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Zero Waste Production Coconut Charcoal Syam Saputro Kudus with Lean Manufacturing Implementation

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Abstract
Export demand for coconut charcoal always increases from year to year. According to data from the Badan Pusat Statistik (BPS), the export value of coconut charcoal rose by 4.69%, increase from USD 145.1 million in 2019 to USD 151.9 million in 2020. Indonesia exported 188,050 tons of coconut charcoal, with the export value totaling USD 145.09 million. So, this requires producers to be able to meet export demand. Syam Saputro Kudus is a producer of coconut charcoal which is exported to various countries. The production capacity of this charcoal factory is approximately 240 tons per month. From this production capacity, Syam Saputro Kudus has set a production target of 200 tons per month. Unfortunately, from existing data it is found that the company has not been able to meet the production target. Failure to achieve production targets was caused by transportation, inventory, deffect and over processing problems. This is a fundamental problem for a producer in meeting production targets. This study aims to apply lean manufacturing through the use of Cost-Based Value Stream Mapping (Cost-VSM) method, so that it can be a solution for Syam Saputro Kudus in meeting production targets. Meanwhile, the expected outcome of this research is the creation of a future VSM model which can be used as a reference for entrepreneurs in minimizing non-value-added activities so as to achieve efficiency to increase productivity.

INTRODUCTION

One of the rapidly growing processing industry commodities is the coconut charcoal industry. According to data from the Badan Pusat Statistik (BPS), the export value of coconut charcoal rose by 4.69%, increase from USD 145.1 million in 2019 to USD 151.9 million in 2020. According to statistics from the Badan Pusat Statistik (BPS) compiled by the Directorate General of Plantations in 2019, Indonesia exported 188,050 tons of coconut charcoal, valued at USD 145.09 million (Ditjenbun, 2021).

Syam Saputro Kudus was established on August 18, 2017, in Kudus, Central Java. This company specializes in producing coconut shell briquette charcoal for shisha or hookah. The production strategy used by this company is make-to-order (MTO). The product produced by this company is only one type with sizes according to demand. There are several standard size codes that are the company's production references, namely 2.2, 2.5, and 2.6. The products produced by Syam Saputro Kudus are specifically for export to Europe and Middle Eastern countries.

The production of coconut charcoal consists of several processes: sorting, grinding, mixing, cooking, molding and cutting, oven drying, cooling, and packaging. The production capacity of this charcoal factory is approximately 240 tons per month. From this production capacity, Syam Saputro Kudus sets a production target of 200 tons each month. However, it was shown that the company has not been able to meet the production target.

Based on the obtained data, Syam Saputro Kudus's production from January to October 2023 had an average production target achievement rate of 81.05%. Interviews and observations at the company with production personnel revealed that the failure to meet production targets was due to issues related to transportation, inventory, defects, and over processing.

Several issues contribute to transportation problems, such as the considerable distance between different processing areas and the reliance on manual labor, which requires additional workers to move processed goods. Additionally, the company faces inventory-related challenges, including insufficient stock of finished products and an excessive amount of work-in-process materials within the production line. Defects are also still frequently found during production, particularly in the cooking and cutting stages. These defects lead to over processing, as rework must be carried out to correct the issues.

Based on the issues mentioned above, the root causes of waste in the production process have been identified. Therefore, improvements are needed on the production floor using a lean approach to minimize production costs and increase productivity (Asmal et al., 2023; Ossei-Bremang et al., 2023; Spirio et al., 2024). Lean can reduce non-value-adding activities and enhance productivity. Lean is a systematic approach focusing on continuous improvement in quality, cost, and delivery by striving to eliminate all types of waste, ensuring smooth process flow, and improving the system's responsiveness to customer needs (Bernhard et al., 2023; Costa et al., 2024; Hizam et al., 2024). The lean approach used in the production line is called lean manufacturing. The main goal of lean manufacturing is continuous improvement by maximizing value for customers and eliminating the seven wastes to increase company profits (Bernhard et al., 2023; Hizam et al., 2024).

Value Stream Mapping is used to identify all activities in the production process, from raw materials to finished goods (Kundgol et al., 2019). In the VSM method, activities or processes that have value-added and those that do not have value-added can be identified (Dinesh et al., 2022; Rahima Shabeen & Aravind Krishnan, 2022). The use of VSM, which is considered appropriate for lean, has led to its development and integration with various aspects, one of which is cost. The integration between cost aspects and VSM uses the Activity Based Costing (ABC) method (Magnus & Venschott, 2024; Mohan Prasad et al., 2020; Wiese et al., 2022). Integrating costs in this way enables the identification of unnecessary expenses and activities, making it more effective for management to gain insights into the processes or actions that drive costs (Kosasih et al., 2020). By identifying value-added and non-value-added activities within the production process, the company can implement targeted improvements to achieve its production goals. Therefore, integrating Value Stream Mapping (VSM) with cost analysis is essential for Syam Saputro Kudus.

RESEARCH METHODS

The object of this research is Syam Saputro Kudus, located in Central Java. Syam Saputro Kudus is a manufacturing industry that produces coconut shell briquette charcoal specifically for shisha. This research was conducted from the end of 2023 until its completion. Data collection method in this study was carried out through monitoring and communication study. During monitoring, the researcher conducted direct observations on the production floor, while the communication study was used to obtain information through interviews with company representatives. Time dimension used in this research is cross-sectional, as it was conducted over a specific period. The scope and depth of the study in this research constitute a case study. The data processing in this research will yield quantitative data, which will be analyzed descriptively to determine appropriate recommendations and improvement strategies to address the company's problems.

RESULTS AND DISCUSSION

In the process of producing coconut charcoal at Syam Saputro Kudus, there are 8 main processes, divided into 8 workstations. The total production time is 311.6 hours, with production process time of 128 hours, and a lead time of 183.6 hours.

The production process is analyzed using a flow process chart, which provides a detailed overview of the entire workflow. This chart highlights key elements such as operation time, waiting periods (delays), transportation, storage, and inspection activities.

Table 1. Production Time Calculation

No.	Process	Process Time	VA Time	NVA Time	NNVA Time
1	Sorting Workstation	308,9	251,0	57,9	0
2	Grinding Workstation	469,6	428,6	41,1	0
3	Mixing Workstation	549,7	289,7	123,6	136,4
4	Cooking Workstation 1	577,0	547,9	29,1	0
5	Cooking Workstation 2	684,4	432,8	41,6	210
6	Molding and Cutting Workstation	895,9	532,9	123	240
7	Oven Drying Workstation	3625,4	3619,5	5,9	0
8	Packaging Workstation	568,2	485,7	60,1	22,3
	Total	7679,0	6408,1	482,2	788,7

A critical component of this analysis is the cost line within the cost-integrated value stream mapping. The cost analysis focuses on two primary types of costs: activity costs, which are directly tied to performing specific tasks, and holding costs, which arise from storing inventory over time.

Table 2. Cost Line Calculation

No.	Process	Holding Cost		Description	Total Activity Cost	
1	Sorting Workstation	Rp	6,400,000	Raw material	Rp	52,225,914
2	Grinding Workstation	Rp	1,200,000	WIP between sorting and grinding	Rp	628,848
3	Mixing Workstation		-	-	Rp	3,845,882
4	Cooking Workstation 1		-	-	Rp	346,774
5	Cooking Workstation 2		-	-	Rp	407,894
6	Molding and Cutting Workstation		-	-	Rp	959,250
7	Oven Drying Workstation	Rp	600,000	WIP between molding-cutting and oven drying	Rp	1,394,769
8	Packaging Workstation	Rp	22,800,000	Finished good	Rp	2,195,496
	Total	Rp	23,400,000		Rp	62,004,827

Based on this analysis, the Current Cost-Value Stream Mapping can be illustrated to clearly identify process inefficiencies and cost drivers within the production flow.

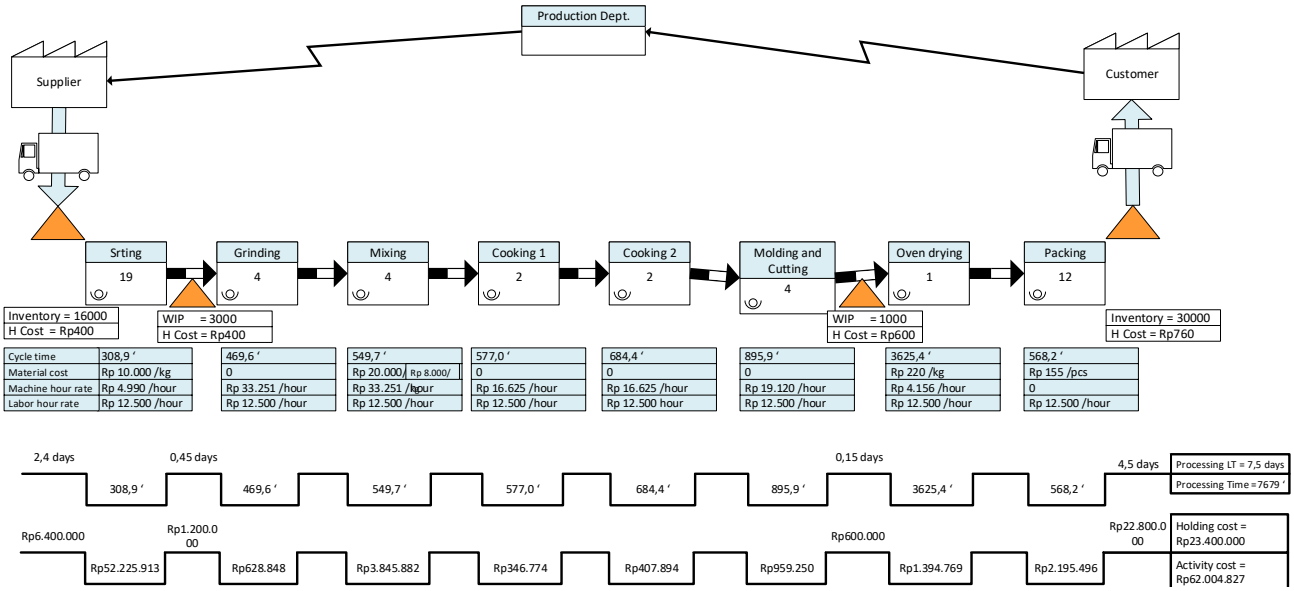

Figure 1. Current Cost-Value Stream Mapping

From the current state value stream mapping, each operator's activity was carefully detailed to identify inefficiencies within the production flow. As a result, several types of waste were identified. These include inventory waste from excessive storage and work-in-progress (WIP), transportation waste due to frequent manual handling between workstations, and over-processing waste caused by minor discrepancies in the production recipe. These findings highlight the need for process standardization and workflow optimization to improve overall efficiency.

Table 3. Total Types of Production Process Activities

No.	Proses	VA	NVA	NNVA
1.	Sorting Workstation	4	4	0
2.	Grinding Workstation	4	3	0
3.	Mixing Workstation	4	3	1
4.	Cooking Workstation 1	4	2	1
5.	Cooking Workstation 2	4	3	1
6.	Molding and Cutting Workstation	6	3	1
7.	Oven Drying Workstation	3	1	1
8.	Packaging Workstation	1	2	1
	Total	30	21	6

There are facts that the raw material procurement method has not been properly executed. Therefore, in this improvement recommendation, we will reduce inventory waste using the EOQ lot sizing technique. The improvement aims to reduce total production costs. Total production costs decrease by 1% compared to previous costs. The decrease in production costs will impact Syam Saputro Kudus's profit margin.

From the identified wastes, several improvement recommendations are obtained for implementation in future value stream mapping. Firstly, inventory waste is generated from storing coconut charcoal raw materials, inventory waste during sorting and crushing, inventory waste between molding and cutting, and storing finished products. The second type of waste is waiting time caused by inefficient operator activities such as machine setup or leaving workstations. The last type of waste is transportation, resulting from manual material handling between workstations. The final type of waste is over processing due to recipe errors.

https://journal.umy.ac.id/index.php/st/issue/view/1148

The recommendations of this study for Syam Saputro Kudus include first reducing coconut charcoal raw material inventory to cut storage costs and lead time. EOQ calculations indicate that the company will make only two orders over the next seven days. Additionally, the average daily storage volume has decreased to 17,675 kg over the last 7 days (Dinesh et al., 2022; Rahima Shabeen & Aravind Krishnan, 2022). Furthermore, reducing staff at the sorting workstation is also recommended (Ossei-Bremang et al., 2023; Utama & Abirfatin, 2023). Since the appropriate number of employees is 9, Syam Saputro Kudus is advised to reduce its workforce by 10 people. With fewer employees, the sorting workstation will not experience overproduction leading to WIP. The main reason for waste in storage is uncertainty about ship delivery times, which means goods are shipped to the port waiting for delivery dates. Given that storing finished products in the port warehouse will incur additional costs, initially, the company chose to store them at the factory.

Improvements for the second waste include improving setup times using SMED techniques, conducting performance evaluations, and implementing rewards and punishments for employee performance to reduce inefficient operator activities (Alves e Silva et al., 2024; Costa et al., 2024; Kundgol et al., 2019). The goal of performance evaluation is to ensure employees work more orderly and avoid leaving workstations during working hours.

The third waste can be addressed by providing industrial trucks in the form of carts with a carrying capacity of 300-500 kg. Carts allow carrying at least five bags at a time, making transportation faster. It is recommended to address the last waste by conducting simple laboratory tests to assess acceptable material samples before starting the process (Alves e Silva et al., 2024; Dinesh et al., 2022).

Next, we create a future cost-integrated value stream map from several improvement proposals and illustrate the production process after the improvements.

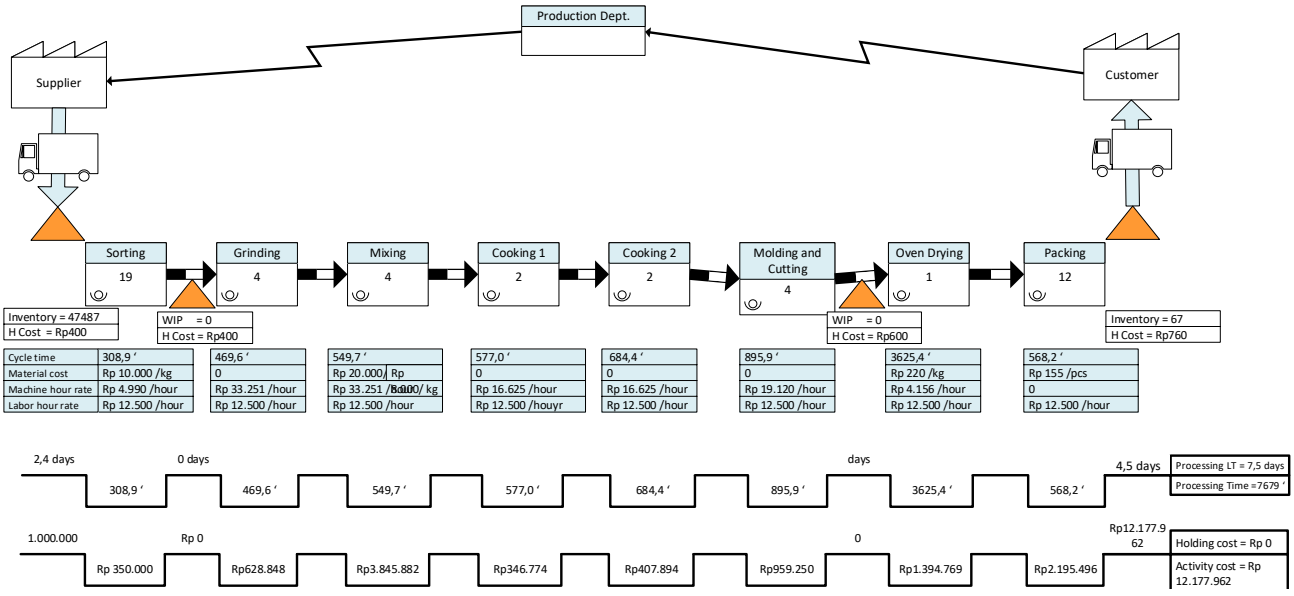

Figure 2. Future Cost-Value Stream Mapping

Based on the improvements implemented, we found that the total production time has decreased by 21.3% or 3988.38 minutes compared to the total production time before. This reduction is due to decreased inventory of raw materials and work in process between the sorting and crushing stations. Improvements in the Future Value Stream Mapping have also been observed to reduce total production costs. Total production costs have decreased by 1% from the previous costs, amounting to Rp608,120.

CONCLUSION

Based on the calculations and discussions, it is found that in the process of producing coconut charcoal, Syam Saputro Kudus has 8 main processes divided into 8 workstations, with a total production time of 18,694.5 minutes or 12.98 days. Based on the identification, 29 value-adding activities were identified, requiring 5,688.1 minutes, with a batch cost of Rp 60,576,719. There are 23 non-value-adding activities, requiring 11,497.7 minutes, with a batch cost of Rp 1,646,152. There are also 6 mandatory but non-value-adding activities with a duration of 1,508.7 minutes and a batch cost of Rp 681,954.

From the identification conducted in the coconut charcoal production process at Syam Saputro Kudus, four types of waste were identified: waiting, transportation, inventory, and over processing. Waiting waste includes 10 activities costing Rp 258,409. Transportation waste includes 12 activities costing Rp 459,993. There is only one over processing activity costing Rp 27,750. The largest waste is inventory, consisting of four activities costing Rp 900,000.

Recommendations for raw material storage are provided using the EOQ method. Further recommendations are made to calculate the number of workers to reduce WIP between the sorting and crushing workstations. Performance evaluation and SMED technique implementation recommendations are provided to address unnecessary waiting times. For transportation waste, the recommendation is to use carts as transportation tools. Lastly, for over processing waste, it is recommended to conduct laboratory testing on incoming materials to obtain appropriate recipes.

Based on the improvement recommendations provided, in the Future Value Stream Mapping, the total production time at Syam Saputro Kudus has decreased by 21% or 3,988.38 minutes. Total production costs have also decreased by 1% or Rp 608,120.

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