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Optimization of Production Capacity Jumbo Bag by Method Theory of Constraints

Delinda Brilian Cahayani[1], Rr. Rochmoeljati[1]

[1]*The National Development University "Veteran" of East Java, Industrial Engineering, Surabaya, Indonesia*

**Corresponding Author: Delinda Brilian Cahayani*
Email: 21032010125@student.upnjatim.ac.id

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Abstract

PT. XYZ is a company engaged in production jumbo bag with a capacity of 500–2000 kg. Increased demand occurred in jumbo bag with a capacity of 500 kg which causes problems in the production process, especially at work stations Cutting (SK-4), which experienced obstacles in the form of bottleneck due to limited resource capacity. This condition hampers efficiency and productivity, so that companies are unable to meet production targets during the period May to October 2024. This research aims to optimize production capacity jumbo bag by applying Theory of Constraints (TOC) through approach Drum-Buffer-Rope And Linear Programming which is processed using software POM-QM. Research stages include identification constraint, exploitation constraint, non-subordinatin constraint, as well as elevation constraint. From the results of this research, a solution was obtained in the form of addition shift work at the station Cutting (SK-4) through reduction shift at the station Needle Loom (SK-3) without reducing the number of operators, managed to increase the efficiency of the production process significantly. The implementation results show an increase in production time capacity from 129511 minutes to 291399.8 minutes (an increase of 26%) as well as an increase output production of 1,476 unit to 3,320 unit. Thus, the company managed to overcome obstacles bottleneck, increase operational productivity, and achieve predetermined production targets more optimally.

Introduction

In an increasingly competitive industry, companies are required to continuously innovate and improve operational efficiency. This improvement can take various forms, including advancements in technology, streamlining work processes, and optimizing resource management, all aimed at increasing productivity and maintaining a competitive edge (Ayustina et al., 2023). Production, in a business context, refers to the goods or services generated by a company within a specific timeframe, where the added value created during the production process contributes directly to company profits (Widjaja et al., 2022). Effective production process management not only enhances efficiency but also enables businesses to better meet market demand (Suroso & Yulvito, 2020). High-quality, value-added products not only satisfy consumers but also maximize profits for producers (Purwadinata & Batilmurik, 2020).

However, suboptimal production systems can lead to numerous operational challenges, such as material buildup due to delays at specific workstations, imbalances in production schedules, and prolonged setup times. These inefficiencies often result in bottlenecks that

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hinder the overall production flow (Abdilah & Nurbani, 2022). In today's fast-paced business environment, the ability to meet customer demand while maintaining optimal production capacity is essential for sustaining competitiveness (Frahdiansari et al., 2024) Effective production capacity optimization ensures timely delivery, reduces risks associated with delays or supply shortages, and upholds operational efficiency (Suwarso et al., 2021).

Production capacity, defined as the maximum output a facility can produce within a given timeframe, is a critical factor for operational success. Properly optimized capacity enhances resource utilization and minimizes the risk of production delays, thereby enabling companies to meet contractual targets (Suroso & Yulvito, 2020). Companies must strategically manage production capacity to align with market demands and operational objectives (Rudiawan, 2021).

PT. XYZ is a prominent manufacturer of plastic sacks, including its flagship product, flexible intermediate bulk containers (jumbo bags), which are designed to transport large quantities of goods. These jumbo bags, with capacities ranging from 500 kg to 2000 kg, cater to various industrial needs. However, the growing demand for 500 kg jumbo bags has created bottlenecks in the production process, particularly at the cutting workstations. These bottlenecks arise due to disparities in production shifts between the loom and needle loom processes and the limited number of cutting machines, which are not fully automated. Such constraints, compounded by inefficient setup times, have prevented the company from meeting its production targets during the May to October 2024 period.

To address these challenges, research was conducted utilizing the Theory of Constraints (TOC) methodology, incorporating the Drum-Buffer-Rope (DBR) concept and the Linear Programming method supported by POM-QM software. The DBR approach focuses on optimizing production flow by identifying and managing system constraints to ensure that production aligns with the maximum capacity of the bottleneck station (Istikomah & Prasetyaningsih, 2021). Linear programming, a mathematical optimization technique, aids in determining the best possible solution while accounting for existing constraints (Susdarwono, 2020). In this context, POM-QM software facilitates calculations and system analysis, providing a user-friendly platform for implementing the Simplex method (Lina et al., 2022).

The implementation of Theory of Constraints (TOC) involves several key steps: identifying constraints, exploiting these constraints, subordinating other processes to the constraints, and elevating the constraints to improve overall system performance (Rohman & Muhammad, 2022)). This approach emphasizes continuous improvement by addressing the primary obstacles that impede the achievement of company objectives (Hasanah et al., 2020). The Theory of Constraints (TOC) philosophy is widely recognized for its effectiveness in enhancing production systems, improving material management, increasing assembly line productivity, and optimizing project completion timelines (Saputra, 2020) By focusing on the most critical limitations, Theory of Constraints (TOC) enables companies to boost overall output and achieve their goals more efficiently (Ahadi, 2022)

Theory of Constraints (TOC) is a management philosophy centered on continuous improvement, with a strong emphasis on identifying and addressing the primary constraints within a production system to achieve organizational goals, including long-term profitability (Nanda et al., 2022). In production systems, controlling product capacity requires pinpointing control points and effectively managing constraints, which significantly influence overall system performance. In the context of production capacity optimization, Theory of Constraints (TOC) is instrumental in evaluating and mitigating the effects of bottlenecks or obstacles encountered at specific workstations (Ikhwana et al., 2024). This methodology encompasses a series of systematic steps aimed at enhancing system performance sustainably (Situmorang et al., 2023). The approach underscores the importance of concentrating on

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barriers that hinder goal attainment and implementing strategic measures to overcome these barriers, thereby expediting production flow. Numerous studies have highlighted the success of Theory of Constraints (TOC) based strategies in identifying and resolving bottlenecks in production environments (Kurniawan et al., 2022).

By applying Theory of Constraints (TOC), companies can pinpoint bottleneck workstations and devise strategies to minimize production time. This method has proven invaluable in optimizing production capacity by systematically analyzing and mitigating disruptions to the production flow (Wulandari et al., 2023). For PT. XYZ, the application of Theory of Constraints (TOC) is anticipated to enhance the production capacity of flexible intermediate bulk containers, ensuring the company can meet consumer demands more effectively. This initiative aims to identify and resolve production process obstacles, increasing the output of jumbo bags and enabling the company to fulfill market expectations.

Optimizing production capacity not only resolves immediate operational issues but also yields long-term benefits, such as reducing operational costs, enhancing product quality, and minimizing the risk of losses due to delivery delays. Additionally, the Theory of Constraints (TOC) approach can serve as a foundation for developing sustainable growth strategies. By integrating advanced technologies and effective management practices, companies can establish enduring competitive advantages in the marketplace(Adhiputra, 2021).

As part of Theory of Constraints (TOC) implementation, PT. XYZ can invest in employee training and development programs to enhance workforce skills in operating production machinery. This initiative supports the broader goal of effective production capacity optimization. Regular evaluations of Theory of Constraints (TOC) effectiveness are also crucial to swiftly and efficiently address emerging obstacles. By fostering a culture of continuous improvement, the company ensures that Theory of Constraints (TOC) implementation aligns with its long-term vision and mission. Thus, the adoption of Theory of Constraints (TOC) represents not only a practical solution to current production challenges but also a strategic move toward achieving sustainable organizational success.

The production process at PT. XYZ highlights the importance of addressing bottlenecks to ensure seamless operations. The cutting workstations, identified as a primary constraint, exemplify the challenges posed by manual and semi-automated systems in meeting rising production demands. The difference in production shifts between upstream processes such as loom and needle loom operations further exacerbates inefficiencies. These operational disparities underscore the critical need for a systematic approach like TOC to streamline workflows and enhance productivity.

The Drum Buffer Rope methodology within Theory of Constraints (TOC) is particularly effective in managing production constraints. The "drum" represents the bottleneck, setting the pace for the entire production system. The "buffer" ensures that work-in-progress inventory is available to prevent bottleneck downtime, while the "rope" synchronizes upstream processes with the bottleneck's capacity. This synchronization minimizes idle time and ensures a smooth production flow (Istikomah & Prasetyaningsih, 2021). By implementing Drum Buffer Rope, PT. XYZ can align its production processes to the capacity of its cutting workstations, thereby mitigating delays and enhancing overall efficiency(Bidiawati & Setiawati, 2020).

The use of linear programming further complements Theory of Constraints (TOC) by providing a quantitative framework for decision-making. Linear programming enables the company to allocate resources optimally, considering constraints such as machine availability, labor capacity, and material supply (Santi & Deharja, 2020). POM-QM software facilitates these calculations, offering insights into potential improvements and allowing for data-driven decisions (Ervil & Yulanda, 2020). This integration of mathematical optimization and Theory

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of Constraints (TOC) principles empowers the company to address its production challenges comprehensively (Yudistira & Muhammad, 2022).

Beyond operational improvements, the implementation of Theory of Constraints (TOC) fosters a culture of continuous learning and adaptation. For PT. XYZ, this involves regularly assessing the effectiveness of TOC strategies and making iterative adjustments based on performance data. Employee involvement is critical in this process, as their insights and expertise contribute to identifying practical solutions and driving sustained improvements. Training programs and workshops can equip employees with the skills needed to adapt to new systems and technologies, ensuring that the workforce remains a valuable asset in the company's optimization efforts.

The long-term implications of Theory of Constraints (TOC) adoption extend beyond immediate production targets. By addressing constraints systematically, PT. XYZ can enhance its ability to respond to market fluctuations and customer demands. This adaptability positions the company as a reliable supplier in the competitive market for jumbo bags. Furthermore, the efficiency gains achieved through Theory of Constraints (TOC) implementation can translate into cost savings, improved profitability, and a stronger market presence.

In conclusion, the Theory of Constraints offers a robust framework for addressing production challenges at PT. XYZ. By focusing on bottlenecks and implementing strategies such as Drum Buffer Rope and Linear Programming, the company can optimize its production capacity and meet growing demand for its products. The integration of Theory of Constraints (TOC) principles with employee development initiatives ensures that these improvements are sustainable and aligned with the company's long-term objectives. As industries continue to evolve, adopting innovative approaches like Theory of Constraints (TOC) will be crucial for companies seeking to maintain their competitive edge and achieve operational excellence.

Methods

In this research, it is necessary to identify the variables that influence production capacity. The dependent variable in this research is the amount of production capacity according to the target. The independent variables in this research are production targets, number of product requests, actual production, work period at a work station, work resource data, efficiency and utility, set up time at a work station. In this research, data was also collected which included product demand data or production target data, actual production data, work resource data, work element data for each work station, efficiency and utility factor data, set up time data per work station. In this research, data collection to optimize the production capacity of Flexible Intermediate Bulk Containers (Jumbo Bags) was carried out through direct observation of the production process at PT. XYZ by recording and documenting activities directly. Apart from that, interviews with operators at each work station were also carried out to obtain information related to the production process, where the resource person provided answers based on the company's actual conditions.

In this research, the main priority is to overcome the problem of not achieving production capacity caused by a bottleneck at one of the work stations, which is characterized by the available capacity being smaller than the required capacity. In conducting data analysis, this research adopted the Theory of Constraints (TOC) method with a drum buffer rope approach and linear programming, which is a systematic approach that can help identify and overcome existing obstacles in the production process. This method is carried out through four main stages, starting with identifying constraints or obstacles that exist in the production process. This first stage aims to identify and analyze various constraints or obstacles that limit production capacity. In this context, analysis is carried out to find various factors or conditions that hinder the smooth production process and reduce overall production efficiency.

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Determining these constraints is very important because by knowing what the obstacles are, more appropriate corrective steps can be taken.

The second stage in Theory of Constraints (TOC) analysis is constraints exploitation, which aims to determine the optimal number of units that can be produced with available resources. In this stage, it is carried out by creating a mathematical model using linear programming and processing it using POM QM software. Efforts are made to maximize the use of existing resources, so that production output can be increased significantly even though it is limited to a certain amount or type of resource. Exploitation of these constraints focuses on maximizing the use of existing capacity, with the aim of increasing productivity without requiring additional investment in new resources or equipment. By properly exploiting existing resources, it is hoped that the overall efficiency and effectiveness of the production process can be increased.

The third stage is the subordination of non-constraints, which aims to synchronize all existing resources in the production system. At this stage, attention is paid to ensuring that all resources used in the production process work in harmony and support each other. By making an illustration of a drum buffer rope and calculating the buffer time, it is hoped that the production process can run more efficiently, and obstacles that may occur between existing resources can be minimized. This synchronization is important so that the production process can run smoothly without any disruption or imbalance between the various elements involved, whether in terms of time, labor or use of equipment.

The final stage in the Theory of Constraint method is elevation constraints, which aims to optimize capacity at work stations that experience constraints or barriers. At this stage, various efforts are made to increase capacity at work stations that experience constraints, such as improving processes, increasing the number of resources, or introducing new technology that can help increase efficiency at the station. By optimizing capacity at work stations that are experiencing problems, it is hoped that we can increase overall production capacity and meet the targets that have been set. In addition, through these elevation constraints, the optimal capacity that can be achieved at each work station can be determined, so that decisions regarding necessary improvements and investments can be made more precisely.

Results and Discussion

Identify the Constraint

At this stage, identifying constraint is carried out by analyzing the problems faced by the company. The main focus of the research is directed at improving production time capacity (capacity constraints), because this constraint is considered to have a significant influence on the company's current operational conditions. To identify the location of constraints in the production process, the production time capacity required to achieve the set production targets is measured.

The identification process begins by calculating the standard time and set-up time at each work station in the process of making jumbo bags with a capacity of 500 kg. This calculation is carried out thoroughly to ensure the accuracy of the data that will be used in further analysis. The results of measuring standard time and set-up time at each work station in the jumbo bag production process with a capacity of 500 kg can be seen in Table 1.1 below.

Table 1. Standard Time and Set Up Time for Jumbo Bag Production Capacity 500kg

Work Station	Standard Time (Minutes)	Set Up Time (Minutes)
Extruder (WS-1)	27,99	2.48
Loom (WS-2)	17,30	3.83
Needle Loom (WS-3)	7,40	1.11

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Cutting (WS-4)	17,04	4.94
Sewing (WS-5)	12,22	2.37
Packing (WS-6)	5,81	2.04

Source: Data Processing Results

Based on the table 1.1, it can be seen that the standard time for the 500kg capacity jumbo bag production process, respectively, at work station 1 is 27.99 minutes, work station 2 is 17.30 minutes, work station 3 is 7.40 minutes, work station 4 is 17.04 minutes, work station 5 was 12.22 minutes, and work station 6 was 5.81 minutes. Time set up in the production process jumbo bag 500kg capacity respectively at work station 1 of 2.48 minutes, work station 2 of 3.83 minutes, work station 3 of 1.11 minutes, work station 4 of 4.94 minutes, work station 5 of 2.37 minutes, and work station 6 was 2.04 minutes.

After the standard time for each work station is obtained, the next step is to calculate the required time capacity (CA) and available time capacity (CR) to be able to determine the production time capacity that does not meet the production target. Calculation of adequacy of production time capacity is carried out to determine whether the process is in good condition bottleneck (insufficient capacity) or non-bottleneck (sufficient capacity) namely by calculating the variance or difference between available capacity (CA) and required capacity (CR). The results of calculating available production time capacity (CA), required production time capacity (CR), as well as variances at work stations 1 to work station 6 during the period May - October 2024 can be seen in Table 1.2 below.

Table 2. Calculation of Available Production Time Capacity (CA), Required Production Time Capacity (CR) and Variance

Month	Work Station	CA	CR	Variance	Information
May 2024	1	138457.36	71216.82	67240.54	*non-bottleneck*
	2	106505.66	44004.52	62501.14	*non-bottleneck*
	3	133132.08	18816.57	114315.50	*non-bottleneck*
	4	32694.34	43362.06	-10667.72	*bottleneck*
	5	80015.09	31088.73	48926.36	*non-bottleneck*
	6	44015.09	14792.09	29223.01	*non-bottleneck*
June 2024	1	126919.25	80902.75	46016.49	*non-bottleneck*
	2	97630.19	49989.41	47640.78	*non-bottleneck*
	3	122037.74	21375.74	100661.99	*non-bottleneck*
	4	29969.81	49259.58	-19289.76	*bottleneck*
	5	73347.17	35317.00	38030.17	*non-bottleneck*
	6	40347.17	16803.91	23543.26	*non-bottleneck*
July 2024	1	149995.47	89580.90	60414.57	*non-bottleneck*
	2	115381.13	55351.60	60029.54	*non-bottleneck*
	3	144226.42	23668.64	120557.77	*non-bottleneck*
	4	35418.87	54543.47	-19124.61	*bottleneck*
	5	86683.02	39105.33	47577.69	*non-bottleneck*
	6	47683.02	18606.40	29076.62	*non-bottleneck*
August 2024	1	149995.47	78327.30	71668.17	*non-bottleneck*
	2	115381.13	48398.05	66983.08	*non-bottleneck*
	3	144226.42	20695.27	123531.14	*non-bottleneck*
	4	35418.87	47691.45	-12272.58	*bottleneck*
	5	86683.02	34192.72	52490.30	*non-bottleneck*

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Month	Work Station	CA	CR	Variance	Information
	6	47683.02	16268.97	31414.05	*non-bottleneck*
Sept 2024	1	138457.36	86949.46	51507.89	*non-bottleneck*
	2	106505.66	53725.64	52780.02	*non-bottleneck*
	3	133132.08	22973.38	110158.70	*non-bottleneck*
	4	32694.34	52941.26	-20246.92	*bottleneck*
	5	80015.09	37956.61	42058.49	*non-bottleneck*
	6	44015.09	18059.84	25955.26	*non-bottleneck*
Oct 2024	1	155764.53	84402.01	71362.52	*non-bottleneck*
	2	119818.87	52151.58	67667.29	*non-bottleneck*
	3	149773.58	22300.30	127473.28	*non-bottleneck*
	4	36781.13	51390.18	-14609.05	*bottleneck*
	5	90016.98	36844.55	53172.43	*non-bottleneck*
	6	49516.98	17530.72	31986.26	*non-bottleneck*

Source: Data Processing Results

Based on Table 2, you can see the work station Cutting (SK-4) experienced bottleneck or non-fulfillment of production time capacity during the period May - October 2024. Production time capacity that cannot be fulfilled respectively is 10667.72 minutes, 19289.76 minutes, 19124.61 minutes, 12272.58 minutes, 20246.92 minutes, and 14609.05 minutes. This indicates that the work station Cutting need special attention to overcome constraint available so that the production process runs more smoothly. Meanwhile, other work stations, namely Extruder (SK-1), Loom (SK-2), Needle Loom (SK-3), Sewing (SK-5), and Packing (SK-6) did not experience bottleneck.

Expolit the Constraint

Based on the data that has been collected, it is known that in one production process *jumbo bag* capacity of 500 kg, capacity production process time is 60 minutes, while time *set up* takes 15 minutes. To achieve optimal production process time capacity and production quantities, exploitation steps are required *constraint*, namely by maximizing performance at the experiencing workstation *bottleneck*. Identification results *bottleneck* presented in Table 2 shows that the work station *Cutting* (SK-4) is a work station that experiences *bottleneck* for the last six months. Experienced workstation *bottleneck* shown in Table 3 below.

Table 3. Insufficient Capacity

Work Station	Month	CA (Minutes)	CR (Minutes)	Variance	Information
4	May 2024	32694.34	43362.06	-10667.72	*bottleneck*
	June 2024	29969.81	49259.58	-19289.76	*bottleneck*
	July 2024	35418.87	54543.47	-19124.61	*bottleneck*
	August 2024	35418.87	47691.45	-12272.58	*bottleneck*
	Sept 2024	32694.34	52941.26	-20246.92	*bottleneck*
	Oct 2024	36781.13	51390.18	-14609.05	*bottleneck*

Source: Data Processing Results

Based on Table 3, it is known that the minimum availability at work station 4 is 36781.13 minutes. Below is presented Table 4.4 which contains information regarding the minimum capacity availability at each work station that will be used for the exploitation process *constraint*. This process is carried out on all work stations *bottleneck* nor *non bottleneck* to increase production efficiency.

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Table 4. Minimum Capacity Availability for Each Work Station

Work Station	Standard Time (Minutes)	Set Up Time (Minutes)	Minimum Availability
WS – 1	27.99	2.48	155764.53
WS – 2	17.30	3.83	119818.87
WS – 3	7.40	1.11	149773.58
WS – 4	17.04	4.94	36781.13
WS – 5	12.22	2.37	90016.98
WS – 6	5.81	2.04	49516.98

Source: Data Processing Results

Max: Z = $60_{X1} + 15_{X2}$

s.t. : $27{,}99_{X1} + 2{,}48_{X2} \leq 155764{,}53$

$17{,}30_{X1} + 3{,}83_{X2} \leq 119818{,}87$

$7{,}40_{X1} + 1{,}11_{X2} \leq 149773{,}58$

$17{,}04_{X1} + 4{,}94_{X2} \leq 36781.13$

$12{,}22_{X1} + 2{,}73_{X2} \leq 90016.98$

$5{,}81_{X1} + 2{,}04_{X2} \leq 49516.98$

$X_1 \leq 17553$

$X_2 \leq 0$

$X_1, X_2 \geq 0$

The mathematical model above is used as input in the POM-QM Software to obtain the optimal solution. The input and calculation results are shown in Figure 1. below.

	X1	X2		RHS	Equation form
Maximize	60	15			Max 60X1 + 15X2
Constraint 1	27.99	2.48	<=	155764.5	27.99X1 + 2.48X2 <= 155764.5
Constraint 2	17.3	3.83	<=	119818.9	17.3X1 + 3.83X2 <= 119818.9
Constraint 3	7.4	1.11	<=	149773.6	7.4X1 + 1.11X2 <= 149773.6
Constraint 4	17.04	4.94	<=	36781.13	17.04X1 + 4.94X2 <= 36781.13
Constraint 5	12.22	2.73	<=	90016.98	12.22X1 + 2.73X2 <= 90016.98
Constraint 6	5.81	2.04	<=	49516.98	5.81X1 + 2.04X2 <= 49516.98
Constraint 7	1	0	<=	17553	X1 <= 17553
Constraint 8	0	1	<=	0	X2 <= 0
Constraint 9	1	0	>=	0	X1 >= 0
Constraint 10	0	1	>=	0	X2 >= 0

Figure 1. Data Input in POM-QM Software

Based on results running on Software POM-QM can be concluded that the value of the linear programming calculation above can be concluded that the value of $X_1 = 2158{,}52$ and $X_2 = 0$, then the value of Z = $60_{X1} + 15_{X2}$ is adalah Z = 60(2158,52) + 15(0) = 129511,0. This shows that the maximum production capacity that will be obtained is 129511 minutes.

Optimal solution or output The calculation is shown in Figure 2 below.

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Variable	Status	Value
X1	Basic	2158.52
X2	Basic	0
slack 1	Basic	95347.62
slack 2	Basic	82476.56
slack 3	Basic	133800.6
slack 4	NONBasic	0
slack 5	Basic	63639.9
slack 6	Basic	36976
slack 7	Basic	15394.48
slack 8	Basic	0
surplus 9	Basic	2158.52
surplus 10	NONBasic	0
Optimal Value (Z)		129511.0

Figure 2. Data Output in POM-QM Software

Subordinate to the Non-Constraint

Sub ordination process non-constraint intended to illustrate output the maximum that can be achieved by the process that has constraint. However, this must be supported by operational decision making that is in accordance with the capacity constraints. In order to maintain overall system performance, subordination of non-constraint elements is carried out by implementing Drum-Buffer-Rope.

Based on identification results constraint, it is known that the workstation Cutting (SK-4) is an experiencing element bottleneck, so the work station Cutting (SK-4) is designated as drum in this level. The next step is to decide buffer, which is done by applying buffet hours. Calculation buffer time can be seen in the following Table 1.5.

Table 5. Buffer Time Calculation

Work Station	Month	CA (Minutes)	CR (Minutes)	Buffer Time (Minutes)
4	May 2024	32694.34	43362.06	10667.72
	June 2024	29969.81	49259.58	19289.76
	July 2024	35418.87	54543.47	19124.61
	August 2024	35418.87	47691.45	12272.58
	Sept 2024	32694.34	52941.26	20246.92
	Oct 2024	36781.13	51390.18	14609.05

Source: Data Processing Results

Based on the calculation results above, the value *buffer time* is obtained by subtracting the available capacity from the required capacity. The results show that *buffer time* The highest occurred in September 2024, namely 20246.92 minutes. Therefore, an illustration was made *Drum-Buffer-Rope* to synchronize the experiencing workstation *bottleneck* with other work stations, as shown in Figure 3 below.

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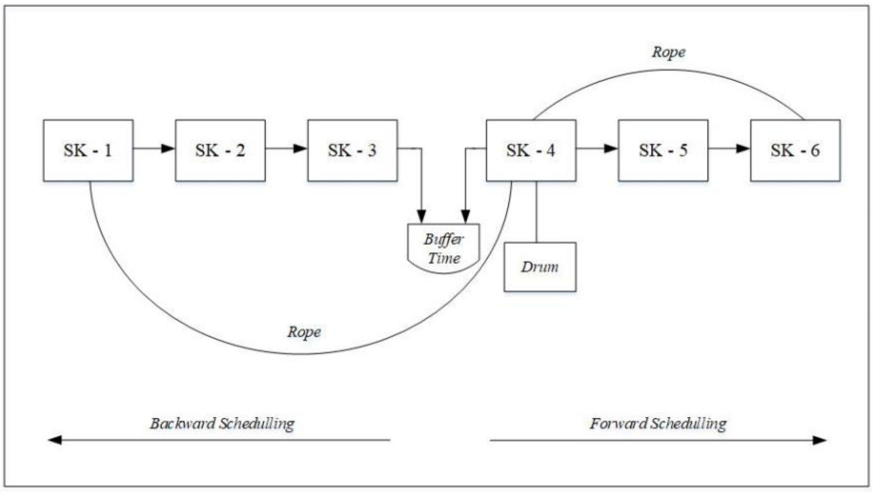

Figure 3. Illustration of Drum-Buffer-Rope

Elevate the Constraint

Elevation *constraint* carried out to re-plan production to meet production capacity and avoid *bottleneck*. Based on the results of exploitation *constraint* on the process *Cutting* (SK-4), an alternative solution is given in the form of addition *Shift* work. Addition *Shift* work is required to meet capacity at the workstation *Cutting* (SK-4) in the period May - October 2024. *Shift* additional can be obtained by allocating *Shift* at the station *beg Needle Animal* (SK-3), from the initial 3 *Shift* with 5 operators it becomes 2 *Shift* with a fixed number of operators. Thus, the work station *Cutting* (SK-4) which previously operated 2 *Shift* with 2 operators can be increased to 3 *Shift* with 3 operators. Based on the data in table 4.34, a recalculation of available capacity (CA) and variance at work stations is carried out *Sewing* (SK-3) and *Cutting* (SK-4) to confirm if there are any problems *bottleneck* has been resolved by adjusting the amount *Shift* on both workstations. Calculation results of available production time capacity (CA), required production time capacity (CR), as well as variances at work stations *Needle Loom* (SK-3) and work station *Cutting* (SK-4) after adjustment *Shift* work during the period May - October 2024 can be seen in Table 1.6 below.

Table 6. Results of Providing Work Shift Adjustment Solutions

Work Station	Month	CA (Minutes)	CR (Minutes)	Variance	Information
May 2024	3	88754.72	18816.57	69938.15	*non-bottleneck*
June 2024		81358.49	21375.74	59982.75	*non-bottleneck*
July 2024		96150.94	23668.64	72482.30	*non-bottleneck*
August 2024		96150.94	20695.27	75455.67	*non-bottleneck*
Sept 2024		88754.72	22973.38	65781.34	*non-bottleneck*
Oct 2024		99849.06	22300.30	77548.76	*non-bottleneck*
May 2024	4	73562.26	43362.06	30200.20	*non-bottleneck*
June 2024		67432.08	49259.58	18172.50	*non-bottleneck*
July 2024		79692.45	54543.47	25148.98	*non-bottleneck*
August 2024		79692.45	47691.45	32001.00	*non-bottleneck*
Sept 2024		73562.26	52941.26	20621.00	*non-bottleneck*
Oct 2024		82757.55	51390.18	31367.37	*non-bottleneck*

Source: Data Processing Results

Table 6 shows that there is no variance with negative values. It can be concluded that addition *Shift* work as a solution to overcome *bottleneck* at the work station *Cutting* (SK-3), while

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reduction *Shift* work at a workstation *Sewing* (SK-4) which is transferred to the work station *Cutting* (SK-3) does not cause *bottleneck* at the work station *Sewing* (SK-4). Thus, production time capacity is adequate to meet production time needs and customer requests. Therefore, the minimum capacity availability for each work station is also different and can be seen in Table 7 below.

Table 7. Minimum Capacity Availability for Each Work Station After Adjusting Work Shifts

Work Station	Standard Time (Minutes)	Set Up Time (Minutes)	Minimum Availability
WS – 1	27.99	2.48	155764.53
WS – 2	17.30	3.83	119818.87
WS – 3	7.40	1.11	99849.06
WS – 4	17.04	4.94	82757.55
WS – 5	12.22	2.37	90016.98
WS – 6	5.81	2.04	49516.98

Source: Data Processing Results

Max: Z = $60_{X1} + 15_{X2}$

s.t. : $27{,}99_{X1} + 2{,}48_{X2} \leq 155764{,}53$

$17{,}30_{X1} + 3{,}83_{X2} \leq 119818{,}87$

$7{,}40_{X1} + 1{,}11_{X2} \leq 99849{,}06$

$17{,}04_{X1} + 4{,}94_{X2} \leq 82757{,}55$

$12{,}22_{X1} + 2{,}73_{X2} \leq 90016{,}98$

$5{,}81_{X1} + 2{,}04_{X2} \leq 49516{,}98$

$X_1 \leq 17553$

$X_2 \leq 0$

$X_1, X_2 \geq 0$

The mathematical model above is used as input *Software POM-QM* to obtain the optimal solution. Results *input* and the calculations are shown in Figure 4 below.

	X1	X2		RHS	Equation form
Maximize	60	15			Max 60X1 + 15X2
Constraint 1	27.99	2.48	<=	155764.5	27.99X1 + 2.48X2 <= 155764.5
Constraint 2	17.3	3.83	<=	119818.9	17.3X1 + 3.83X2 <= 119818.9
Constraint 3	7.4	1.11	<=	99849.06	7.4X1 + 1.11X2 <= 99849.06
Constraint 4	17.04	4.94	<=	82757.55	17.04X1 + 4.94X2 <= 82757.55
Constraint 5	12.22	2.73	<=	90016.98	12.22X1 + 2.73X2 <= 90016.98
Constraint 6	5.81	2.04	<=	49516.98	5.81X1 + 2.04X2 <= 49516.98
Constraint 7	1	0	<=	17553	X1 <= 17553
Constraint 8	0	1	<=	0	X2 <= 0
Constraint 9	1	0	>=	0	X1 >= 0
Constraint 10	0	1	>=	0	X2 >= 0

Figure 4. Data Output in POM-QM Software

Optimal solution or *output* the calculation is shown in Figure 5 below.

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Variable	Status	Value
X1	Basic	4856.66
X2	Basic	0
slack 1	Basic	19826.5
slack 2	Basic	35798.63
slack 3	Basic	63909.75
slack 4	NONBasic	0
slack 5	Basic	30668.55
slack 6	Basic	21299.77
slack 7	Basic	12696.34
slack 8	Basic	0
surplus 9	Basic	4856.66
surplus 10	NONBasic	0
Optimal Value (Z)		291399.8

Figure 5. Data Output in POM-QM Software

Based on results *running* on *Software* POM-QM can be concluded that the value of the linear programming calculation above can be concluded that the value of $X_1 = 4856{,}66$ and $X_2 = 0$, then the value of Z = $60_{X1} + 15_{X2}$ is Z = 60(4856,66) + 15(0) = 291399,8. This shows that the maximum production capacity that will be obtained is 291399,8 minutes.

Based on the calculation results of the maximum production capacity before adjustment *Shift* work and after adjustment *Shift* work, it can be seen that the result of the increase in production capacity is 87605.37 minutes or 26% and it is also known that the maximum production capacity that can be obtained is 291399.8 minutes, where the previous production capacity was 129511. The maximum capacity can also be known *jumbo bag* 500kg capacity that can be produced by PT. XYZ after adjustment *Shift* work is 3320 *pcs*. Thus, the company can meet the production targets as presented in Table 1.8 below.

Table 8. Increase in Total Production Capacity

Month	Consumer Demand (Pcs)	Intality Capacity (Pcs)	Capacity After Work Shift Adjustments (Pcs)
May 2024	2544	1476	3320
June 2024	2890		
July 2024	3200		
August 2024	2798		
Sept 2024	3106		
Oct 2024	3015		

Source: Data Processing Results

Based on table, it is known that the increase in production capacity at PT. XYZ with an initial capacity of 1476 pcs and after adjustments *Shift* working production capacity is 3320 pcs. This increase can enable the company to achieve the production targets that have been set.

Conclusion

The main obstacles that affect the production process flexible intermediate bulk container (jumbo bag) at PT. XYZ, namely existence Constraint Capacity which is the main obstacle in achieving production efficiency. This condition is characterized by the need for production capacity that exceeds the capacity of available resources, thus creating an imbalance that leads to bottleneck. Bottleneck This specifically occurs at work stations Cutting (SK-4) during the

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period May to October 2024. This capacity imbalance not only hampers work flow at the relevant stations, but also has a negative impact on overall efficiency and productivity on the production line. Identification bottleneck through the production time capacity variance calculation shows that the work station Cutting (SK-4) has a negative variance, which indicates that this station is a critical point that requires major attention.

With approach Theory of Constraints (TOC), which involves a series of systematic steps to overcome identified obstacles and increase production volumes jumbo bag according to the targets that have been set. This approach begins with the identification stage constraint, exploitation constraint through optimization of existing resources using methods linear programming with Software POM-QM, subordination constraint by counting buffer time and implementing illustrations drum buffer rope, up to the elevation stage constraint which involves strategically adjusting production processes. The main solution implemented is to add Shift work at a workstation Cutting (SK-4) through adjustments Shift working at a workstation Needle Loom (SK-3). Workstation Needle Loom which previously operated with 3 Shift reduced to 2 Shift without reducing the number of operators, so that the work station Cutting which originally operated with 2 Shift and 2 operators can be increased to 3 Shift with 3 operators. This adjustment had a significant impact in increasing production time capacity, from 129,511 minutes to 291399.8 minutes, this is an increase of 87605.37 minutes or the equivalent of 26% of the previous capacity. The impact of increasing production time capacity is directly visible in the increase in the number of products produced. Initial production capacity only reached 1,476 unit managed to increase to 3,320 unit after adjustments are made. With this achievement, the company was not only able to overcome the main obstacles in the form of bottleneck in the production process, but can also achieve predetermined production targets more efficiently, productively and optimally, while strengthening the company's competitiveness in meeting market demand.

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