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Lean Manufacturing Implementation in Indonesian Coffee Processor

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***Abstract*—The rapid competition between business and sustainability policy has encouraged the coffee industry in Indonesia to make their business more environmentally friendly. However, this initiative has yet to be fully underway. Several inefficiencies still prevail in Arabica coffee production sites, such as product defects in inventory, the inefficiency of production machine performance, and dependence on manpower that can increase the production and inventory costs. Therefore, the Arabica coffee agroindustry needs to improve its performance by addressing these issues in production activity using the lean manufacturing approach. Several tools proven influential to reduce waste in the agroindustry are Value Stream Mapping (VSM) and VALSAT. VSM could document the entire mapping of material and information management, but cannot classify the time required to complete the whole process. VALSAT has several derivative tools, but polyacrylamide (PAM) and Supply Chain Response Matrix (SCRM) are mostly used in agroindustry to classify value-added time of processes and illustrate the supply chain cumulative inventory of a company. The result of this study shows that the Indonesian Arabica coffee industry could reduce its cycle time by 57%, lead time by 63%, and changeover time by 50%. In addition, the recommendations result in the involvement of only 2 people during the drying process and eliminate the non-value-added time, while improving the overall production efficiency and capacity.**

Keywords— Coffee industry; Lean Manufacturing; Value Stream Mapping; Process Activity Mapping; Supply Chain Response Matrix.

I. Introduction

Arabica Coffee is one of the superior commodities in Indonesia which has a high degree of global competitiveness. The concept of sustainability has been stressed to build an environmentally friendly industry. The lean manufacturing approach is a concept that can support a company to improve its production performance by eliminating its waste. There are seven types of waste mostly recognized as a form of production inefficiencies, such as defect, overproduction, waiting time, transportation, inventory, motion, and excess processing [1]. For the past two years, the company has suffered from product defects in inventory as it incurs an inventory cost of approximately $2000 per year, and the production machine inefficiency extends the lead time by two to three times a day and therefore affects the service level received by customers. If those inefficiencies remain unsolved, then the company will face business failure.

In coffee company, there are several steps of production ranging from sorting, washing, pulping, fermentation, drying, hulling, to packaging [27]. The tool with the lean manufacturing concept can be used to detect waste by illustrating the process called Value Stream Mapping (VSM) [2][3]. Several studies have discovered the benefit of VSM in reducing production lead time, cycle time, work line, and the necessity for manpower [4] [5].

However, VSM cannot classify the time based on a product's value proposition. Therefore, it has to be supported by process activity tools, as the basis to supply chain response matrix and inform inventory cumulative to involved actors throughout the supply chain [6].

This paper aims to eliminate waste in the coffee agroindustry to elevate customer satisfaction by improving the efficiency of coffee production using VSM, Process Activity Mapping (PAM), and Supply Chain Response Matrix (SCRM) approaches.

II. Literature Review

A. Lean Manufacturing Concept and Tools

Lean manufacturing is a concept of waste elimination in the industrial sector. It aims at improving business performance while increasing customer satisfaction. By maintaining business effectiveness and efficiency as well as environmental consideration, the company will earn higher profit, prevent risks, and maintain its continuity [7,28]. Only a few companies are taking this step because this approach depends on the leadership's commitment to ensuring quality management [8].

Generally, there are several lean manufacturing tools known as managing transport, inventory, motion, waiting time, over-processing, overproduction, and defects waste such as 5S, VSM Total Productive Maintenance (TPM), Kaizen Blitz Events, Kanban, Just in Time, Setup Reduction, Poka Yoke and Value Stream Analysis Tools (VALSAT) [9] [10].

B. Value Stream Mapping

The VSM is a popular tool in lean manufacturing approach. It is used to determine business streams (information, and material), activity, lead time, resources, manpower use, takt time, and uptime of a business [11]. These strategies are mostly used to visualize the business process and identify waste through inefficient time through the current state mapping of VSM. Current state mapping will serve as the basis of company evaluation, and then the company will create a strategy to improve its performance which will be represented in future/proposed state mapping of VSM.

Several steps should be done to implement these tools [12]: (1) The first step is to identify the targeted products or services and determine the third party (supplier and distributor) related to the coffee company; (2) The next step is drawing the current mapping which shows the current process, delays, and required information concerning how the coffee is delivered to the customer (including the production process from raw material until finish product); (3) Third, it is imperative to analyze and evaluate the current state mapping in terms of waste selection and the strategy for eliminating the waste; (4) The fourth step is to draw the future map of VSM as it represents implemented recommendation on business process; (5) Eventually, it is important to maintain the continuous improvement through process efficiency.

C. Value Stream Analysis Tools

Other than VSM, VALSAT has arisen as a decent complementary strategy to draw and identify industrial waste. However, VALSAT shows stronger detail in classifying the stages into value-added, non-value-added, and non-value-added activities classification [1]. Before the whole process is accomplished, those stages will be divided into several types of activity such as operation (○), delay (D), transportation (⇨), storage (▽), and inspection (□). One of the VALSAT tools is called PAM (Table I).

TABLE I. PROCESS ACTIVITY MAPPING

Activities	**Type of Activity**				
	○	**D**	⇨	▽	□
Activities 1	…	…	…	…	…
Activities 2	…	…	…	…	…
Activities 3	…	…	…	…	…

After listing the process stage and classifying the activity, the next stage is accumulating the inventories of all related supply chain actors using another tool of VALSAT called Supply Chain Response Matrix (SCRM). SCRM is mostly used in manufacturing to figure the longest leading time taken by supply chain actors and reduce the lead time as well which will affect the service received by customers. Some companies use these tools combination to support their lean concept [6] [13].

At the outset of the research activity, the observation of the coffee industry products and organizational backgrounds was conducted. The observation focused on evaluating the tangible waste of the coffee industry. After that, literature review was carried out to find to eliminate the waste and improve business performance through efficiency improvement. There were some stages after accomplishing the literature review, such as collecting data on the waste and proposing recommendations.

To identify the waste, an interview with the coffee company was carried out to observe some tangible waste deemed impactful to the business. The next step was identifying the coffee industry processing in how the raw material (coffee seed) turned into the green bean and then recording the time required in every stage to create the current state mapping using VSM. After that, the waste was identified using the time classification of Process Activity Mapping and Supply Chain Response Matrix as the basis to develop the inventory waste.

D. Value Stream Mapping

There are several types of the time visualized in VSM, such as cycle time, changeover time, uptime, available time, takt time, and lead time. The definition of each time is hereby presented [4] [14]:

- Cycle time is the time needed to work in one lap process.
- Changeover time is the time between the first run of a production of a product to the second one.
- Available time is the amount of time needed by a company to complete the whole process in a day.
- Lead time is the accumulation of the whole activity time for all processes.
- Takt time is the operation time used in every unit of product.
- Uptime is the percentage ratio of the processing time against available time, as expressed in (1).

$$Uptime = \frac{Available\ time - Change\ over\ time}{Available\ time} \quad (1)$$

E. Waste Analysis

VSM aided in observing the waste. The next step is waste analysis to determine how to manage it properly. Moreover, it is important to think about effective and efficient recommendations for future practice and eliminating waste to make the future VSM more efficient.

F. Recommendations for Future VSM

The coffee company needs to ponder future VSM. This can help the company to realize how efficiently the process works.

G. Cost Analysis

Lastly, there is an accumulation of budgeting to find out how much a coffee company needs to invest on the recommendation to gain more benefits for his company.

III. RESULTS AND DISCUSSION

This research project aimed to analyze waste in the current condition and determine ways to mitigate waste in the future. Therefore, it starts with VSM current mapping and ends up with the projection of future VSM which will visualize the efficiency of business operations.

A. VSM Current State Mapping

The data on current state mapping was the available time of five hours. The production of green bean coffee was divided into eight steps (sorting, soaking, pulping, fermentation, washing, drying, hulling, and packaging). Every single step was analyzed to discover its cycle time and the overall changeover time. This small-medium coffee industry processes approximately 125 kg of coffee fruit on average per day during 4 months of harvest. In total, the annual production capacity is 15 tons. The yield obtained is in a ratio of 6 kg coffee cherry and 1 kg green bean, resulting in a total annual yield of 2.5 tons of green bean. Moreover, this coffee processing has been established for 20 years and always complied with the process standard directed by the local government and research center. However, there were slight inefficiencies identified at certain phases that would be visualized by the current VSM.

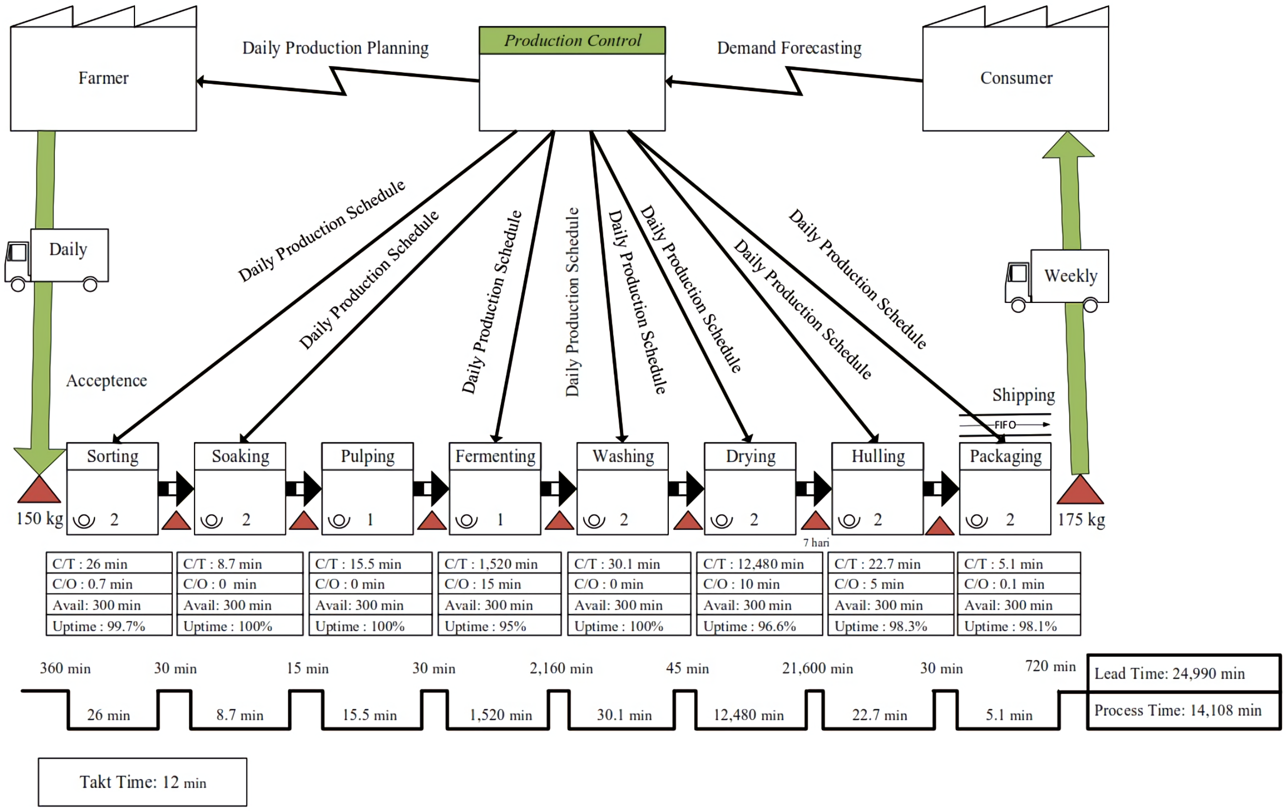

Fig. 1. Current SVM

Based on Fig. 1, the first production step was harvesting which requires 360 minutes. With 3 people working, it took 20 minutes to transport the coffee fruit to the production station. The farmer had been educated to harvest the ripe coffee fruit indicated by the red color of the fruit. Picking up the red coffee fruit positively affected the whole process, especially in the pulping process, and aided in identifying coffee fruit with defects [15]. When the pulping process was properly managed, the resources would be utilized efficiently. The harvested coffee fruit then would be transported to the sorting station.

It took 8 minutes to set up the sorting machine and approximately 26 minutes in the sorting process before the fruits were conveyed to the soaking area. The sorting process was done to remove dirt and twig mingled in the harvest bag, and also to separate the unripe coffee fruits accidentally taken with the ripe ones. However, the unripe coffee fruits would be processed as a natural bean by dry process. The ripe fruits were then soaked to separate empty fruits (defect) from ripe ones before the pulping process.

The pulping process took 15.5 minutes to remove the skin from the coffee bean. The pulp-covered beans were then moved to a vessel to start the fermentation process which took 24-36 hours. However, the industry only took 25.3 hours. The fermentation ended when the pH of beans was 4.6 and the pulp was fully released from the bean [16]. Afterward, the coffee beans were washed to prevent a longer fermentation.

The washing process needed 30 minutes and 2 people were involved because of the manual mechanism. Actually, the industry owned a broken coffee washer machine yet it had been left unrepaired due to the absence of routine maintenance. The machine maintenance could improve the productivity and profitability rate of industrial operation as well as effectiveness and efficiency of the industrial operation, [17] while minimizing the risk on product quality.

After washing, the coffee beans were dried by sun drying for 7-10 days. In this industry, sun drying took 8.7 days to gain 11-

12% moisture. This rate could prolong the shelf life and ease the hulling process of beans.

Lastly, the hulling process taking 22.7 minutes was done to remove the coffee parchment from the beans. The coffee beans were then packaged using plastic bags in a small amounts and using plastic sacks in a big amounts to safely keep the beans from any physical, chemical, and biological defects. In the end, coffee beans were shipped within 3 days to the consumer, as illustrated in Table II.

TABLE II. CURRENT VSM

Component	Resources required
Total lead time	24,990 minutes
Manpower	6 workers
Total cycle time	14,108 minutes
Non-value-added time	0.3%

Table II describes a higher amount of lead time compared to its cycle time. The analysis identified 10,882 minutes of unprocessed time. It happened because the drying process was difficult to predict due to the volatile climates. Moreover, the unused machine and the dependence on manpower reduced the efficiency and thus extended the cycle time. Hereunder are the data displaying changeover time of the entire green beans processing.

TABLE III. CURRENT CHANGEOVER TIME

Production Stage	Time (Minutes)
Sorting	0.7
Soaking	0
Pulping	0
Fermentation	15
Washing	5
Drying	10
Hulling	5
Packaging	0.1
Total Changeover Time	**35.8**

Table III illustrates the changeover time of all processes. In total, the production required 35.8 minutes to accomplish a changeover from all processes. The biggest changeover time is identified in fermentation which is necessary to manage coffee quality. The other time is the washing process because it needs to fill out the other vessel to wash fermented beans. Afterward, drying takes 10 minutes to move all of the washed beans into the drying basket. Such detailed analysis clearly shows how important it is for the company to ensure efficient processing efficiency through activity mapping.

B. Process Activity Mapping

Process activity mapping is mostly used to describe and classify every activity whether a certain process is valuable or not. PAM will divide the time by activity type. There are 29 activities in coffee industry as shown in Table IV.

TABLE IV. ACTIVITY MAPPING

Code	Activity	Duration	O	D	T	S	I	Category
1	Harvesting preparation	00:30:00		✓				NVA
2	Harvesting departure	00:19:42			✓			NNVA
3	Harvesting 1	03:32:05	✓					VA
4	Resting time	00:22:01		✓				NVA
5	Harvesting 2	03:06:03	✓					VA
6	Weighing	00:06:14					✓	NNVA
7	Departing back	00:22:12			✓			NNVA
8	Coffee fruit transfers	00:04:10			✓			NNVA
9	Vessel soaking filling	00:08:22		✓				NVA

TABLE IV. CONTINUE

10	Sorting process	00:25:28					✓	VA
11	Pulping machine set up	00:05:42		✓				NVA
12	Transferring coffee fruit to soaking area	00:03:18			✓			NNVA
13	Soaking process	00:08:37	✓					VA
14	Transferring clean coffee fruits to pulping station	00:04:57			✓			NNVA
15	Pulping process	00:15:27	✓					VA
16	Transferring clean coffee fruits to fermentation station	00:01:08			✓			NNVA
17	Sorting pulped beans	00:30:32					✓	VA
18	Fermentation process	23:21:24	✓					VA
19	Vessel washing filling	00:06:29		✓				NVA
20	Post-fermentation washing	00:30:28	✓					VA
21	Transferring clean fermented coffee beans to drying station	00:07:31			✓			NNVA
22	Drying process	208:00:00	✓					VA
23	Storing parchment coffee	00:28:17				✓		NNVA
24	Transferring parchment coffee to hulling station	00:03:37			✓			NNVA
25	Hulling process	00:22:42	✓					VA
26	Sorting green bean	00:23:08					✓	VA
27	Transferring green bean to packaging station	00:03:30			✓			NNVA
28	Packaging	00:05:01	✓					VA
29	Inventory management	1 Week				✓		NNVA
Total time in minute			**24,707**					
Total time in hour			**412**					

Table IV shows the information of some activities classified into value-added, non-value-added, and necessary but non-value-added. The classification is further visualized in Fig. 2.

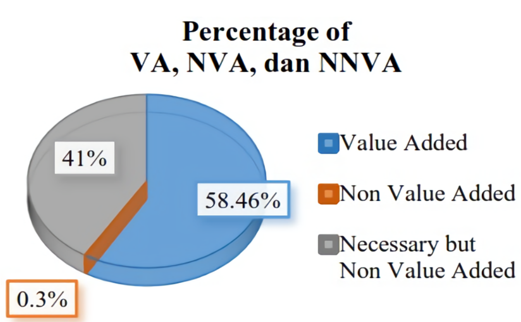

Fig. 2. Percentage Time of PAM

Figure II describes several details in the processing line in the coffee industry, such as 58.46% value-added time, 41% necessary but non-value-added time, and 0.30% non-value-added time. Non-value-added time is generally known as waste which must be eliminated. Moreover, PAM can visualize the overall coffee industry which comprises of 58.13% operational time, 40.92% storage time, 0.3% transportation time, 0.35% inspection time, and 0.3% delay time. Delay time should be eliminated because it does not contribute to product value and processing efficiency.

C. Supply Chain Response Matrix (SCRM)

In this case, supply chain response matrix specifically aims at understanding the supply chain actors and its cumulative inventory. Based on SCRM, the company expects to increase its efficiency in the inventory management as it influences the overall processing cost.

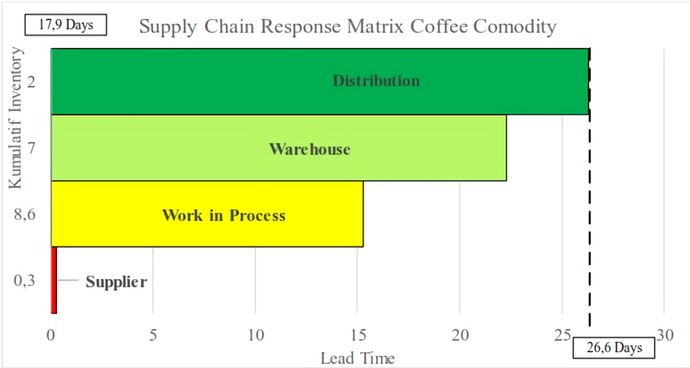

Fig. 3. Supply Chain Response Matrix

There are some actors |involved in the supply chain of the coffee industry, such as suppliers or farmers (Fig. 3). The supplier has a role as a coffee cultivator and coffee fruit provider for the coffee industry. The supplied coffee will be processed in the industry for about 8.6 days. However, the industry may set 14 days of lead time to anticipate the uncertainty during the drying stage. Then, the coffee will be stored at a warehouse for a week. The distribution usually takes place for 2 days, but the coffee industry sets 4 days of lead time to anticipate a future delay. Therefore, it is clear that the work in process and storing stage take most of the processing time because of the drying process and slow marketing line.

D. *Waste Analysis*

The waste analysis is vital to describe the waste resources and how to manage them properly. Several waste have been discovered in the coffee industry. However, waste analysis is subject to individual industry characteristics because every industry is not solely bound to the standard set by the government. The waste analysis contributes to the improvement of the overall business performance (Table V).

TABLE V. WASTE ANALYSIS

Waste Type	Cause	Management
Defect	• No extra inspection at harvesting • Manual washing • Less maintenance of machine and tools	• Conducting Harvest time inspection • Fixing the washing machine • Running regular maintenance for machine and tools
Waiting	• Unprepared production • No specific daily scheduling	• Setting earlier schedule before production • Determining daily production schedule
Inventory	• Overproduction made the inventory bulky	• Fasten the selling rate
Motion	• Disposition of pulping process	• Lower the pulping machine position
Excess Process	• Less maintenance of hulling and pulping machine and tools.	• Routine maintenance of machine and tools maintenance
Transportation	• Drying station and hulling station distance about 7 meters	• Move the hulling machine near the drying station

Table V documents six waste related to the coffee industry, namely defect, waiting, inventory, motion, excess process, and transportation. Each of these has to be eliminated to reduce loss and increase the industry profit. This waste analysis would be the base for proposing recommendations for improving the overall performance and efficiency of coffee processing.

E. *Recommendation and Future VSM*

The recommendation can be stated based on VSM, PAM, SCRM, and the results of the waste analysis. VSM has made it clear that the biggest time is devoted to the drying process. Therefore, it would be better if the company invests in a drying machine to reduce its dependence on climate conditions. Sun drying is done until the bean moisture reaches 42%, which takes approximately 3 days, and then followed by the use of a drying machine with 20-45 kilograms capacity and 3 hours of drying [18]. The temperature is also controlled at 60ºC to reach the expected moisture content of 11-12% and to maintain the quality. The machine needs 1.5 kg of gas to power the drying process. By contrast, modern technology can improve industry productivity, reduce the cost of manpower and material, and reduce potential waste [19][20].

Instead of involving two people in the washing process, the use of one person combined with a washing machine may help to dry 1500 kg of beans per hour. This combination only takes 6 minutes of washing each day. In consequence, the business must maintain the machine to prolong its durability, maintain the product quality, and fasten the process. Maintenance should not be seen as a burden for the business, yet rather as a regular investment to maintain product performance and increase competitiveness by reducing costs and providing better services [17][21].

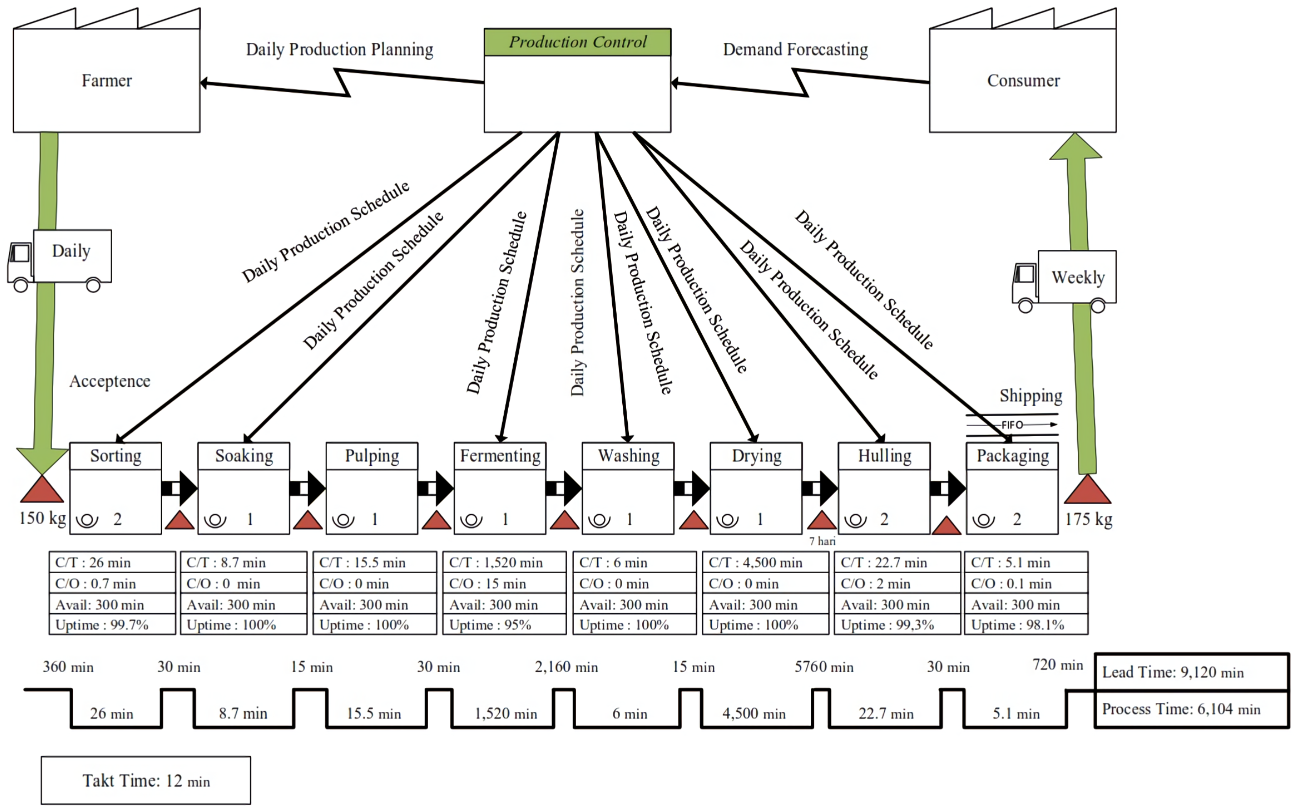

Fig. 4. Supply Chain Response Matrix

The industrial layout also affects the efficiency of each process. Each industry needs to consider the layout based on its manufacturing process. In this case, the hulling process must be closer to the drying process station to reduce the risk of loss during transportation. In general, the more transportation is involved, the higher the risk of production loss. Therefore, shortening transportation lines would be the best solution to prevent losses [22][23].

Production preparation also plays an important role in the production process. This preparation will start with creating a production schedule. The production technically requires setup time to reduce the changeover time and speed up the cycle time. Thus, the processing time will increase and make up the largest part of the total production time. By making a production schedule and setting time, productivity will increase and the uncertain process will be nullified while avoiding potential waste [24][25].

Lastly, keeping too many products in the inventory decreases product quality and increases the inventory cost. To date, the industry has applied the FIFO (First In First Out) concept. However, it cannot speed up the product movement. As such, the company needs to sell its products through e-commerce, social media, and door-to-door café selling. E-commerce can be a shortcut for the agroindustry supply chain to reach its customer, especially during the pandemic [26]. To understand the impact of these recommendations, future VSM should take into account the proposed recommendation as seen in Fig. 4. Future VSM has illustrated a more efficient process compared to the current one.

TABLE VI. FUTURE VSM RESULT

Component	**Value**
Total lead time	24,990 minutes
Manpower	6 workers
Total cycle time	14,108 minutes
Non-value-added time	0.3%

Table VI shows that the lead time has decreased from 24,990 minutes to 9,120 minutes; manpower is reduced from 6 to 4 workers; total cycle time falls from 14,108 minutes to 6,104 minutes, and non-value-added time is nullified.

TABLE VII. CHANGEOVER TIME IN FUTURE VSM

Production Stage	**Time (Minute)**
Sorting	0,7
Soaking	0
Pulping	0
Fermentation	15
Washing	0

Drying	0
Hulling	2
Packaging	0,1
Total changeover time	**17,8**

Subsequently, the changeover time in future VSM illustrates the accumulation of changeover time in every production station where the reduction time occurs in the washing, drying, and hulling process (Table VII). The use of a washing machine and drying machine will make the changeover time more efficient. This is because the maximum production capacity has been achieved by the use of machines. The hulling process will take only 2 minutes because of the shorter distance taken to transport the green bean to the hulling station.

F. Cost Analysis

The cost analysis determines the required cost to apply the recommendations which are geared to the same purposes. These involve preventing waste and bottlenecks during production, preventing transportation problems from the harvesting point to the processing point, and fastening the drying process regardless of weather conditions. The cost analysis is displayed in Table VIII, which also describes the necessary investments.

TABLE VIII. COST ANALYSIS

No.	Recommendation	Cost
1	Machine maintenance/year	200,000 IDR (13.80 USD)
2	Transportation maintenance/year	300,000 IDR (20.70 USD)
3	Drying machine investment	20,000,000 IDR (1,379 USD)
	Total Cost	**20,500,000 IDR (1,413.50 USD)**

1 USD = 14.500,- IDR

The table above shows that the biggest cost lies in the drying machine investment, reaching 1,379 USD. This investment will nullify the need to wait for 7 to 10 days to dry out the fermented coffee. Instead, the drying machine will require only 3 hours to reach the same drying quality, meaning a shorter production process. By implication, this reduces the dependence on manpower while allowing the company to elevate production efficiency and capacity. In total, the recommendation will cost 1,413.50 USD (Table VIII).

CONCLUSION

The results of lean analysis using VSM and VALSAT have concluded that recommended strategies will improve the overall production efficiency. This is indicative of reduced manufacturing lead time by 63%, cycle time by 57%, and changeover time by 50.2%. In addition, the recommendations result in the involvement of only 2 people during the drying process and eliminate the non-value-added time. These recommended strategies cost the small-medium coffee industry 1,413.50 USD.

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REFERENCES

[1] Hines, Peter and Rich, N, The Seven Value Stream Mapping Tools, International Journal of Operation and Production Management, Vol. 17 No. 1, 1997, pp. 46-64.

[2] Goriwondo, Mhlanga, and Marecha, Use of Stream Mapping Tool for Waste Reduction in Manufacturing Case Study for Bread Manufacturing in Zimbabwe, International Conference on Industrial Engineering and Operations Management, 2011, pp. 236-241.

[3] Prasetyo and Wicaksono, Desain Perbaikan untuk Meningkatkan Nilai Efisiensi Manufaktur Keberlanjutan menggunakan Sustainable Value Stream Mapping (Studi Kasus: CV Mugiharjo), 2019, Industrial Engineering Online Journal, Vol. 7 No. 4, pp. 1–7.

[4] Ahmad, F and Aditya, D., Minimizing Waste with a Value Stream Mapping Approach, Journal of Industrial Systems Optimization, Vol. 18 No. 2, 2019, pp. 107-115.

[5] Tarapituxwong, Tantranon, dan Duangpatra, Production Process Improvement Using Value Stream Mapping: A Case Study of Organic Coffee Firms in Thailand, Journal FEU Academic Review, Vol. 8 No. 2, 2015, pp 128-143.

[6] Rimawan, Molle, and Putra, Lean Production Design with Waste and Method Analysis of VALSAT for Assembly Process of Four Wheel Vehicle Components, International Journal of Innovative Science and Research Technology, Vol. 11 No. 3, 2018, pp. 449-455.

[7] Mor, Singh, and Bhardwaj, Learning on Lean Production: A Review of Opinion and Research within Environmental Constraints, Operations and Supply Chain Management, Vol. 9 No. 1, 2016, pp. 61-72.

[8] Nordin, Deros, and Wahab, Lean Manufacturing Implementation in Malaysian Automotive Industry: An Exploratory Study, Operations and Supply Chain Management, Vol. 4 No. 1, 2011, pp. 21-30.

[9] Lute and Charkha, Review of Lean Manufacturing Implementation: Case of Junction Box Post Processing Phase, International Journal of Civil, Mechanical and Energy Science, Special Issue 1, 2017, pp. 22-27.

[10] Satria and Yuliawati, Perancangan Lean Manufacturing menggunakan Waste Assessment Model dan VALSAT untuk Meminimumkan Waste, Jurnal Rekayasa Sistem Industri, Vol. 7 No. 1, 2018, pp. 55-63.

[11] Bhose, Pooja, Sulanke, and Hermant, Value Stream Mapping: Case Study on Residental Construction Sector, International Journal of Engineering Sciences Research Technology, 2015, pp. 353-360.

[12] Kengar, Kadam, Pandit, and Vingale, Manufacturing System Performance Improvement by Value Stream Mapping a Literature Review, IJIRSET, Vol. 2 Issue 9, 2013, pp. 12709-12716.

[13] Auliandri and Alfiani, Lean Manufacturing Approach to Reduce Wastefulness During Production of Train Car-Body Using VALSAT Method, Knowledge E, 2018, pp. 1256-1269.

[14] Hidayat, Tama, and Efranto, Lean Manufacturing Approach with VSM and FMEA Methods to Reduce Waste in Plywood Products, Journal of Industrial Systems Engineering and Management, Vol. 2 No. 5, 2014, pp. 1032-1043.

[15] Schwan, Silva, and Batista, Handbook of Plant-Based Fermented Food and Beverage Technology, Brazil: CRC Press, 2012.

[16] Jackels SC, Jackels CF, Characterization of The Coffee Mucilage Fermentation Process Using Chemical Indicators: A Field Study in Nicaragua, J Food Sci, Vol. 70, 2005, pp. 321-325.

[17] Alysouf, Imad, The Role of Maintenance in Improving Companies Productivity and Profitability, International Journal Production Economics, Vol. 105, 2007, pp. 70-78.

[18] Sary, Ratna, Kaji Eksperimental Pengeringan Biji Kopi dengan Menggunakan Sistem Konveksi Paksa, Jurnal Polimesin, Vol. 14 No. 2, 2016, pp. 13-18.

[19] Kamaruddin, Syariazulfa, Mohammad, and Mahbub, Barrier and Impact of Mechanisation and Automation in Construction to Achieve Better Quality Products, Social and Behavioral Sciences, Vol. 222, 2015, pp. 111-120.

[20] Syahri, Heryanto, Wibowo, and Hatmoko, Waste Analysis with Value Stream Mapping in Multi-storey Building Column Work, Journal of Civil Engineering Works, Vol. 6 No. 4, 2017, pp. 192-200.

[21] Mushavhanamadi, Khathutshelo and Selowa, Tumiso Brian, The Impact of Plant Maintenance on Quality Productivity in Gauteng Breweries, Proceedings of the International Conference on Industrial Engineering and Operations Management, 2018, pp. 1743-1753.

[22] Lipinska, Tomaszewska, and Krajewska, Identifying Factors Associated with Food Losses during Transportation: Potentials for Social Purposes, Sustainability, 2019, pp. 1-15.

[23] Villarreal, Garcia, Rosas, Eliminating Transportation Waste in Food Distribution: A Case Study. Transportation Journal Vol. 48 No. 2, 2009, pp. 72-77.

[24] Esa, Rahman, and Jamaludin, Reducing High Setup Time in Assembly Line: A Case Study of Automotive Manufacturing Company in Malaysia, Procedia Social and Behavioral Sciences, Vol. 211, 2015, pp. 215-220.

[25] Sanderson, M. Penelope, The Human Planning and Scheduling Role in Advanced Manufacturing Systems: An Emerging Human Factors Domain, Human Factors, Vol. 31 No. 6, 1989, pp. 635-666.

[26] Mata, Quesada, and Mata-Marin, Can E-Commerce Provide a Solution to the Coffee Paradox, IFIP World Information Technology Forum (WITFOR), 2016, pp. 181-194.

[27] Endar Hidayat, Asmak Afriliana, Gusmini Gusmini, Masuda Taizo, Hiroyuki Harada. 2020. Evaluate of Coffee Husk Compost. International Journal of Food, Agriculture, and Natural Resources. Vol 1 (1):37-43. https://doi.org/10.46676/ij-fanres.v1i1.8

[28] Giuliano Marodin, Alejandro Germán Frank, Guilherme Luz Tortorella, Torbjørn Netland. 2018. Lean product development and lean manufacturing: Testing moderation effects. International Journal of Production Economics. Vol 203. https://doi.org/10.1016/j.ijpe.2018.07.009.