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Optimization of Production Process by Applying Theory of Constraint (TOC) at CV. Wijaya Mandiri Label

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A B S T R A C T

CV. Wijaya Mandiri Label is a company engaged in the printing industry sector located in Sidoarjo which provides printing services inside and outside Sidoarjo. In the production process, problems arise after several years of operation at work stations that cause bottlenecks in the production capacity of bontax and OPP sticker printing, thus hindering the production process to run optimally. This resulted in an inefficient sticker production process in meeting targets that made throughput not optimal. To overcome these problems, researchers conducted research that explored the use of Theory of Constraints (TOC) and supporting methods, namely linear programming, to optimize the company's production process and analyze data on working hours and product production demand. From the results of the research, it was concluded that the company experienced Capacity Constraints which caused bottlenecks at the fourth work station in the last six months. After exploiting the constraints on the bottleneck workstation, throughput is obtained using a linear programming calculation formulation with the results of x_1= 0 and x_2 = 3,948.47 amounting to IDR16,781,000 in WinQSB software. The final stage of constraint elevation is carried out by allocating operators to bottleneck work stations and obtaining an increase in throughput of IDR6,322,300 or a percentage increase of 27.4% using WinQSB software.

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1. INTRODUCTION

The role of the service industry in the current free market era is needed, this causes intense competition where only industries that have the best competence and performance can survive. Based on this, intense competition requires every company to run its business efficiently. The production process is one of the operations carried out to add benefits or create uses by utilizing resources to meet consumer needs (Purwadinata & Batilmurik, 2020). If the production process can run well, the company will be able to create efficiency in producing products and can increase profits in running it's business. To improve efficiency and product integrity, process optimization is mandatory.

Therefore, quality and productivity optimization must be achieved simultaneously (Gofur et al., 2023). CV Wijaya Mandiri Label is a company engaged in the printing industry sector located in Sidoarjo. The services provided by company are not only limited to one area, but also outside Sidoarjo. In recent years, the company has experienced an increase in production demand. However, this triggers the emergence of obstacles in the process of fulfilling production demand, where the company's performance decreases in meeting production demand due to non-optimal production process activities. This decline in production capacity performance can lead to inefficient production processes. If left unchecked, it will become a constraint that can cause a buildup and imbalance of production capacity at the workstation.

Table 1. Operational data

Date	Work Time/hour	Demand Bontax	Demand Opp	Efficiency Bontax/hour	Efficiency Opp/hour
01/03/23	8	200	-	25	-
02/03/23	8	240	120	30	15
03/03/23	8	-	120	-	15
08/03/23	8	-	480	-	60
11/03/23	8	-	258	-	32,25
13/03/23	8	-	96	-	12
14/03/23	8	-	24	-	3
15/03/23	8	277	-	34,565	-
16/03/23	8	307	-	38,33	-
17/03/23	8	-	240	-	30
18/03/23	8	-	240	-	30
20/03/23	8	579	-	72,36	-
21/03/23	8	-	120	-	15
24/03/23	8	-	120	-	15
25/03/23	8	-	31	-	3,875
27/03/23	8	280	-	35	-
28/03/23	8	304	-	38,02	-
30/03/23	8	117	-	14,605	-
31/03/23	8	-	240	-	30

The problem is supported by operational data in Table 1. where production capacity fluctuates. This shows that there are behaviors or obstacles in the production process that affect the efficiency of the production process, namely constraint capacity or obstacles to the fulfillment of non-optimal capacity. This study aims to optimize the production process by identifying bottlenecks with the Theory of Constraints method at CV. Wijaya Mandiri Label. Theory of Constraints (TOC) is a system approach that focuses on identifying and managing bottlenecks in the production process that affect overall system performance. The Theory of Constraint method is used to make process improvements at work stations to repair or remove bottlenecks that focus on increasing throughput and maximum production capacity with existing resources in the system (Salimah & Dzikron, 2021). Theory of Constraint guides the identification and handling of constraints that may interfere with the system's process of achieving its goals (Syiam & Hastuti, 2021). Therefore, in this study TOC is used as a tool to assist companies in exploiting the constraints that occur to produce maximum throughput and increase capacity in the production process at workstations. Some previous research that has been done to optimize the production process at the printing workstation is done with the time study method. This research uses the Theory of Constraint method for continuous analysis and provides proposals on the production process optimization process. Based on research conducted by Kristiana & Sunarni (2018), it is known that by applying Theory of Constraint to overcome the limited resources that become constraints can increase the throughput obtained by the existing capacity of the total demand by 74.43%. Kristiana & Sunarni also concluded that the lack of labor causes the number of working hours to be insufficient and affects the amount of production capacity so that it causes bottlenecks in the production line.

2. LITERATURE REVIEW

Production optimization can be interpreted as an activity in production prosess to get the minimum value of a function, it’s because another goal of the production process is to minimize the effort and maximize the profit to be achieved (Krisna & Sumiati, 2023). According to Widjaya (2004) cited from the journal Ervil & Yulanda (2020), reveals that constraints are everything that hinders the system from achieving which performance is better, which is contrary to company goals, to generate profits for the company. Theory of Constraints (TOC) was first introduced by Eliyahu M. Goldratt in the book The Goal: A Process of Ongoing Improvement in the early 1980s. The Goal is a business novel about how to overcome barriers to making money. This theory explains how to start identifying chronic productivity and chronic quality successfully (Rahmawati et al., 2019). Meanwhile, in a journal written by Situmorang et al., (2023) revealed that the Theory of Constraints (TOC) method is a method used for process improvement that can assist companies in making decisions regarding resource management.

According to (Eunike et al., 2021), implementing improvements when considering using the TOC approach in analyzing operating systems, there are 5 (five) stages that are commonly used to improve company operating performance, namely: (a) Constraint Identification, (b) Constraint Exploitation, (c) Subordination of Non-Constraint, (d) Constraint Elimination, and (e) Constraint Elevation. The term "drum-buffer-rope" in the TOC concept according to (Adhiputra, 2021) is used to manage production flow in a production system. The drum-buffer-rope (DBR) concept can be seen in Figure 1.

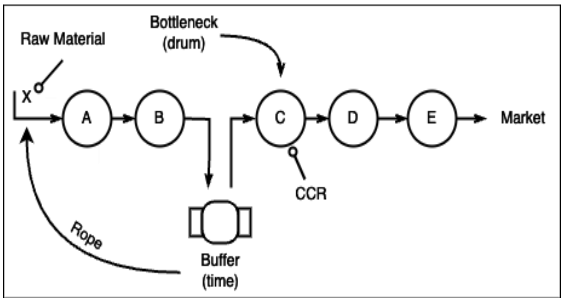


Figure 1. Drum buffer rope
Source : Adhiputra (2021)

Drum-buffer-rope is an application of the TOC concept that is used to manage resources to maximize the performance of the system by paying attention to time buffers and work stations that experience bottlenecks so that they can be improved (Bidiawati & Setiawati, 2020). Linear programming is a mathematical technique that solves the problem of allocating limited resources to achieve the optimal point of an objective, such as maximizing profits or minimizing costs. The mathematical model in linear programming usually consists of an objective function and a system of linear equations (Aini et al., 2021).

This research uses the implementation of the drum buffer rope (DBR) method and linear programming as tools in Theory of Constraint to provide an appropriate view of the required production process and the use of linear programming as a mathematical method that is useful for optimizing solutions within certain constraints to optimize throughput and production flow. Whereas the literature review conducted only focuses on increasing throughput using Theory of Constraint to manage bottlenecks that occur in companies with work measurements. According to (Fathurohman, 2020), work time measurement (time study) is basically a job measurement technique by collecting data based on the time to complete a job. In the context of the type of measurement of work time, the technique of measuring work time with stopwatch or stopwatch time study according to Wingnjosoebroto (1995) cited from the journal Hudaningsih dkk., (2019) is used to measure the time required by the operator to complete his work with normal conditions and speed using a stopwatch. This measurement method is good for work that has repetitive movements in a short period of time (Fathurohman, 2020).

In determining the standard time in measuring working time, an adjustment factor is used. The adjustment factor (performance rating) is the basis for assessing the operator's ability to work either directly or indirectly (Pradana & Pulansari, 2021). The calculation of the adjustment factor is calculated using the Westinghouse rating system table (Heldayani & Yuamita, 2022). There are criteria used to measure the adjustment factor according to (Suroso & Yulvito, 2020) as follows: (1) Skill, (2) Effort, (3) Condition, and (4) Consistency. Production capacity is a term for the measurement parameters produced by a machine to produce in a certain period of time. Production capacity is expressed in the number of products produced per unit time (Prawiro & Adi, 2021).

3. RESEARCH METHOD

This research was conducted at CV Wijaya Mandiri Label. The data taken comes from the production workstation and everything related to the flow of the production process. This research uses the Theory of Constraint method to optimize the production process. Data collection was carried out for six months from February to July 2023. Before conducting research, it is necessary to test the uniformity and adequacy of company data. This test is carried out so that the data collected is uniform and not too extreme so as not to disturb the accuracy of the research data. Next is to determine the value of cycle time, normal time, and standard time with production time data and workstation performance data. The processed data is used to determine the production capacity of each workstation.

Capacity planning and production behavior control need to be considered by the company. These two things affect the amount of production output where overproduction or underproduction can occur (Sitorus et al., 2022).

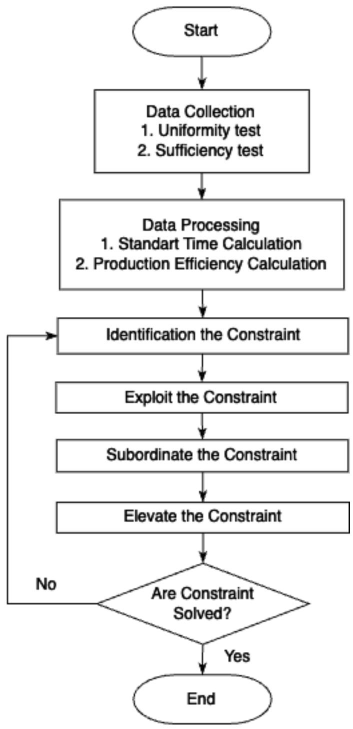


Figure 2. Study Framework

The production capacity obtained is analyzed and identified using the Theory of Constraint method. This method consists of five stages to manage constraints. In the constraint subordination stage, a drum buffer rope is used to synchronize bottleneck and non-bottleneck workstations. Furthermore, adjustments and improvements are made using linear programming by determining constraints and research solutions to produce maximum throughput and constraints can be overcome.

4. RESULT AND DISCUSSION

In this step, the observation time data of the bontax sticker production process at each workstation is used to determine the value of data sufficiency and data uniformity seen in Table 2.

Table 2. Observation time of bontax sticker production process

Cycle Time	Workstation (minutes)				
	(SK-1)	(SK-2)	(SK-3)	(SK-4)	(SK-5)
1	2.61	2.78	3.73	6.52	2.79
2	3.17	3.19	2.81	5.32	2.58
3	2.51	2.54	2.73	6.12	2.38
4	2.37	3.32	3.37	7.29	3.27
5	2.43	2.3	2.59	4.35	3.59
6	2.15	3.25	2.47	6.32	2.32
7	3.47	2.72	2.74	7.3	3.15
8	2.21	2.62	2.78	6.52	3.28
9	3.18	2.44	2.39	5.15	2.29
10	2.4	2.61	2.78	5.4	2.48
11	2.13	2.57	2.59	4.25	3.59
12	2.15	3.25	3.67	6.22	3.32
13	3.17	2.72	2.74	6.3	3.25
14	2.21	2.62	3.58	6.72	3.28
15	3.18	2.44	2.39	5.15	2.29

Data Sufficiency Test

Based on the production process observation time data in Table 1. the data sufficiency test is carried out as follows:

$$N' = \left(\frac{\frac{2}{a}\sqrt{N\sum x_i^2 - (\sum x_i)^2}}{\sum x_i} \right)^2$$

$$N' = \left(\frac{\frac{2}{0.1}\sqrt{75 \times (1021.76) - (65977.05)}}{256.86} \right)^2$$

$$= 64{,}601 \approx 65$$

From this calculation, the value of N' < N is obtained where N' = 65 and N = 75. So that the data is considered sufficient for further calculations without observing the time again.

Data Uniformity Test

To find out that the data processed is uniform, a data uniformity test is carried out by calculating the average observation time and calculating the standard deviation to get the upper control limit and lower control limit values.

a. Average observation time ($\bar{x}$)

$$\bar{x} = \frac{\sum \bar{x}}{n}$$

$$\bar{x} = \frac{2.61+3.17+2.51+2.37+2.43+...+2.21+3.18}{15}$$

$$= \frac{39.34}{15} = 2.623 \text{ minutes}$$

b. Standart deviation (σ)

$$\sigma = \sqrt{\frac{\sum(xi-\bar{x})}{n-1}}$$

$$\sigma = \sqrt{\frac{(2.61-2.623)+(3.17-2.623)+(2.51-2.623)+(2.51-2.37)+...+(2.21-2.623)}{15-1}}$$

$$= 0.457$$

The results of the calculation of the mean and standard deviation seen in Table 2. are used to calculate the UCL and LCL values with the equation below:

c. Upper control limit (UCL)

$$UCL = Z + (k \times \sigma_{\bar{x}})$$

$$UCL = 2.623 + (2 \times 0.457) = 3.536$$

d. Lower control limit (LCL)

$$LCL = Z - (k \times \sigma_{\bar{x}})$$

$$LCL = 2.623 - (2 \times 0.457) = 1.708$$

Based on the results of the above equation, it is known that there is no data that exceeds UCL or less than LCL. So, it can be concluded that the time data collected at the platting workstation (SK-1) type of bontax sticker is uniform. Furthermore, data calculation is carried out on other work stations.

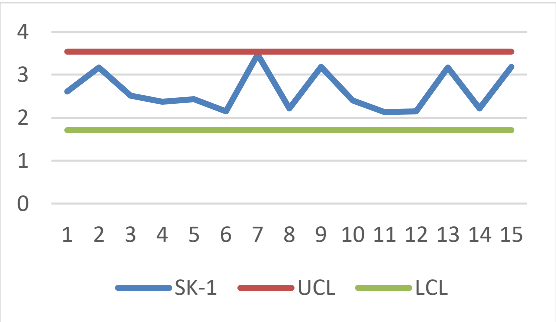


Figure 3. Data uniformity test
Source : data processing

Measurement of working time

Before measuring working time, first calculate the performance rating value and allowance data. Determination of the performance rating value is determined by grouping each operation from the entire production floor process (Rahmawati & Nursubiyantoro, 2019)

1) Normal time (Nt)

Calculation of performance rating using Westinghouse

Work Factor

Skill	: Good (C1)	=	+0.06
Effort	: Good (C1)	=	+0.05
Environment	: Good (C)	=	+0.02
Consistency	: Average (D)	=	+0.00
Total	:	=	+0.13

$$Nt = Ct \times p \text{ (rating factor)}$$

$$Nt = 2.623 \times 1.13 = 2.964$$

2) Standart time (St)

The calculation of standard time is done by considering the allowance factor as follows:

Allowance

Self Needs	:	3
Unavoidable delay	:	3
Energy Expended	:	6
Work Attitude	:	2
Work Movement	:	0
Eye Fatigue	:	19
Atmosphere	:	0,5
Environment	:	0
Total	:	33.5 (%)

$$St = Nt(1 + L)$$

$$St = 2.964(1 + 33.5\%) = 3.956 \text{ minutes}$$

The results of the calculation of the standard time of each workstation for making bontax stickers can be seen in Table 3.

Table 3. Standart time

Workstation	Standart Time (minutes)	
	Bontax Sticker	OPP Sticker
SK-1	3.956	3.818
SK-2	3.726	3.916
SK-3	4.042	4.064
SK-4	8.469	8.502
SK-5	3.951	3.967

The company's ability to meet customer demand is measured by how much production capacity exists. To determine the production capacity of each workstation, capacity measurements are made using the demand data in Table 4.

Table 4. Demand Data February - July 2023

Month	Demand (pcs)	
	Bontax Sticker	OPP Sticker
February	3130	2420
March	2389	2131
April	2918	3105
May	2515	2975
June	2593	2362
July	2611	2612

Identification of Constraint

Calculation of production capacity is used to determine bottleneck work stations. The process of determining bottleneck work stations is known through the percentage of load from the calculation of available capacity and required capacity.

1) Capacity requirement (CR)

$\mathrm{CR} = \sum a_{ik} b_{kj}$

$\mathrm{CR} = (2{,}419.72 \times 3.956) + (3{,}129 \times 2.849)$

$\mathrm{CR} = 20{,}511.8$ minutes

2) Capacity available (CA)

$\mathrm{CA} = \mathrm{Ava.\,Work\,Time} \times \mathrm{Utill} \times \mathrm{Eff}$

$\mathrm{CA} = (3 \times 8 \times 26 \times 60 \text{ minutes}) \times 0.97 \times 0.92$

$\mathrm{CA} = 33{,}562$ minutes

Table 5. Bottleneck and non-bottleneck workstations

Workstation	Month	CA	CR	Load Percentage	Desc.
SK-1	February	33562	20511.8	61%	non-bottleneck
	March	33562	17587.3	52%	non-bottleneck
	April	33562	19497.7	58%	non-bottleneck
	May	33562	20544.3	61%	non-bottleneck
	June	33562	19276.3	57%	non-bottleneck
	July	33562	20303.4	60%	non-bottleneck
SK-2	February	22374	20092.1	90%	non-bottleneck
	March	22374	17245.5	77%	non-bottleneck
	April	22374	19228.6	86%	non-bottleneck
	May	22374	20236.7	90%	non-bottleneck
	June	22374	18910.1	85%	non-bottleneck
	July	22374	19957.7	89%	non-bottleneck
SK-3	February	22080	21350.5	97%	non-bottleneck
	March	22080	18315.6	83%	non-bottleneck
	April	22080	20361.4	92%	non-bottleneck
	May	22080	21442.1	97%	non-bottleneck
	June	22080	20078.9	91%	non-bottleneck
	July	22080	21169.3	96%	non-bottleneck
SK-4	February	33562	44705.5	133%	bottleneck
	March	33562	38350.0	114%	bottleneck
	April	33562	42629.0	127%	bottleneck
	May	33562	44892.5	134%	bottleneck
	June	33562	42041.6	125%	bottleneck
	July	33562	44323.0	132%	bottleneck
SK-5	February	33562	20858.7	62%	non-bottleneck
	March	33562	17893.4	53%	non-bottleneck
	April	33562	19889.8	59%	non-bottleneck
	May	33562	20945.9	62%	non-bottleneck
	June	33562	19615.8	58%	non-bottleneck
	July	33562	20680.2	62%	non-bottleneck

From the results of the workload calculation in Table 5. Work stations that have a load percentage of more than 100% are indicated to be bottleneck work stations.

Exploiting the Constraint

From the results of constraint identification in Table 5. It is known that the bottleneck workstation is SK-4. To optimize the amount of throughput and increase the amount of production of the company, it is necessary to take steps to exploit the constraints by maximizing performance at work stations that have bottlenecks using linear programming methods.

Based on data obtained at the company, bontax sticker products produce a throughput of IDR3.750, while OPP sticker products produce a throughput of IDR4.250. So, the formulation as input to the WinQSB software is as follows:

Maks. : $Z = 3{,}750x_1 + 4{,}250x_2$

s.t. : $3.95x_1 + 3.82x_2 \leq 33562$…(SK-1)

$3.73x_1 + 3.92x_2 \leq 22{,}{,}374$…(SK-2)

$4.04x_1 + 4.06x_2 \leq 22{,}080$…(SK-3)

$8.47x_1 + 8.50x_2 \leq 33{,}562$…(SK-4)

$3.95x_1 + 3.97x_2 \leq 33{,}562$…(SK-5)

$x_1 \leq 16{,}155.60$

$x_2 \leq 15{,}605.12$

$x_1, x_2 \geq 0$

So the processing results using WinQSB software obtained are presented in Figure 3.

	Decision Variable	Solution Value	Unit Cost or Profit c(j)	Total Contribution	Reduced Cost	Basis Status	Allowable Min. c(j)	Allowable Max. c(j)
1	X1	0	3,750.0000	0	-485.0001	at bound	-M	4,235.0000
2	X2	3,948.4710	4,250.0000	16,781,000.0000	0	basic	3,763.2820	M
	Objective	Function	(Max.) =	16,781,000.0000				
	Constraint	Left Hand Side	Direction	Right Hand Side	Slack or Surplus	Shadow Price	Allowable Min. RHS	Allowable Max. RHS
1	C1	15,083.1600	<=	33,562.0000	18,478.8400	0	15,083.1600	M
2	C2	15,478.0100	<=	22,374.0000	6,895.9950	0	15,478.0000	M
3	C3	16,030.7900	<=	22,080.0000	6,049.2100	0	16,030.7900	M
4	C4	33,562.0000	<=	33,562.0000	0	500.0000	0	46,226.6000
5	C5	15,675.4300	<=	33,562.0000	17,886.5700	0	15,675.4300	M
6	C6	0	<=	16,155.6000	16,155.6000	0	0	M
7	C7	3,948.4710	<=	15,605.1200	11,656.6500	0	3,948.4710	M
8	C8	0	>=	0	0	0	-M	0
9	C9	3,948.4710	>=	0	3,948.4710	0	-M	3,948.4710

Figure 4. Data output from WinQSB
Source : data processing

Based on the Figure 4, it can be concluded that the output results from WinQSB software know the value is:

$x_1 = 0$ and $x_2 = 3{,}948.47$.

$Z = 3{,}750x_1 + 4{,}250x_2$

$Z = 3{,}750(0) + 4{,}250(3{,}948.47)$

$Z = 16{,}781{,}000.$

Subordinate of Non Constraint

To ensure the overall performance of the system is maintained, non-constraint subordination is performed using the Drum-Buffer-Rope method. The initial stage in applying the drum-buffer-rope concept is to determine the drum, so the setting workstation becomes the drum at this stage. Next, determine the buffer as shown in Table 6.

Table 6. Time buffer

Workstation	Month	CA (minutes)	CR (minutes)	Time Buffer (minutes)
Setting	February	33562	44705.5	11143.9
	March	33562	38350.0	4788.4
	April	33562	42629.0	9067.4
	May	33562	44892.5	11330.9
	June	33562	42041.6	8480.0
	July	33562	44323.0	10761.4

Based on the results of the above calculations where the time buffer value is obtained from the amount of capacity required minus the available capacity so that the largest time buffer value occurs in May, namely 11330 minutes or 188 hours.

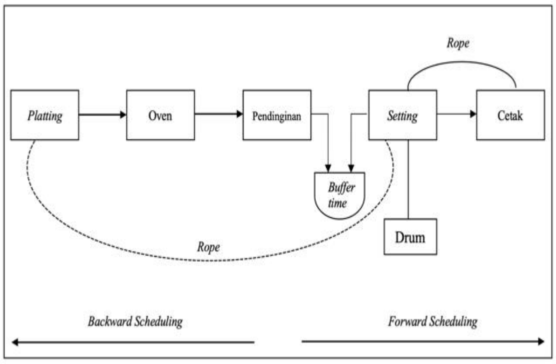


Figure 5. Drum buffer rope map
Source : data processing

The time buffer that has been calculated previously is placed at the station before the bottleneck station with the aim of protecting the production rate (throughput) of the system coming from the previous station in order to minimize constraints and prevent products from accumulating in the production system.

Constraint Elevation

The elevation stage is carried out based on the improvement results of the Drum-Buffer-Rope (DBR) method.

Worker Shift Addition

The addition of shifts can be done by taking shifts at other work stations with the provision of shifts, namely at the Platting or Print work station. The additional number of operators needed to fulfill the required capacity in February at the Setting workstation is obtained by dividing the capacity requirement (CR) by the capacity available (CA).

Table 7. Shift changes

WS	Month	First Op	CR (minutes)	CA (minutes)	OP Needs	Changes OP	Desc.	CA'
I	February	3	20511.8	22080	2	-1	Allocate 1 operator to SK-4	22080
	March	3	17587.3	22080	2	-1		22080
	April	3	19497.7	22080	2	-1		22080
	May	3	20544.3	22080	2	-1		22080
	June	3	19276.3	22080	2	-1		22080
	July	3	20303.4	22080	2	-1		22080
IV	February	3	44705.5	33561.6	4	1	Plus 1 from SK-1 and SK-5	56525
	March	3	38350.0	33561.6	4	1		56525
	April	3	42629.0	33561.6	4	1		56525
	May	3	44892.5	33561.6	4	1		56525
	June	3	42041.6	33561.6	4	1		56525
	July	3	44323.0	33561.6	4	1		56525
V	February	3	20858.7	22080	2	-1	Allocate 1 operator to SK-4	22080
	March	3	17893.4	22080	2	-1		22080
	April	3	19889.8	22080	2	-1		22080
	May	3	20945.9	22080	2	-1		22080
	June	3	19615.8	22080	2	-1		22080
	July	3	20680.2	22080	2	-1		22080

Changes in the number of operators affect the amount of capacity available (CA) at the workstation. Thus it is necessary to re-formulate with linear programming for additional capacity as follows:

Maks. : $Z = 3{,}750x_1 + 4{,}250x_2$

s.t. : $3.95x_1 + 3.82x_2 \leq 22{,}080$…(SK-1)

$3.73x_1 + 3.92x_2 \leq 22{,}374$…(SK-2)

$4.04x_1 + 4.06x_2 \leq 22{,}080$…(SK-3)

$8.47x_1 + 8.50x_2 \leq 56{,}525$…(SK-4)

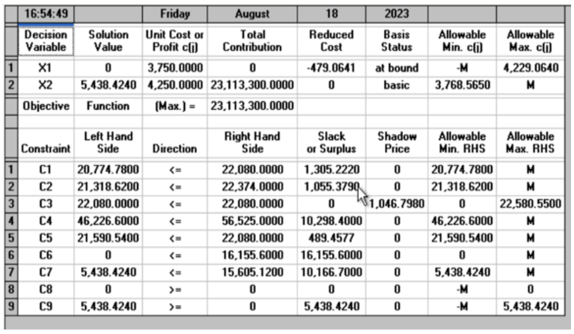
$3.95x_1 + 3.97x_2 \leq 22{,}080$…(SK-5)

$x_1 \leq 16{,}155.60$

$x_2 \leq 15{,}605.12$

$x_1, x_2 \geq 0$

The calculation of the Linear Programming mathematical model above is used as input to the WinQSB software worksheet so as to get the optimal solution. The calculation input is shown in Figure 6.



	16:54:49		Friday	August	18	2023		
	Decision Variable	Solution Value	Unit Cost or Profit c(j)	Total Contribution	Reduced Cost	Basis Status	Allowable Min. c(j)	Allowable Max. c(j)
1	X1	0	3,750.0000	0	-479.0641	at bound	-M	4,229.0640
2	X2	5,438.4240	4,250.0000	23,113,300.0000	0	basic	3,768.5650	M
	Objective	Function	(Max.) =	23,113,300.0000				
	Constraint	Left Hand Side	Direction	Right Hand Side	Slack or Surplus	Shadow Price	Allowable Min. RHS	Allowable Max. RHS
1	C1	20,774.7800	<=	22,080.0000	1,305.2220	0	20,774.7800	M
2	C2	21,318.6200	<=	22,374.0000	1,055.3790	0	21,318.6200	M
3	C3	22,080.0000	<=	22,080.0000	0	1,046.7980	0	22,580.5500
4	C4	46,226.6000	<=	56,525.0000	10,298.4000	0	46,226.6000	M
5	C5	21,590.5400	<=	22,080.0000	489.4577	0	21,590.5400	M
6	C6	0	<=	16,155.6000	16,155.6000	0	0	M
7	C7	5,438.4240	<=	15,605.1200	10,166.7000	0	5,438.4240	M
8	C8	0	>=	0	0	0	-M	0
9	C9	5,438.4240	>=	0	5,438.4240	0	-M	5,438.4240

Figure 6. Output data from WinQSB
Source : data processing

Based on the Figure 6, it can be concluded that the output results from WinQSB software know the value is:

$x_1 = 0$ and $x_2 = 5438.42$

$Z = 3{,}750x_1 + 4{,}250x_2$

$Z = 3{,}750(0) + 4{,}250(5{,}438.42)$

$Z = 23{,}113{,}300.$

Table 8. Throughput comparisson

	X1	X2	Throughput
Before	0	3,948.47	16,781,000
After	0	5,438.42	23,113,300

From the Table 8, it shows that the throughput in the initial condition is IDR16,781,000 while the throughput after adding operators is IDR23,113,300. So that we get an increase in throughput of IDR6,332,300 or a percentage increase of 27.4%.

5. CONCLUSION

This research uses the TOC approach to analyze the production process at CV Wijaya Mandiri. This research develops a problem solving method using linear programming. It is known that the constraints that occur in the sticker printing production process at CV. Wijaya Mandiri Label in the form of Capacity Constraints or excess capacity required from the available resource capacity. With the capacity owned, the production process at CV. Wijaya Mandiri Label experiences bottlenecks. The workstation that experienced bottleneck from February to July was the Setting workstation (SK-4). The output generated from data processing using linear programming obtained the initial condition throughput amount of IDR16,781,000 and the final condition throughput result of IDR23,113,300. This result is obtained from the addition of operators in SK-4 by allocating operators in SK-1 and SK-5 to SK-4. So that the total increase in throughput obtained was IDR6,322,300 or a percentage increase of 27.4%. Based on these calculations, the results of the production volume that produces maximum throughput are greater than the company's throughput, so it is more optimal in fulfilling production capacity in the production process. This study has limitations in the time limit used. Future researchers can conduct research with a longer data collection period.

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