 has 1.6 hours of working hours. One worker in the mixing process handles two workstations with 5.5 hours of working hours used for the mixing process so that the SK3 working hours are 2.8 hours. One worker in the SK5 product testing process handles a total of 5 product testing workstations so that each SK5 has 1.6 hours of working hours.

Product Categories

Product categories refer to a way to group products based on certain characteristics or attributes that they have. It also helps in the management of the company's inventory and operational strategy. PT XYZ categorizes products A, B, C and D as shown in table 3.



Table 3. Product Categories

Product	A	B	C	D
Category	25 Kg	50 kg	75 S/d 100 kg	125- 300 kg
Order Quantity	13	7	4	4
Profit	70	75	80	85

In table 3, it can be explained that Product A is categorized with products ordered by customers as much as 25 kg' as many as 13 products with a profit taken by the company of 70, as well as other products.

Cycle Time

Cycle time in the context of this study refers to the time it takes to complete one production cycle of each machine involved in the manufacture of the four products studied. Data on this cycle time is obtained through direct observation and recording of the performance of all workstations used in the manufacturing process. Table 4 presents a breakdown of cycle times for each workstation and product, providing a comprehensive overview of production performance in terms of the time it takes to complete each production cycle. This analysis of cycle times makes it possible to evaluate the efficiency and consistency of production of each workstation, as well as identify potential narrowing or capacity increases that can be made to improve overall productivity.

Table 4. Production process cycle time

Workstation (SK)			Product A	Product B	Product C	Product D	\Total
Machine Cleaning Process	SK 1		5,0	4,1	3,5	4,4	17,0
Raw Material Weighing Process	SK 2		1,8	3,8	3,8	2,8	12,2
Mixing Process	SK 3		0,5	0,6	0,8	0,6	2,4
Extruding Process	SK 4		5,7	7,5	11,8	13,1	38,0
Product Testing Process	SK 5		6,4	5,6	5,7	6,8	24,5
Total			19,4	21,6	25,5	27,6	94,2



Normal Time

In the context of this study, normal time refers to the cycle time of the product after considering the assessment factor. Product cycle time, measured at each workstation, is the result of direct observation of the time it takes to complete a single production cycle. The purpose of determining the assessment factor is to normalize the working time of workers in the most typical conditions, so that the process time used can reflect the most representative work situation. The assessment of the assessment factors of the workers at each workstation is based on the adjustment assessment factor table, which is explained in detail in Table 5. This information helps to adjust the working hours of workers to suit normal conditions, allowing for more accurate and representative calculation of process times in production analysis.

The rating factor (P) assessment of workers at the workstation obtained from the table of adjustment rating factor provisions is shown in Table 5.

Table 5. Rating Performance

Rating Performance	Operator SK1	Operator SK2	Operator SK3	Operator SK4	Operator SK5
Skill	0,06	0,03	0,06	0,11	0,06
Effort	0,05	0,05	0,05	0,10	0,05
Condition	0,00	0,00	-0,03	0,00	0,04
Consistency	0,01	0,01	0,01	0,01	0,01
Total	0,12	0,09	0,09	0,22	0,16

The normal time calculation for the production of Products A - D at each workstation is calculated using the following formula:

$$\text{Normal Time (WN)} = \text{Cycle Time} \times \text{Rating Performance (P)}$$

The results of the normal time calculation are in table 6.

Table 6. Normal Time

Workstation (SK)		Product A	Product B	Product C	Product D	Total
Machine Cleaning Process	SK 1	5,6	4,6	3,9	4,9	19,1
Raw Material Weighing Process	SK 2	2,0	4,2	4,1	3,1	13,3
Mixing Process	SK 3	0,6	0,7	0,8	0,6	2,7
Extruding Process	SK 4	6,9	9,1	14,4	15,9	46,4



Product Testing Process	SK 5	7,5	6,5	6,6	7,9	28,4
Total		22,5	25,0	29,8	32,4	109,8

Standard Time

After calculating the normal time for each workstation, the next step is to determine the standard time. Standard time is normal time plus allowance. Relaxation is additional time given outside of essential work activities and is considered reasonable. This relaxation takes into account the time needed for rest, movement between workstations, and other factors that can affect work efficiency but are not included in normal times. By adding leeway to normal times, the resulting standard time provides a more accurate representation of the actual time it takes to complete a task or production process. Assessment of the Allowance of workers at the workstation obtained from the table of Allowance provisions shown in Table 7.

Table 7. Allowance Table

% Allowances	Operator SK1	Operator SK2	Operator SK3	Operator SK4	Operator SK5
Energy Produced	7,0	7,0	7,0	7,5	6,0
Work attitude	1,0	1,0	1,0	1,0	1,0
Work movement	0,0	0,0	0,0	0,0	0,0
Eye fatigue	1,0	1,0	0,0	0,0	2,0
Workplace temperature conditions	10,0	10,0	10,0	10,0	5,0
Atmospheric conditions	0,0	0,0	2,5	2,5	0,0
Good environmental conditions	0,0	0,0	1,0	1,0	0,0
Total	19,0	19,0	21,5	22,0	14,0

After obtaining the allowance for each machine in all workstations, the next step is to calculate the standard time to produce Product A - D in each workstation using the following formula:

$$\text{Standard Time (WB)} = \text{Normal Time} \times \{100\% / (100\% - \% \text{ Allowance})\}$$

The results of the standard time calculation are in Table 8.



Table 8. Standard Time

Workstation (SK)			Product A	Product B	Product C	Product D	Total
Machine Cleaning Process	1	SK	6,9	5,7	4,8	6,0	23,5
Raw Material Weighing Process	2	SK	2,4	5,1	5,0	3,8	16,4
Mixing Process	3	SK	0,7	0,8	1,0	0,8	3,4
Extruding Process	4	SK	8,9	11,7	18,5	20,4	59,5
QC Testing Process	5	SK	8,7	7,5	7,6	9,2	33,0
Total			27,6	30,9	37,1	40,2	136

Rough Cut Capacity Planning (RCCP)**Workstation Capacity**

In this study, Rough Cut Capacity Planning (RCCP) was used to analyze the Workstation Capacity. The available and required capacity data of each workstation is presented in Table 11. From the table, the most significant data is the lack of capacity, for example, SK4 of the Extruding workstation which requires a capacity of 353 hours, but the SK4 only has a capacity of 241 hours, indicating the need for capacity increase (Sirait et al., 2013). This lack of capacity is a potential cause of bottlenecks at each workstation, which requires additional workers or production machines to ensure a smooth production process and avoid unwanted delays. After getting the Standard Time at all work stations, then calculate the Capacity Requirement (CR) and Capacity Available (CA) for the production of Product A - D at each work station.

Effective Time of Work

Effective time at a workstation refers to the period of time in which a worker or employee is really productive and focused on doing his or her duties or work. In addition to ineffective time, such as rest or other activities that do not directly contribute to the main task. With the formula of Effective working time = (Working time + Overtime time) x 90% as applied in PT XYZ in the table 9.



Table 9. Effective Time Table

Workstation	Number of working days	Business hours	Number of machines/Labor	Overtime hours	Total working time	Effective time (Total working time x 90%)
SK1	28	2,5	3	0	210,0	189,0
SK2	28	1,6	3	0	134,4	121,0
SK3	28	2,8	3	0	235,2	211,7
SK4	28	5,5	3	0	462,0	415,8
SK5	28	1,6	3	0	134,4	121,0

Efficiency and Utilization

Efficiency is a measure of the productivity of a worker, work center, department or factory and is measured as the ratio of the standard number of hours spent on production to the number of hours spent on work. With the formula $\text{Efficiency} = (\text{Normal Time} - \text{Cycle Time}) / \text{Cycle Time} \times 100\%$ Utilization, it is a measurement of how well a resource or facility is used in a certain period of time. Calculate the level of utilization or use of resources in a specific context, such as in production or operations. With the formula, $\text{Utilization} = (\text{Time required for each SK} / \text{Effective time of work}) \times 100\%$. So that with the data in PT XYZ, the efficiency and utilization of each workstation is in accordance with the table 10.

Table 10. Efficiency and Utilization

Workstation	Efficiency	Utilization
SK1	98%	66%
SK2	99%	63%
SK3	99%	8%
SK4	96%	54%
SK5	98%	143%

By using the following CA and CR formulas:

Capacity Available (CA): (Number of machines x working hours x working days x U x E)

Capacity Requirement (CR) = $\sum$ (order x Wb)



The results of the capacity calculation are in Table 11.

Table 11. Workstation Capacity

Workstation	Number of working days	Business hours	Efficiency (Machine state)	Utilisation	Number of machines/Labor	Available capacity	Product A demand capacity	Product B demand capacity	Product C demand capacity	Product D demand capacity	Total demand capacity	S elisih capacity
SK	28	2,5	98%	66%	3,0	137	90	40	19	24	174	- 36
SK2	28	1,6	99%	63%	3,0	84	32	36	20	15	103	- 19
SK3	28	2,8	99%	8%	3,0	18	9	6	4	3	22	- 5
SK4	28	5,5	96%	54%	3,0	241	115	82	74	82	353	- 111
SK5	28	1,6	98%	143%	3,0	188	113	53	31	37	233	- 45

Based on the calculations shown in Table 11, it shows that to produce the capacity of the product in accordance with the order, it is obtained that:

- SK1 requires an additional 36 hours of work because it has a shortage of 36 hours of work.
- SK2 requires an additional working hour of 19 hours because it has a shortage of 19 working hours.
- SK3 requires an additional 5 hours of work because it has a shortage of 5 hours of work.
- SK4 requires an additional 111 working hours because it has a shortage of 111 working hours.
- SK5 requires an additional 45 hours of work because it has a shortage of 45 hours of work.

So that it is necessary to add working hours in SK1, SK2, SK3, SK4 and SK5 to achieve production capacity in fulfilling customer orders.

Optimization with Linear Programming POM-QM

In addition to using the RCCP approach in analyzing the capacity of the workstation, the following is also an analysis of the problem of the capacity of the workstation that is not optimal using the Linear Programming method in the POM-QM software. Linear Programming Analysis in the context of Production and Operations



Management (POM) and Quantitative Methods (QM) is a mathematical technique used to optimize resource allocation in the production process or operation of an organization. Linear Programming analysis is used to achieve specific goals in production or operations management, such as maximizing profits, reducing costs, or minimizing runtime. In the problem of the capacity of the workstation, the data is identified as follows:

Purpose function:

$$\text{Maximize } Z = 70A + 75B + 80C + 85D$$

Function of constraints:

$$\text{Kendala SK1: } 6,9A + 5,7B + 4,8C + 6,0D \leq 174$$

$$\text{Kendala SK2: } 2,4A + 5,1B + 5,0C + 3,8D \leq 103$$

$$\text{Kendala SK3: } 0,7A + 0,8B + 1,0C + 0,8D \leq 22$$

$$\text{Kendala SK4: } 8,9A + 11,7B + 18,5C + 20,4D \leq 353$$

$$\text{Kendala SK5: } 8,7A + 7,5B + 7,6C + 9,2D \leq 233$$

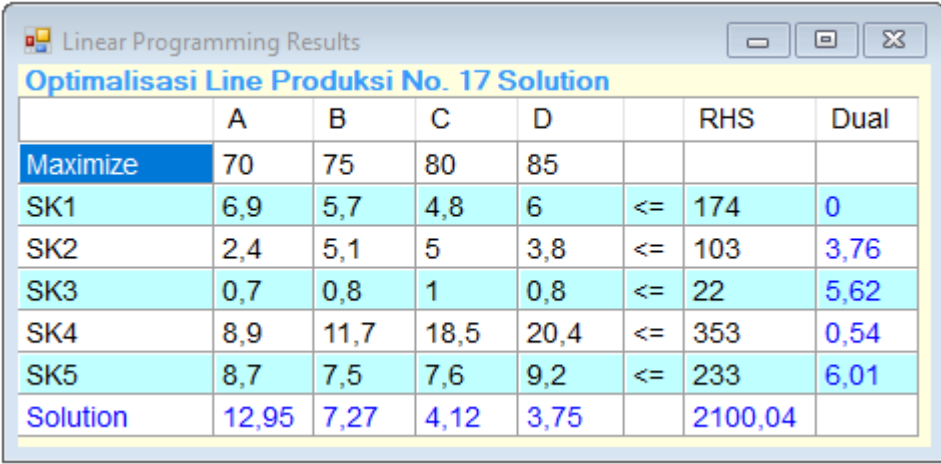
In the use of software based on the POM-QM linear program, the data input on the software can be seen in Figure 2.

Optimalisasi Line Produksi No. 17							
	A	B	C	D		RHS	Equation form
Maximize	70	75	80	85			Max 70A + 75B + 80C + 85D
SK1	6,9	5,7	4,8	6	<=	174	6.9A + 5.7B + 4.8C + 6D <= 174
SK2	2,4	5,1	5	3,8	<=	103	2.4A + 5.1B + 5C + 3.8D <= 103
SK3	0,7	0,8	1	0,8	<=	22	0.7A + 0.8B + C + 0.8D <= 22
SK4	8,9	11,7	18,5	20,4	<=	353	8.9A + 11.7B + 18.5C + 20.4D <= 353
SK5	8,7	7,5	7,6	9,2	<=	233	8.7A + 7.5B + 7.6C + 9.2D <= 233

Figure 2. Input Data

Next, the program is run after data input by clicking the solve button and producing output as shown in Figure 3.





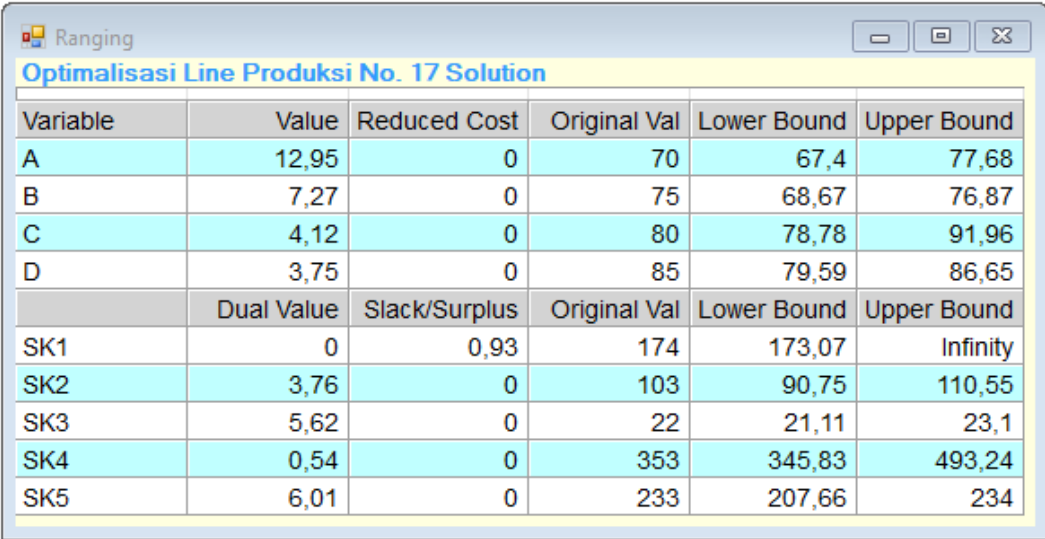
Linear Programming Results

Optimalisasi Line Produksi No. 17 Solution

	A	B	C	D		RHS	Dual
Maximize	70	75	80	85			
SK1	6,9	5,7	4,8	6	<=	174	0
SK2	2,4	5,1	5	3,8	<=	103	3,76
SK3	0,7	0,8	1	0,8	<=	22	5,62
SK4	8,9	11,7	18,5	20,4	<=	353	0,54
SK5	8,7	7,5	7,6	9,2	<=	233	6,01
Solution	12,95	7,27	4,12	3,75		2100,04	

Figure 3. Linear Programming Result

In Figure 3, the results of the optimal solution of the objective function can be seen. In this case, the optimal solution is achieved at the number of products A = 12.95; B = 7.27; C = 4.12 and D = 3.75 with a total product of 28.09 which can generate a profit of Z = 2,100.04.



Ranging

Optimalisasi Line Produksi No. 17 Solution

Variable	Value	Reduced Cost	Original Val	Lower Bound	Upper Bound
A	12,95	0	70	67,4	77,68
B	7,27	0	75	68,67	76,87
C	4,12	0	80	78,78	91,96
D	3,75	0	85	79,59	86,65
	Dual Value	Slack/Surplus	Original Val	Lower Bound	Upper Bound
SK1	0	0,93	174	173,07	Infinity
SK2	3,76	0	103	90,75	110,55
SK3	5,62	0	22	21,11	23,1
SK4	0,54	0	353	345,83	493,24
SK5	6,01	0	233	207,66	234

Figure 4. Ranging

In the table above there are lower bound and upper bound which are useful for sensitivity analysis:

For SK1 (Cleaning Machine) ≤ 174

- a. Upper bound: A resource that is not scarce because it has an excess capacity of 0.93 hours.
- b. Lower bound: For the cleaning process of the clockwork, it can be reduced to 173.07 hours without changing the solution above. But if it is subtracted less than 173.07 hours, then the change will affect the above solution.

For SK2 (Weighing of raw materials) ≤ 103

- a. Upper bound: For the raw material weighing process, it can add up to 110.55 hours of man-hours which will not change the above solution. But if the process is increased by more than 110.55 hours, the change will affect the above solution.
- b. Lower bound: For the raw material weighing process, the working hours can be reduced to 90.75 hours without changing the above solution. But if it is subtracted less than 90.75 hours, then the change will affect the above solution.

For SK3 (Mixing) ≤ 22

- a. Upper bound: For the extruding process, it can add up to 23.1 hours of work which will not change the above solution. But if the process is increased by more than 23.1 hours, the change will affect the above solution.
- b. Lower bound: For the mixing process, the working hours can be reduced to 21.11 hours without changing the solution above. But if it is subtracted less than 21.11 hours, then the change will affect the above solution.

For SK4 (Extruding) ≤ 353

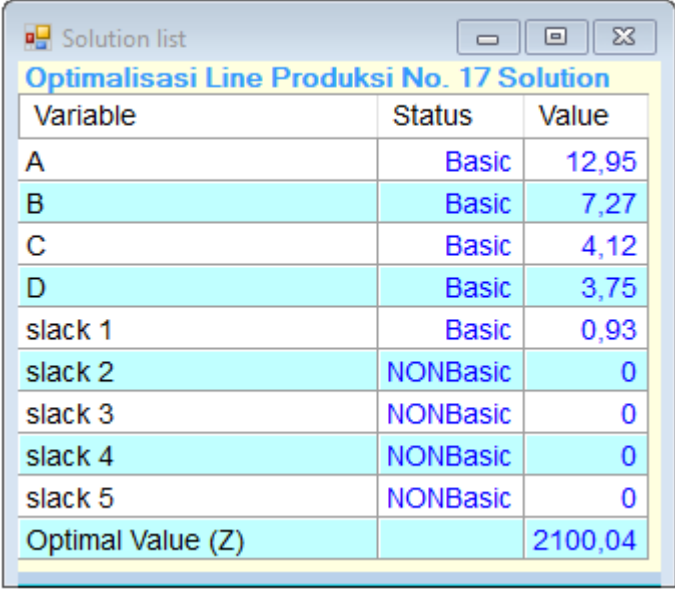
- a. Upper bound: For the extruding process, it can add up to 493.24 hours of work which will not change the above solution. But if the process is increased by more than 493.24 hours, the change will affect the above solution.
- b. Lower bound: For the extruding process, the working hours can be reduced to 345.83 hours without changing the solution above. But if it is subtracted less than 345.83 hours, then the change will affect the above solution.

For SK5 (Product Testing) ≤ 233

- a. Upper bound: For the extruding process, it can add up to 234.0 hours of work which will not change the above solution. But if the process is increased by more than 234.0 hours, the change will affect the above solution.



- b. Lower bound: For the product testing process, the working hours can be reduced to 207.66 hours without changing the solution above. But if subtracted less than 207.66 hours, the change will affect the above solution.



Variable	Status	Value
A	Basic	12,95
B	Basic	7,27
C	Basic	4,12
D	Basic	3,75
slack 1	Basic	0,93
slack 2	NONBasic	0
slack 3	NONBasic	0
slack 4	NONBasic	0
slack 5	NONBasic	0
Optimal Value (Z)		2100,04

Figure 5. Solution List

In Figure 5, the Solution list shows that to get an optimal production process:

- Product A was produced as many as $12.95 \approx 13$ products
- Product B was produced as many as $7.27 \approx 7$ products
- Product C was produced as many as $4.12 \approx 4$ products
- Product D was produced as many as $3.75 \approx 4$ products.

CONCLUSION

By using the Rough Cut Capacity planning (RCCP) calculation method, effective production capacity can be determined. Where it is known that the accumulation at the workstation is obtained from the calculation of production capacity using the RCCP approach method in SK1 (Machine cleaning), SK2 (Raw material weighing), SK3 (Mixing), SK4 (Extruding) and in SK5 (Product testing). There is a bottleneck because the capacity required in SK1 – SK5 exceeds the available capacity, so it is necessary to add effective

working hours to SK1 for 36 hours (5 shifts), SK2 for 19 hours (2 shifts), SK3 for 5 hours (1 shift), SK4 for 111 hours (14 shifts) and SK5 for 45 hours (6 shifts).

The results of the sensitivity analysis can be concluded that the improvement of the capacity of the workstation at PT. XYZ using RCCP has been optimized based on analysis on Linear Programming software POM-QM with Product A = $12.95 \approx 13$, Product B = $7.27 \approx 7$, Product C = $4.12 \approx 4$ and Product D = $3.75 \approx 4$. Or in other words, the capacity based on Linear Programming POM-QM is optimal with a maximum capacity that can be worked on of 28 products, with details of 13 products A, 7 products B, 4 products C and 4 products D.

Based on the results of the calculation with the RCCP method approach and through the analysis of Linear Programming is optimal, the capacity can be improved by adding a Workstation (SK4) by 111 hours or by adding an extruder machine of 1 unit. Meanwhile, SK1, SK2, SK3 and SK5 can use additional overtime hours.

REFERENCES

- Bachtiar, A. (2018). Perencanaan kapasitas produksi dengan pendekatan biaya marginal pada pabrik tahu SBR Bengkulu. *Creative Research Management Journal*, 1 (1), 21.
- Christanty, E. M. A., Setyanto, N. W., & Hamdala, I. (2014). Optimasi Kapasitas Produksi Dalam Penyusunan Jadwal Induk Produksi Menggunakan Integer Linear Programming (ILP)(Studi Kasus: CV. PABRIK MESIN GUNTUR MALANG). *Rekayasa dan Manaj. Sist. Ind*, 2(6), 1147-1157.
- Irawan, I., Nasiatin, T., Adha, S., Julyanto, O., Rani, C. P., & PK, R. D. (2020). Analysis Of Production Capacity Planning and Control in PT. Krakatau Wajatama with Rought Cut Capacity Planning (RCCP). *Journal of Industrial Engineering & Management Research*, 1(2), 207-218.
- Irensya, A. (2018). PERENCANAAN KAPASITAS UNTUK MENGOPTIMALKAN PROSES PRODUKSI PERHIASAN LOGAM MULIA EMAS PT. XYZ. Program Studi Manajemen S1 Universitas Widyatama.
- Putra, T. A., & Furqon, C. (2015). Analisis Kapasitas Produksi Unit Ammonia dan Urea Pabrik 1A (Studi Kapasitas Produksi pada Industri Pupuk). *Jurnal Aplikasi Manajemen*, 13(3), 410-422.
- Ramadhani, A. S. (2020). Pengukuran waktu baku dan analisis beban kerja untuk menentukan jumlah optimal tenaga kerja pada proses cetak produk lipstick. *Operations Excellence*, 12(2), 177-188.

338



- Rasbina, A., Sukaria, S., & Ikhsan, S. (2013). Perencanaan Jadwal Indusk Produksi Pada PT. XYZ. E-Jurnal Teknik Industri FT USU Vol 2, No. 1, Mei 2013 pp. 54-57.
- Sirait, M.E., Sukaria, S., & Aulia, I. (2013). Perencanaan Kebutuhan Kapasitas (Rough Cut Capacity Planning) Industri Pengolahan Peralatan Rumah Tangga di PT X. e-Jurnal Teknik Industri FT USU Vol 2, No. 2, pp. 28- 34.
- Sugarindra, M., & Nurdiansyah, R. (2020). Production Capacity Optimization with Rough Cut Capacity Planning (RCCP). In IOP Conference Series: Materials Science and Engineering (Vol. 722, No. 1, p. 012046). IOP Publishing.
- Syahril Iskandar, M. (2020). Metode Deskriptif.

