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Operating Expenes Problem-Solving Through Workforce and Process Analysis For a Rubber Manufacturing Plant In Bandung

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Abstrak. *Biaya operasional yang tinggi telah berdampak besar pada pabrik produksi karet CV XYZ di Bandung. Tenaga kerja, khususnya di bagian barang jadi, menyumbang bagian terbesar dari pengeluaran operasional, dengan biaya sebesar Rp 377.190.000. Studi efisiensi tenaga kerja dan proses diperlukan untuk mengurangi biaya. Studi ini bertujuan untuk mengevaluasi kinerja tenaga kerja dan proses di divisi barang jadi CV XYZ dan memberikan rekomendasi untuk perbaikan. Menurut studi kapasitas, CV XYZ memiliki kapasitas yang cukup untuk memenuhi permintaan saat ini tanpa melebihi batas. Produk kecil digunakan sebesar 65,91% dari waktu, produk sedang 67,73%, dan produk besar 53,81%. Tingkat efisiensi untuk produk berukuran sedang adalah 81,59%, produk besar 64,82%, dan produk kecil 79,41%. Limbah menunggu diidentifikasi sebagai proses yang paling umum melalui pemetaan proses yang menyeluruh. Delapan pekerja ditemukan berada di bawah beban kerja, sedangkan satu pekerja memiliki beban kerja yang normal, menurut studi beban kerja. Rekayasa ulang proses bisnis mengusulkan untuk mengintegrasikan komponen atau operasi agar lebih baik. Selama proses vulkanisasi karet, metode yang diusulkan mengurangi waktu diam pekerja. Distribusi beban kerja baru dihitung menggunakan proses bisnis yang telah direkayasa ulang sebagai dasar. Meskipun masih berada di bawah kategori beban kerja rendah, ini mengarah pada pengurangan jumlah pekerja dan peningkatan beban kerja. Dengan menggunakan metode yang diusulkan ini, CV XYZ dapat menghemat Rp 125.730.000,00, atau 33% dari biaya tenaga kerja langsungnya.*

Kata kunci: *Pemetaan Proses Bisnis; Analisis Beban Kerja; Manufaktur Karet.*

Abstract. *High operational costs have had a major impact on Bandung's CV XYZ rubber production plant. Labor, specifically in the completed goods section, accounts for the largest portion of operational expenditures, costing Rp 377,190,000. A labor and process efficiency study is required in order to cut expenses. This study intends to evaluate the labor and process performance of CV XYZ's finished goods division and make recommendations for enhancements. CV XYZ has enough capacity, according to the capacity study, to satisfy current demand without going beyond. Small products are used 65.91% of the time, medium products 67.73%, and large products 53.81%. The efficiency rate for medium-sized products is 81.59%, large-sized products is 64.82%, and small-sized products is 79.41%. Waiting waste was identified as the most common process by a thorough process mapping. Eight workers were found to be under load, whereas one worker had a typical workload, according to the workload study. Reengineering business processes proposes integrating components or operations to better. During the rubber vulcanization process, the suggested method cuts down on worker idle time. The new workload distribution is computed using the re-engineered business process as a base. Even though it falls under the under-load category, this leads to fewer employees and a greater burden. By using this suggested method, CV XYZ can save Rp 125.730.000,00, or 33% of its direct labor expenditures.*

Keywords: *Business Process Mapping; Workload Analysis; Rubber Manufacturing.*

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Introduction

Bandung is home to CV XYZ, a facility that produces rubber. This plant, which employs 25 people in total, makes a variety of rubber compounds and rubber parts. CV XYZ can manufacture 165 different product variations in addition to seven different types of rubber compounds. Producing rubber compounds from natural and synthetic rubber for press and roll industry machinery is the main focus of CV XYZ's business operations. CV XYZ furthermore offers metal and rubber components. Make-to-order (MTO) production is used by CV XYZ, meaning that orders from clients are the basis for production starting. CV XYZ does not have a minimum quantity requirement due to its small to medium business scale.

CV Xyz had suffered a loss due to Pandemi Covid-19. Their financial documents, however, demonstrate that they gradually recovered the loss. The management was able to successfully restore them to achieve operating profits. However, CV XYZ finds it harder and harder to provide more affordable prices as rivals keep coming up with new ideas to cut expenses. The financial statements for 2023 reveal that labor expenditures, particularly in the finished goods section, account for the majority of CV XYZ's operating costs. The UMR salary for nine permanent employees come to around Rp 3,492,500 per month (BPS Bandung Regency, 2023). This indicates that CV XYZ has to pay Rp 377,190,000 a year for direct labor expenditures. The production manager claims that this raises the cost of the production process. Thus, an evaluation of the effectiveness of the current procedure and workforce size is required.

Within the context of labor and the production process in the finished goods division, this study suggests a solution to the issue of operational expenses at CV XYZ, a rubber manufacturing firm in Bandung. Production data from 2023 purchase orders is the basis for the data used. To find areas for improvement, this research will map business processes, evaluate production capacity, and analyze workload. It is anticipated that using this strategy will result in relevant recommendations that will save operational expenses and boost productivity in CV XYZ.

The objective of this study is to optimize labor performance and manufacturing processes while generating considerable cost savings for the organization by offering clear recommendations and practical execution. CV XYZ will be able to maintain its competitiveness in the increasingly difficult market by putting the suggested recommendations into practice.

Literature Review

Capacity Analysis

Capacity analysis determines an organization's production capacity to meet changing product or service demands. The first step in capacity analysis is assessing current production levels and resources. This involves gathering data on the output rates of machinery, the efficiency of labor, and the availability of raw materials. By understanding these factors, a business can identify bottlenecks or areas where production is hindered (Stevenson, 2018).

Design Capacity

Design capacity is the maximum output rate a system can achieve under ideal conditions.

$$Design\ Capacity = Maximum\ Output\ Rate\ x\ Available\ Time$$

Equation shows the formula for calculating design capacity, multiplying the maximum output rate by the available time. The maximum output rate is often calculated based on the system's design specifications, including the number of machines, workers, and other resources available.

Effective Capacity

Effective capacity is the maximum output that can actually be produced by considering downtime, maintenance, and other factors that can reduce production capacity. It is what can be realistically achieved and sustained.

$$Effective\ Capacity = Design\ Capacity - Lost\ Output$$

Equation shows the formula for calculating effective capacity, which can be obtained by subtracting the design capacity output by the lost output. This can be done directly by subtracting the amount of output or as a percentage from the design capacity that will be multiplied by the design capacity output.

Capacity Utilization Rate

The capacity utilization rate measures the extent to which an enterprise is using its design capacity. It indicates how much of the available production capacity is being used over a specific period.

$$Capacity\ Utilization\ Rate = \left(\frac{Actual\ Output}{Design\ Capacity}\right) x\ 100\%$$

Equation calculates the utilization rate, which is the actual output divided by the design capacity multiplied by 100% to yield a percentage.

Capacity Efficiency Rate

The capacity efficiency rate measures how effectively a facility uses its production capacity. It compares the actual output produced to the effective capacity.

$$Capacity\ Efficiency\ Rate = \left(\frac{Actual\ Output}{Effective\ Capacity}\right) x\ 100\%$$

Equation calculates the efficiency rate, which is the actual output divided by the effective capacity multiplied by 100% to yield a percentage.

Process Mapping

Process mapping is a visual representation technique for illustrating the steps involved in a specific process within an organization. Process maps use symbols and notations to depict actions, decisions, inputs, and outputs, providing a detailed view of how workflows from start to finish (Damij, 2007). This research will use the Business Process Model Notation (BPMN), Supplier, Input, Output, and Customer (SIPOC) diagram, and value stream mapping in the lean manufacturing waste analysis.

Business Process Model Notation (BPMN)

Business Process Model and Notation (BPMN) is a standardized graphical representation for specifying business processes in a business process model. It is developed by the Object Management Group (OMG) and aims to provide a notation understandable by all business stakeholders, including business analysts, technical developers, and business managers. The primary goal of BPMN is to create a standardized bridge for the gap between business process design and process implementation.

Lean Manufacturing

Lean manufacturing is a production philosophy that aims to minimize waste and maximize efficiency in the manufacturing process. This approach focuses on delivering value to the customer while using fewer resources by systematically identifying and eliminating wasteful practices. Originating from the Toyota Production System, lean manufacturing emphasizes continuous improvement, respect for people, and efficient workflows (Womack, Jones, & Roos, 1990). One of the core principles of lean manufacturing is identifying and eliminating the seven types of waste, often referred to as "muda" in Japanese. These include overproduction, waiting, transportation, excess processing, inventory, motion, and defects (Liker, 2004)

Value Stream Mapping

Value stream mapping (VSM) is a lean-management tool used to visualize and analyze the flow of materials and information required to bring a product or service from its initial stages to the customer. It identifies both value-added and non-value-added activities. The primary goal of VSM is to understand and improve the production process (Rother & Shook, 2003). Value stream mapping begins with creating a "current state map," which captures the existing steps, processes, delays, and flows in the production or service delivery. This map includes detailed information about cycle times, inventory levels, and communication methods, offering a clear picture of current work. By documenting these elements, VSM helps identify inefficiencies and waste within the system (Liker & Meier, 2006).

Workload Analysis

Workload analysis is a systematic process for evaluating the necessary efforts to complete specific tasks within a set timeframe. It involves identifying tasks, estimating the required effort, and matching these requirements with available resources. This analysis is crucial for optimizing productivity, ensuring efficient resource allocation, and maintaining employee well-being. Workload analysis could be used to determine the number of required labor. One of the ways to do workload analysis is by using the Full Time Equivalent (FTE) method.

Full Time Equivalent (FTE) Method

The FTE method compares the time needed to complete different tasks with the available effective working hours (Yasmin, 2019, as cited in Wahyulistiani *et al.*, 2022). Workload measurement can be done by gathering information about specific areas through research and analysis (Rachmuddin, 2020, as cited in Wahyulistiani *et al.*, 2022).

$$FTE = \frac{Total\ Standard\ Time\ (Total\ Workload) + Allowance}{The\ Total\ Effective\ Work\ (Company's\ FTE)}$$

Total Standard Time = the total time of the workload, in this case, is the total time needed to complete a particular task Allowance = additional time accounted for in work schedules to cover activities that are not directly related to an employee's main tasks, such as personal breaks outside lunchtime. Total Effective Work = the total time after being subtracted from holidays, such as national holidays, weekends, and annual leave. The result, which is the FTE index, will later be categorized into normal (FTE 1–1.28), overload (FTE < 1.28), and underload (FTE 0.00 – 0.99) (Wahyulistiani *et al.*, 2022). Workload analysis is used to determine the actual condition of labor in CV XYZ. The results of underload and overload will be used to suggest improvements. Using the total FTE index of a task, the optimal number of workers could be calculated.

$$Required\ Labor = \frac{Total\ FTE}{Number\ of\ Employees}$$

Total FTE = sum of FTE index for a particular task. Number of employees = adjusted until the average of the FTE index lies within the normal category

Business Process Reengineering

Business Process Reengineering (BPR) is a management strategy that radically redesigns core business processes to improve productivity, efficiency, and quality significantly. Michael Hammer and James Champy popularized the concept in their book "Reengineering the Corporation." They describe BPR to fundamentally rethink how work is performed within an organization to better support its mission and reduce costs (Hammer & Champy, 1993). Based on the analysis, new process designs are developed to eliminate inefficiencies and better meet organizational goals. The approaches are 1) Eliminating unnecessary operations, 2) Combining operations, 3) Changing operations sequence, 4) Automation, and 5) Simplifying necessary operations.

Research Methodology

This research is a combination of qualitative and quantitative methods, including field observations, interviews, and literature reviews. Data was collected from company archives, purchase order documents, and interviews with key personnel at CV XYZ.

Problem Identification

Initial field observations and interviews were conducted to gain insight into the production process and the core business activity. Interviews with the Production Manager were conducted to get information about the process beyond what was observed. Interviews with the financial manager of CV XYZ were also undertaken to identify the problem by looking at whether an operational aspect brought loss to the company.

Data Collection

After defining the problem, literature reviews were conducted to identify the theoretical foundation for solution creation and the data type that needed to be collected. The data will be collected through the second phase of deep interviews and company archives for secondary data. The primary data is collected through field observation and interviews with the production manager, section head of finished goods, and the production staff to obtain data on the business process, production capacity, and labor policy in CV XYZ. Secondary data is gathered through journals and reports on the Internet to collect data on theoretical foundations and the industry landscape. Historical data of CV XYZ purchase order documents is also collected as secondary data.

Data Analysis

The data collected will be analyzed to assess the current performance of labor and processes using capacity analysis, process mapping, lean manufacturing waste analysis using value stream mapping, and workload analysis. These analyses will be used to make suggestions for improvement, including the optimum number of laborers and re-engineered business processes showing reduced operating costs.

Result and Discussion

Capacity Analysis

According to a capacity analysis, the finished goods division CV XYZ employs nine manufacturing workers in total. Of them, one person is in charge of finishing and packing, five individuals oversee the printing process, two handle cutting, and one person handles quality control. These laborers work seven days a week, from seven in the morning to seven in the afternoon, with an hour-long break between eleven and twelve. On Saturdays, their first shift is from seven in the morning to twelve. Regarding vacation time, CV XYZ combines yearly leave with public holidays to provide a total of twelve holidays annually. With this work plan, the working hours that are available after taking vacations and leave are subtracted to determine the effectiveness of the work time. To make sure that labor and resources are employed as efficiently as possible to satisfy the current demand for production, it is critical to assess this capacity.

Table 1. Total Effective Working Hours of 2023

Period	Working Days/Hours	Total Working Hours
Monday - Friday	7 hours/day x 5 days	35 hours
Saturday	5 hours/day x 1 day	5 hours
Total per week		40 hours
Number of weeks in a year		52 weeks
Total working hours per year	40 hours/week x 52 weeks	2,080 hours
Deduction for leave days	12 days x 7 hours/day	-84 hours
Total working hours per year after leave		1,996 hours

Table 1 provides a detailed calculation of the total working hours in 2023 after accounting for leave days. The 12 days of holidays, worth 7 hours for each day, are deducted from the total working hours in 2023, which is 2,080 hours. The total effective working hours obtained in 2023 is 1,996 hours, or equivalent to 119,760 minutes. CV XYZ has 7 hydraulic press machines: 2 for small products, 4 for medium products, and 1 for large products. One small machine has 1 plate, and the other has 2 plates. The size of the product will determine the size of the mold used. Using this information, the capacity will be analyzed.

Design Capacity

Design capacity is a critical measure in understanding the maximum potential output of a manufacturing system under ideal conditions. It is essential for planning and optimizing production processes to meet demand efficiently. The design capacity for each product size at CV XYZ is calculated based on the number of machine plates, the molding time per piece, and the effective working time available. The table below presents the design capacity for small, medium, and large products, providing a clear picture of the production capabilities for each size category.

Table 2. Design Capacity for Each Product Size

Mold Size	(a) Machine Plate	(b) Molding Time/piece	(c) Effective Working Time	(c÷b x a) Design Capacity
Small	3 pcs	17 mins	119,760 minutes	21,134 pcs
Medium	4 pcs	20 mins	119,760 minutes	23,952 pcs
Large	1 pc	60 mins	119,760 minutes	1,996 pcs

Table 2 summarizes the design capacity that corresponds to the available machine. Considering the production time of 119,760 minutes and the time needed for the molding process of each product, which is 17 minutes to make a small size, 20 minutes to make a medium size, and 60 minutes to make a large size, the design capacity of CV XYZ is 21,134 pcs/year for small size products, 23,952 pcs/year for medium size products, and 1,996 pcs/year for large size products.

Effective Capacity

Allowance time in CV XYZ 17%.The effective capacity is 83% of the design capacity.

Table 3. Effective Capacity for Each Product Size

Mold Size	Design Capacity	Effective Capacity (83%)
Small	21,134 pcs	17,541 pcs
Medium	23,952 pcs	19,880 pcs
Large	1,996 pcs	1,657 pcs

Table 3 summarizes the effective capacity of each size, which is 83% of each design capacity. Effective capacity refers to the maximum output that can be realistically achieved. Therefore, the effective capacity is 17,541 pcs of small product, which is 83% of 21,134 pcs of the small product design capacity; 19,880 pcs of medium product, which is 83% of 23,952 pcs of the medium product design capacity; and 1,657 pcs of large product, which is 83% of 1,996 pcs of the large product design capacity.

Actual Demand

Based on the purchase order documents, CV XYZ issued 45 purchase orders in 2023, an average of 4 each month. The average time between purchase order issuance and the scheduled delivery date is 55 days.

Table 4. Summary of Purchase Orders of 2023 in CV XYZ.

Month	Product Size		
	Small	Medium	Large
January 2023	25	93	0
February 2023	52	0	0
March 2023	1,795	3,342	204
April 2023	2,537	2,417	160
May 2023	4,750	2,168	192
June 2023	1,772	2,119	186
July 2023	151	982	80
August 2023	800	886	10
September 2023	936	1,119	108
October 2023	578	2,048	58
November 2023	494	988	56
December 2023	40	60	20
Total	13,930	16,222	1,074
Average	1,161	1,352	90

Table 4 summarizes the quantity of each product ordered in CV XYZ. The product could be classified by size as small, medium, or large. Cushions, Grommets, Rubber, Rubber Isolators, and Washer Rubber fall into the small-sized product category. Clamps fall into the medium-sized product category, while Hold Fast is categorized as a large-sized product. The size of the product will determine the size of the molding and the time needed for each stage of the process. The amount of product ordered in each size category is summed to determine the number of demand. To examine whether CV XYZ can realistically fulfill the demand, the actual demand must be compared with effective capacity. 18.857

Table 5. Demand and Effective Capacity Comparison

Size	Actual Demand	Effective Capacity	Remark
Small	13,930 pcs	17,541 pcs	Demand < Effective capacity
Medium	16,222 pcs	19,880 pcs	Demand < Effective capacity
Large	1,074 pcs	1,657 pcs	Demand < Effective capacity

Table 5 shows the actual demand for each product size category is less than its effective capacity (13,930 pcs < 17,541 pcs; 16,222 pcs < 19,880 pcs; and 1,074 pcs < 1,657 pcs). This signifies that CV XYZ's current effective capacity is enough to fulfill the demand within the planned operational hours, as there is no record of loss orders and overtime. This will eliminate the need for overtime wages, which add to the operational cost. On the other hand, when the demand is less than the effective capacity, it means that the business can produce more than what is currently needed by customers, which is presently only PT ABC due to the contract. In this scenario, the production facilities and workforce are not being used to their fullest extent because the current demand does not require them.

Capacity Utilization Rate

Table 6. Capacity Utilization Rate

Size	Design Capacity	Actual Output	Utilization Rate
Small	21,134 pcs	13,930 pcs	65.91%
Medium	23,952 pcs	16,222 pcs	67.73%
Large	1,996 pcs	1,074 pcs	53.81%

Table 6 summarizes the utilization rate of CV XYZ's production in 2023. For the small size, the utilization rate is 65.91%, indicating that from a design capacity of 21,134 pcs, only 13,930 pcs were produced. This means that 34.09% of the design capacity, or approximately 7,204 pcs, was not utilized. For the medium size, the utilization rate is 67.73%, meaning that from a design capacity of 23,952 pcs, only 16,222 pcs were produced. Therefore, 32.27% of the design capacity, or approximately 7,730 pcs, was not utilized. For the large size, the utilization rate is 53.81%, showing that from a design capacity of 1,996 pcs, only 1,074 pcs were produced. This means that 46.19% of the design capacity, or around 922 pcs, was not utilized.

Capacity Efficiency Rate

Table 7. Capacity Efficiency Rate

Size	Effective Capacity	Actual Output	Efficiency Rate
Small	17,541 pcs	13,930 pcs	79.41%
Medium	19,880 pcs	16,222 pcs	81.59%
Large	1,657 pcs	1,074 pcs	64.82%

Table 7 summarizes the efficiency rate of CV XYZ's production in 2023. For the small size, the efficiency rate is 79.41%, suggesting that from an effective capacity of 17,541 pcs, only 13,930 pcs were produced. This shows that 20.59% of the effective capacity, or around 3,611 pcs, was inefficient. For the medium size, the efficiency rate is 81.59%, indicating that from an effective capacity of 19,880 pcs, only 16,222 pcs were produced. This reflects that 18.41% of the effective capacity, or around 3,658 pcs, was inefficient. For the large size, the efficiency rate is 64.82%, implying that from an effective capacity of 1,657 pcs, the expected production was about 1,074 pcs. This indicates that 35.18% of the effective capacity, or approximately 583 pcs, was inefficient. Overall, the small-size category has reasonably good utilization and efficiency rates. The medium-size category performs the best in terms of both utilization and efficiency. The large-size category faces the most significant challenges in utilization and efficiency, with higher percentages and quantities of pcs that were not utilized and were inefficient compared to the other categories.

Process Mapping

Business Process Model Notation

The Business Process Modelling Notation (BPMN) shows the processes in CV XYZ's rubber compound division and finished goods division, which acts as the specifier of the process mentioned in the SIPOC diagram. This section only covers the process of the rubber compound division's purchase order.

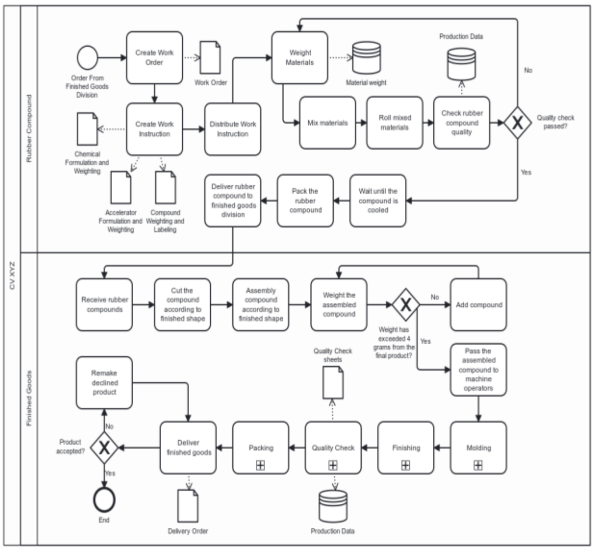

Figure 1. BPMN of CV XYZ's Rubber Compound and Finished Goods

The BPMN in Figure 1 provides a detailed workflow of the production process for rubber compounds and finished goods at CV XYZ, divided into two main sections: rubber compound and finished goods. In the rubber compound section, the process begins with an order from the finished goods division. The order to the rubber compound division will be done a day before the finished goods division's production schedule to ensure no waste in waiting due to delays in material supply. The order is leading to the creation of work orders and instructions. Materials, including accelerators and rubbers, are then weighed, labeled, mixed, and rolled. After cooling, the rubber compound undergoes a quality check. If it passes, the compound is packed and delivered to the finished goods division; if it fails, re-production will be made.

In the finished goods section, the received rubber compounds are cut according to specifications and assembled according to the final product shape. The assembled compounds are weighed, and if the weight does not exceed the tolerance yet (4 grams), an additional compound cut is added. This is necessary to ensure the product will not be defective or, in this case, is categorized as NG or "Not Good" because air bubbles are trapped in the molding because the mold is not filled compactly. The compounds then undergo the molding process by machine operators and the finishing process by the laborer with expertise in cutting out excess rubber. Finished goods are subjected to a final quality control check by measuring areas that are subjected to upper and lower specification limits. After the measurement is written in the quality check sheet report, products are packed and labeled. If the quantity is already sufficient, the product will be delivered based on delivery orders. The process incorporates various checks to ensure product quality and compliance with standards, ensuring a streamlined production flow from raw materials to final delivery.

Lean Manufacturing Waste Analysis

Table 8. Current Process Measurement

Process	Size	Min. Waiting Time (mins)	Max. Waiting Time (mins)	Avg Waiting Time (mins)	Processing Time (mins)
Cutting	Small (24 pcs)	0	0	0	48
	Medium (24 pcs)	0	0	0	120
	Large (6 pcs)	0	0	0	90
Molding	Small (24 pcs)	0	1	0.5	408
	Medium (24 pcs)	0	1	0.5	480
	Large (6 pcs)	0	1	0.5	360

Finishing	Small (24 pcs)	960	960	960	48
	Medium (24 pcs)	960	960	960	120
	Large (6 pcs)	960	960	960	48
Quality Check	Small (24 pcs)	0	1	0.5	24
	Medium (24 pcs)	0	1	0.5	72
	Large (6 pcs)	0	1	0.5	12
Finishing	Small (24 pcs)	1	39	40	3
	Medium (24 pcs)	1	39	40	5
	Large (6 pcs)	1	39	40	12

Table 8 summarizes the current process measurement, which is the minimum waiting time, maximum waiting time, average waiting time, and processing time of each product size. Value stream mapping is performed to illustrate the flow of the production process based on the measured current process. The time used for the mapping is for producing 24 pcs of small-sized and medium-sized products due to its packing that was done in batches. In contrast, for large-sized products, the time needed for processing 6 pcs will be used due to its singular packaging and is the maximum output in a day. The time used is for production using one machine with the condition of 1 operator for each machine.

Value Stream Map

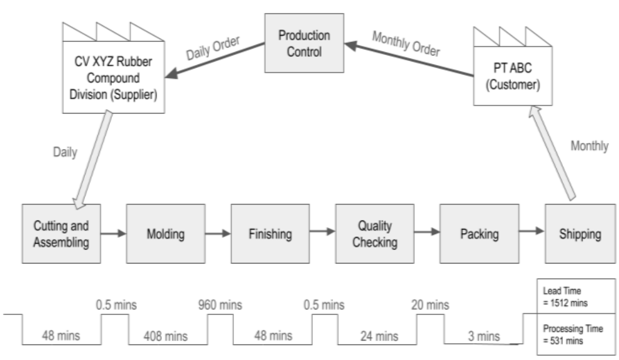

Figure 2. Value Stream Map of Small Product

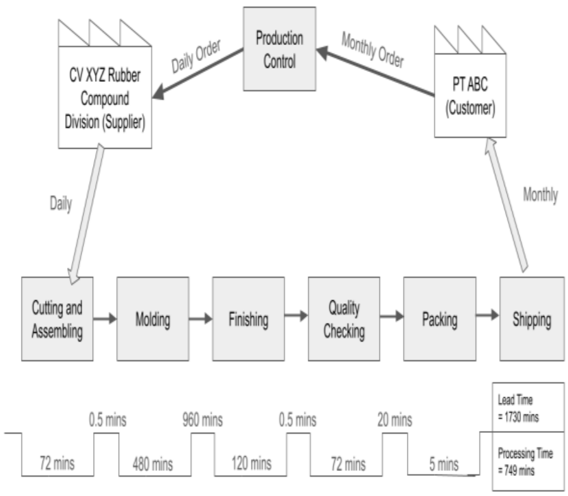

Figure 3. Value Stream Map of Medium Product

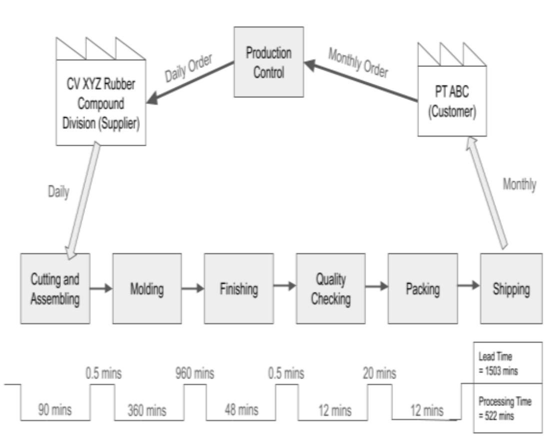

Figure 4. Value Stream Map of Large Product

Based on the value stream mapping on Figure 2, Figure 3, and Figure 4, there are 4 waiting wastes: 0.5 minutes between the cutting and molding process, 960 minutes between the molding and finishing process, 0.5 minutes between the finishing and quality check process, and 20 minutes between the quality check and packing process. Due to laborers being idle during the vulcanization phase in the molding process, there is waste for an average of 0.5 minutes waiting for the molding laborer to arrive at the molding machine. After the molding process, there is a waiting waste of 960 minutes due to the regular working hours already passed, so the laborers are dismissed. Because of that, the next process, which is finishing, can only be resumed on the next day. Due to waiting for approval in the quality check process, there is waiting waste for an average of 0.5 minutes. In the packing process, there is an average of 20 minutes of waiting waste due to unprinted labels for packing. For improvement, the 960-minute waste is ignored in the waste analysis because it is related to the working hours limit. Although the vulcanizing phase in the molding process is considered a value-added activity (processing time), labor is idle during rubber vulcanizing.

Table 9. Time Breakdown of Each Task in the Molding Process

Size	Vulcanizing time (laborer idle)	Total molding process time
Small	14 minutes	17 minutes
Medium	15 minutes	20 minutes
Large	50 minutes	60 minutes

Table 9 compares the vulcanizing time to the total molding process time. It can be seen that throughout the total of 17 minutes of the molding process for small-sized products, the labor only does processing for 3 minutes; from the total of 20 minutes of the molding process for medium-sized products, the labor only does processing for 5 minutes; and from the total of 60 minutes of the molding process for large–sized products, the labor only does processing for 10 minutes.

Table 10. Waiting Waste and Frequency

Process	Sub-process	Size	Waiting Waste	Frequency
Molding	Take out rubber from the mold	Small	0.5 minutes	Every several sub-process
		Medium	0.5 minutes	
		Large	0.5 minutes	
	Vulcanization	Small	14 minutes	Every sub-process
		Medium	15 minutes	
		Large	50 minutes	
Quality Check	Mark quality check sheet	Small	0.5 minutes	Every sub-process
		Medium	0.5 minutes	
		Large	0.5 minutes	
Packing	Attach label	Small	20 minutes	Every several days
		Medium	20 minutes	
		Large	20 minutes	

Table 10 summarizes the time of waiting waste on each subprocess for each product size and the frequency of occurrence. From its duration and frequency of occurrence, idle time due to waiting for the rubber to be fully vulcanized is more critical to be solved.

Workload Analysis

Workload analysis will assess whether the number of existing workers is adequate, excessive, or deficiencies. The initial calculation in capacity analysis (Table 1) shows that in 2023, CV XYZ has 119,760 minutes of effective work time. Furthermore, it is necessary to determine the time tolerance during effective work time. This analysis includes data collection about the time spent on various tasks and comparing them with the effective work time available. In this way, it can be identified whether there is an imbalance in the workload distribution and whether there is a need to rearrange the task or increase/reduce the amount of labor to achieve optimal efficiency.

Table 11. Percentage of Allowance Time in CV XYZ.

Types of Allowances	Description	Percentage
Personal allowances	Going to the washroom, drinking, etc	5%
Fatigue allowances	Relaxation to recover from fatigue due to standing on two feet, tediousness, and high temperature	12%
Total		17%

After determining the effective work time and tolerance time, the next step is to record and calculate the time needed to complete the workload. This involves collecting data on the duration of each task and activity carried out by the workforce to ensure that all the time required is accurately recorded. This data is then used to evaluate whether the current workload can be completed in the available work time or whether there is a need for adjustments in time and resource allocation.

Table 12. Total Time to Complete Activities

Activity	Size	Time/pc (mins)	Quantity (pcs)	Total Time (mins)
Cutting	Small	2	13930	92,636
	Medium	3	16222	
	Large	15	1074	
Molding	Small	3	13930	133,640
	Medium	5	16222	
	Large	10	1074	
Finishing	Small	2	13930	117,562
	Medium	5	16222	
	Large	8	1074	
Quality checking	Small	1	13930	64,744
	Medium	3	16222	
	Large	2	1074	
Packing	Small	0.125	13930	7,269
	Medium	0.208	16222	
	Large	2	1074	

Table 12 shows a summary of the activity and time required. The time to make one product refers to time when workers actively perform tasks in the production process. Quantity refers to the total number of products ordered according to the 2023 purchase order document on CV XYZ. The total time is calculated by multiplying the processing time with the number of each size, which is then added as the total time for the process. After that, the total activity time and tolerance time for each worker are used to calculate the Full-Time Equivalent (FTE) index. This FTE index is important to assess whether the current labor is sufficient, excessive, or less in meeting production needs. With this analysis, companies can identify areas that require adjustments in the distribution of workloads, so as to optimize operational efficiency and reduce the potential for inefficiency in the production process. This evaluation helps in ensuring that human resources are used effectively to achieve the desired production goals.

Table 13. Workload Category Based on FTE Index

Role/Title	FTE Index	Category
Cutting 1	0.56	Underload
Cutting 2	0.56	Underload
Molding 1	0.40	Underload
Molding 2	0.29	Underload
Molding 3	0.26	Underload
Molding 4	0.51	Underload
Molding 5	0.51	Underload
Finishing and packing	1.21	Normal
Quality check	0.71	Underload

Table 13 indicates that CV XYZ overstaffed the finished goods division laborer. Eight laborers in charge of cutting, molding, and quality checks had an FTE index in the range of 0.00 – 0.99, which is considered under load. On the other hand, the finishing laborer, with an FTE index of 1.21, had a normal workload.

Proposed Solution

Proposed Business Process Reengineering

To increase operational efficiency and reduce costs, CV XYZ has proposed several solutions that focus on re -engineering business processes. This re -engineering aims to optimize the use of labor and reduce unproductive waiting times. One of the main changes proposed is the merging of operations or elements in the production process. Table 14 below summarizes the expected improvement from the proposed business process.

Table 14. Business Process Reengineering Improvement

Systematic Reengineering	Current Process	Proposed Process	Improvement Result	Notes
Combine Operations or Elements	Each molding laborer is responsible for operating one machine.	Each molding laborer is responsible for operating 1-2 machines simultaneously.	Reduced waiting waste (idle time)	Each laborer needs to be equipped with finishing scissors and be taught on how to do the finishing.
			Reduced the number of labor	
	Finishing is done by another labor.	Each molding laborer will do the finishing during vulcanization.	Increased FTE index	

Table 14 suggests that the manufacturing process can be significantly optimized by combining operations or elements. In the current setup, each task is performed sequentially, with separate laborers for each stage, leading to idle times. The proposed changes involve multitasking to use idle time during the vulcanization process. By having machine operators also perform finishing tasks while waiting, the plant can reduce the number of laborers required and minimize idle time and lead time. Performing finishing 1 product while waiting for 1 product to be fully vulcanized still provides time to be idle. Thus, it is suggested that a laborer handles more than one machine. The workload distribution and specification can be seen in the description column in Table 4.16. Successfully implementing these changes requires equipping laborers with the necessary tools and providing adequate training to ensure they can effectively handle multiple tasks.

Proposed Business Process Model Notation

To increase efficiency and reduce waiting time in the production process, CV XYZ has proposed a new business process notation model. Figure 5 shows the proposed Business Process Model (BPMN). This model maintains the same sequence of tasks, ranging from receiving rubber compounds to shipping compounds that have been assembled weighing more than 4 grams to engine operators. At this stage, the proposed process is different from the previous parallel process by combining the printing and finishing process carried out by the hydraulic press machine operator. Products that have been printed and completed will undergo a quality checking process until the product sent is received, the process remains the same as the current process.

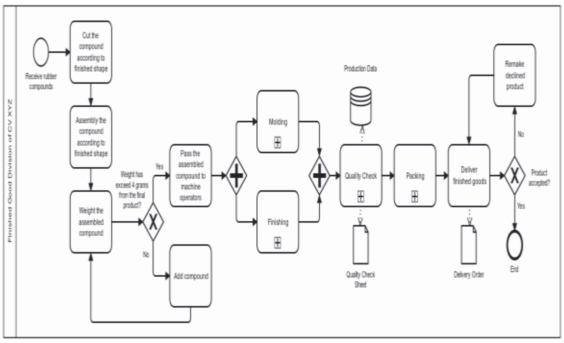

Figure 5. Proposed BPMN

Figure 5 is the proposed Business Process Model Notation. It still has the same sequence of tasks, from receiving the rubber compounds to passing the assembled compound, which weight already exceeds 4 grams from the final product to the machine operators. From here, the process differs from the parallel process by combining the molding and finishing processes undergone by the hydraulic press machine operators. The molded and finished work in progress will then be performed quality check process until the delivered products are accepted, which process is still the same as the current process.

Proposed Value Stream Map

To further increase production efficiency and reduce process time, CV XYZ has developed a new value stream map. Figure 6, Figure 7, and Figure 8 Each shows the proposed value flow map for small, medium, and large products. The combination of the printing and finishing process has produced a shorter processing time and lead time due to the use of idle time during the printing process. Table 4.15 summarizes the comparison of lead time and processing time between the current process and the proposed process, showing significant increases in efficiency.

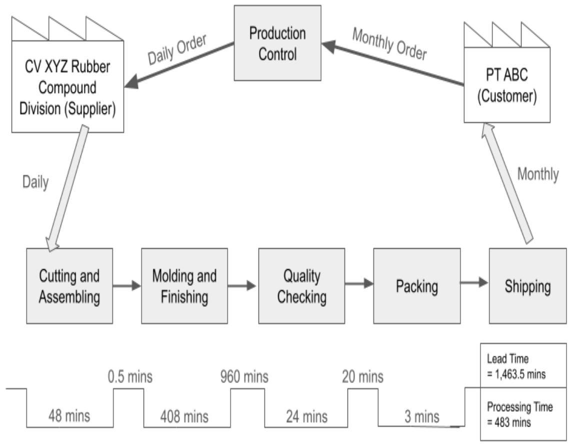

Figure 6. Proposed Value Stream Map of Small Product

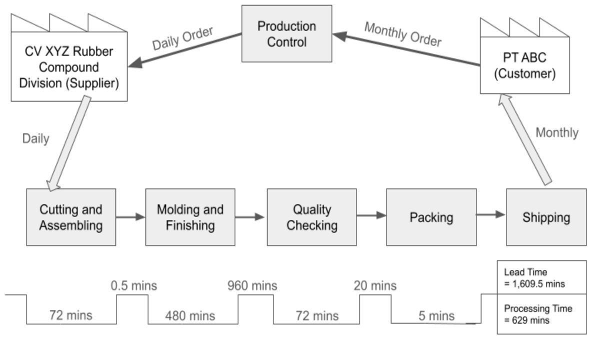

Figure 7. Proposed Value Stream Map of Medium Product

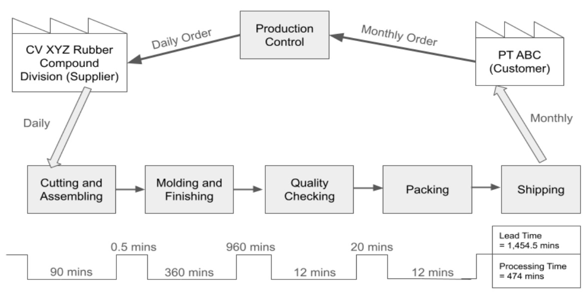

Figure 8. Proposed Value Stream Map of Large Product

Figure 6, Figure 7, and Figure 8, respectively, are the proposed value stream maps for small, medium, and large sizes. The combination of molding and finishing processes has resulted in shorter processing time and lead time due to the utilization of idle time during the molding process. Table 15 summarizes the comparison of the lead time and processing time of the current process with the proposed process.

Table 15. Lead Time and Processing Time Current-Proposed Comparison

	Lead Time (minutes)			Processing Time (minutes)		
	Small *(for 24 pcs)*	Medium *(for 24 pcs)*	Large *(for 6 pcs)*	Small *(for 24 pcs)*	Medium *(for 24 pcs)*	Large *(for 6 pcs)*
Current	1512	1730	1503	531	749	522
Proposed	1463.5	1609.5	1454.5	483	629	474
% Reduced	3.21%	6.97%	3.23%	9.04%	16.02%	9.20%

Proposed Number of Worker

Based on the business process reengineering in Table 15, the new FTE is calculated, and the optimum number of workers can be suggested. The proposed number of laborers is 6, with the proposed FTE index from the re-engineered business process specified as follows.

Table 16. Suggested FTE Index

Role/Title	FTE	Category	Description
Cutting 1	0.94	Underload	
Molding & finishing 1	0.53	Underload	Molding and finishing large size 100%, molding and finishing small size 33%
Molding & finishing 2	0.85	Underload	Molding and finishing medium size 50%
Molding & finishing 3	0.85	Underload	Molding and finishing medium size 50%
Molding & finishing 4	0.56	Underload	Molding and finishing small size 67%
Quality check and packing	0.77	Underload	

Table 16 summarizes the suggested FTE index. Initially, CV XYZ had nine laborers in the finished goods division. The proposed business process reengineering was then used to recalculate the FTE in Table 4.16, which shows that reducing the number of laborers to 6 can be made. The proposed FTE is done by calculating new time on the new workload, adding it with the allowance time, and dividing it by the total available time. The new workload is specified in the description column in Table 4.16. Although the category is still under load, the FTE indexes increased. It is best to avoid motion waste and reduce the dependability on the machine operators. This proposed solution allows CV XYZ to save 33% of direct labor costs, which cost Rp 125.730.000,00 a year.

Conclusion

Because CV XYZ has enough production machines, it can meet demand during scheduled operating hours and avoid paying overtime. Nonetheless, the most common kind of waste in the industrial process is waiting waste. Waiting for the rubber to fully vulcanize during the molding process is one form of waiting waste that occurs. Eight laborers are underloaded and one worker is overloaded, according to workload analysis using the Full-Time-Equivalent index. Additionally, the investigation reveals bottlenecks in the finishing process and an uneven workload distribution. Combining the operational components with the worker's finishing process, which changes the order of work, can cut down on waiting waste, labor idle time, and overall process lead-time. Through the use of that procedure, CV XYZ was able to cut its workforce from nine to six, saving Rp 125.730.000,00 annually on direct labor costs.

To make sure that the personnel, procedure, and capacity can satisfy client demand, more investigation into demand forecasting in CV XYZ is advised. When demand is forecasted properly, CV XYZ can minimize inventory and overproduction waste, as well as minimize and prevent order loss during spikes in demand. It is also advised that more study be done on the effects of 7 production waste on the operational component of the operational cost structure in order to assist CV XYZ in boosting operational profitability.

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