

## Implementation of the Value Stream Mapping Method in the Process of Mixing Paving Block Materials to Reduce Waste in the Production Process at UD. Am Jaya

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### ABSTRACT

This study addresses critical inefficiencies in the paving block production process at UD. AM JAYA, where significant waste was identified in the material mixing stage, including excessive non-value-added time (31%), inventory bottlenecks, and suboptimal layout design. The research aims to systematically identify waste types using Lean Manufacturing principles, quantify production losses, and develop actionable improvements to enhance operational efficiency. Employing Value Stream Mapping (VSM) methodology, the study combines direct observation, time-motion studies (10 repeated measurements per process), and waste quantification through Current and Future State Mapping. Key findings reveal transportation waste (26% of total waste time) and waiting time (22%) as dominant issues, stemming from fragmented workstations and manual material handling. Implemented solutions - workstation consolidation, optimized material flow paths, and semi-automated equipment upgrades - yielded measurable outcomes: 18.24% reduction in cycle time (3,393.46 to 2,774.24 seconds), 24.24% shorter lead time (3.3 to 2.5 days), and elimination of 16.99 seconds of inter-station transportation.



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## 1. Introduction

The manufacturing industry is currently faced with the challenge of increasing efficiency in order to maintain competitiveness in an increasingly competitive market. One of the main problems that is often faced is the existence of waste in the production process which not only reduces productivity but also increases operational costs. According to Cahyo (2020), there are seven types of waste in manufacturing, namely overproduction, waiting time, inefficient transportation, excessive

processing, excess inventory, unnecessary movement, and defective products. This waste is a crucial problem that must be overcome to create added value for customers.

The concept of Lean Manufacturing emerged as a systematic solution to overcome these various forms of waste. Gaspersz (2007) defines Lean as a sustainable approach to eliminating waste while increasing product added value. Lean implementation aims to create an optimal ratio between added value and waste in the production process. One effective *Lean* tool is *Value Stream Mapping* (VSM), which allows companies to visualize the flow of materials and information while identifying non-value-added activities. Waste identification (Fuller, 2018) through VSM can then be followed by improvements using the Kaizen method that focuses on continuous improvement (Gaspersz, 2002).

UD. AM JAYA as a paving block manufacturer faces significant waste problems in its production line. Field observation data shows several indicators of inefficiency such as 31% of production time wasted on unproductive activities, inventory accumulation at several process points that cause bottlenecks, and suboptimal factory layouts that cause inefficient movement and transportation. This problem is even more crucial considering that paving blocks are a superior product with production reaching 250 units per day. Without systematic improvement, these various forms of waste will continue to reduce the company's productivity and profits.

This research focuses on the implementation of VSM to reduce waste in the process of mixing paving block materials. VSM was chosen for its ability to map actual conditions (*Current State Map*), identify waste through *Process Activity Mapping* (PAM), and design repair solutions (*Future State Map*). To deepen the analysis, *the Waste Assessment Model (WAM) was used which combines the Waste Relationship Matrix (WRM) and the Waste Assessment Questionnaire (WAQ) to prioritize waste based on its severity. The root of the problem is then traced using Ishikawa diagrams before formulating a solution based on Kaizen principles.*

Several previous studies have proven the effectiveness of this approach. Prayogo & Octavia (2013) successfully reduced transportation waste and waiting time through improving the layout at PT XYZ's warehouse. Al Faritsy & Suseno (2015) integrate VSM with Six Sigma and 5S to address inventory and overmovement issues. Meanwhile Tyagi et al (2015), using VSM to improve the flow of information in the gas turbine production line. These findings reinforce the relevance of the use of VSM in research at UD. AM JAYA.

This study aims to identify the type and severity of waste in the material mixing process, analyze the root causes of dominant waste, and design measurable improvement proposals. The results are expected to not only provide practical solutions for UD. AM JAYA but also contributes to the development of literature on the application of VSM in small and medium industries, particularly in the construction material production sector. With this data-driven approach, companies can transform towards a more streamlined and competitive production process.

## 2. Literature Review

### a. *Lean Manufacturing*

*Lean manufacturing* is a production philosophy that focuses on eliminating waste in the manufacturing process while maintaining or improving product quality. This concept comes from Toyota's Production System (TPS) and aims to create maximum value for customers with minimal resources. Waste in (Liker, 2004) *lean manufacturing* is categorized into 7 types (7 wastes), namely transportation, inventory, movement, waiting, *overproduction*, *overprocessing*, and production defects. The main principles (Gaspersz, 2007) of *lean* include *just-in-time* (JIT), *continuous improvement* (Kaizen), and *pull systems*.

### b. *Value Stream Mapping (VSM)*

*Value Stream Mapping* (VSM) is a visual tool used in lean manufacturing to analyze the flow of materials and information needed to produce a product or service. The main goal of VSM

is to identify waste such as inventory buildup, lead times, or *non-value-added activities* (Primary, 2020). By mapping the entire value *stream* from suppliers to consumers, companies can see the entire process and determine areas that need improvement (Fernando & Noya, 2014). The VSM consists of two main components: the current state map and the future state map. Implementing VSM helps companies reduce lead times, improve efficiency, and ensure that every step in the process truly delivers value to customers. This tool is often used in conjunction with other lean methods such as Kaizen and 5S to achieve leaner and more effective operations (Damanik et al., 2017).

### 3. Methodology

This research was conducted at UD. AM JAYA, a building materials manufacturing business located in Bangil, Pasuruan. The location was specifically chosen because the company showed significant indications of waste in the production process of paving blocks, with a production volume of up to 250 units per day. The access provided by the company to conduct direct observation and data collection is the main consideration in the selection of this research location.

Data collection is carried out through a comprehensive approach that includes primary and secondary data. Primary data was obtained through direct observation on the production line, where the researcher observed and recorded all production activities in detail. The measurement of the runtime is strictly carried out using a stopwatch with 10 repetitions to ensure data accuracy. Secondary data includes internal company documents such as monthly production reports, factory layouts, production flow diagrams, as well as machine maintenance records, all of which are analyzed to get a comprehensive picture of the existing production system.

The data processing process using the Value Stream Mapping (VSM) approach is carried out through several systematic stages. The process in data processing carried out is as follows:

a. *Creating Current State Mapping*

The creation of Current State Mapping is the first step in the Value Stream Mapping (VSM) methodology which aims to visualize the real conditions of the ongoing production process. The activities carried out include direct observation on the production floor, recording the process time of each workstation, and documenting the workflow in detail. The data collected included cycle time, waiting time, machine capacity, number of labor, and material inventory level.

b. *Waste Identification*

Waste identification is carried out based on seven types of waste (7 wastes) in *lean manufacturing*, namely *overproduction*, *waiting*, *transportation*, *over-processing*, *inventory*, *motion*, and *defects*.

c. *Recommended Improvements*

Based on the results of waste identification, several recommendations for improvement were formulated to improve the efficiency of the production process.

d. *Creation of Future State Mapping*

Future State Mapping is a visualization of the ideal production process after the implementation of various improvement recommendations. At this stage, a more efficient production flow is designed by considering waste reduction and increased added value. Some of the key changes in the Future State Map include simplifying material flow through the incorporation of workstations, adjusting the layout to shorten transportation distances, and optimizing the use of machinery and labor.

## 4. Results and Discussion

### 1) Production Data

UD. AM JAYA is a company that conducts production with a make to stock system, where production will be carried out when the inventory in the warehouse reaches the minimum limit. The make-to-stock production system aims to be a buffer stock for companies in meeting consumer demand, due to inaccurate information flow. Data for the period July to June can be seen in the following table:

Table 1. Production data June - July 2020

Yes	Product	June	July	Total
1	Paving block	550	450	1000
2	Brick	440	510	950
3	Concrete bis	35	20	55
4	Cast pole	35	20	55

From the diatas table, it can be seen that in the last 2 months the most production was carried out was paving blocks as many as 1000 pcs. Because of this, block paving products become objects that are followed by production activities.

#### a. Production Layout

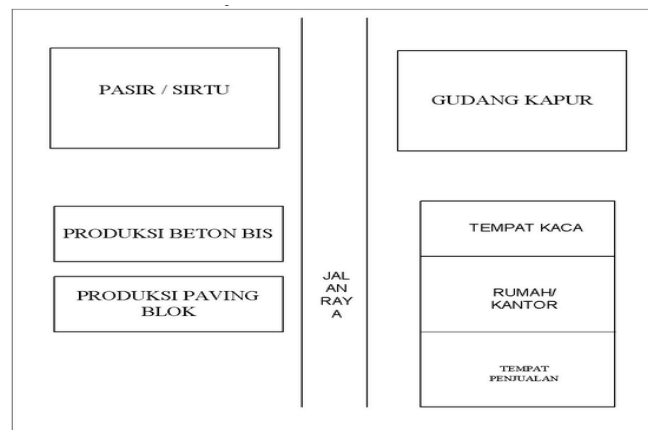


Figure 1. Production layout

#### b. Workstation

From the order of the production process above, it is then grouped into several workstations based on the way of processing materials and tools used. The following is the division of workstations, tools or machines used, as well as their functions in producing paving blocks.

Table 2. workstations and their functions

Workstation	Tool name	Sum	Function
1	Sieve (filter)	1	Crushing raw materials
2	Press machine	2	Printing Paving Blocks
3	Crawl	2	Moving raw materials
4	Cement mixer	2	Raw Material Mixer

## 2) Production Activities

Production activities explain the steps taken in the implementation of the production process. Here are the activities of the Paving Block mixing process:

Table 3. Production Activities

No.	Process	Yes	Activity	Code
1.	Mixing of materials	1.	Moving raw materials	A1
		2.	Measuring raw materials	A2
		3.	Transferring the raw materials to the cement mixer.	A3
		4.	Mixing of materials	A4

### a. Process Time

The process time is the overall time it takes to process raw materials from the beginning to the finished product. Lead time is the period of time between a customer's order and the time the order is completed. Lead time consists of wait time and cycle time, while cycle time is the time it takes for a workstation to process materials. Observations at the time of the process were carried out 10 times using a stopwatch. The following is the processing time on each tool and machine at the workstation in production.

Table 4. Run time (in seconds)

Yes	A1	A2	A3	A4
1	59	28	23	29
2	62	32	24	21
3	47	33	22	24
4	51	35	23	27
5	47	32	25	26
6	64	33	26	25
7	57	34	24	28
8	61	28	26	26
9	57	36	27	23
10	61	27	23	27
<b>Friendly</b>	<b>56,6</b>	<b>31,8</b>	<b>24,3</b>	<b>25,6</b>
<b>Total</b>	<b>566</b>	<b>318</b>	<b>243</b>	<b>256</b>
<b>Wakru Cycle</b>	<b>622,6</b>	<b>349,8</b>	<b>267,3</b>	<b>281,6</b>
<b>Transport Time</b>	<b>56,6</b>		<b>24,3</b>	

From the table above, it can be seen that the production cycle time is 1521.3 seconds = 4.22583 hours. And the lead time is the whole process time 1383 seconds + 86400 seconds (raw material transfer time) + 86400 seconds (shipment preparation) = 174.183 seconds = 0.048 hours = 2 days.

### b. Total Time Calculation

The following is the total lead time and cycle time in the printing process:

Table 5. Total Time

No.	Activities	Cycle time		Lead time	
		second	hour	second	day
1	A1	622,6	0,173	679,2	0,00786
2	A2	349,8	0,0972	406,4	0,0047
3	A3	267,3	0,0742	291,6	0,00338
4	A4	281,6	0,0782	305,9	0,00354

No.	Activities	Cycle time		Lead time	
		second	hour	second	day
Total		1521,3	0,4226	1683,1	0,01948

The lead time is calculated from the order received by the company, until the product reaches the consumer. The lead time of production is 2 (two) days, while the cycle time is calculated from the time the raw material is received, until the finished product enters storage. The cycle time required to produce paving blocks is 4 (four) hours.

### 3) Data Processing

After all the required data is obtained, then data processing is carried out including the following:

#### a. Data Sufficiency Test

The data acupuncture test was performed to determine whether the sample of data obtained was sufficient to represent the entire available population. Testing is carried out on production time at each workstation. The following are the results of the calculation of the cycle time of each process in the manufacture of paving blocks:

$$N' = \left[ \frac{\frac{k}{s} \sqrt{N(\sum X) - (\sum X)^2}}{\sum X} \right]$$

Where:

- N' = number of observations to be made
- N = number of preliminary observations
- $\sum X$  = sum of all measured data
- s = level of precision
- k = confidence level (90% or = 1.95% or k = 2, 99% or k = 3)

Table 6. Calculation of the process time

Yes	A1	A1 <sup>2</sup>	A2	A2 <sup>2</sup>	A3	A3 <sup>2</sup>	A4	A4 <sup>2</sup>
1	59	3481	28	784	23	529	29	841
2	62	3844	32	1024	24	576	21	441
3	47	2209	33	1089	22	484	24	576
4	51	2601	35	1225	23	529	27	729
5	47	2209	32	1024	25	625	26	676
6	64	4096	33	1089	26	676	25	625
7	57	3249	34	1156	24	576	28	784
8	61	3721	28	784	26	676	26	676
9	57	3249	36	1296	27	729	23	529
10	61	3721	27	729	23	529	27	729
Total	566	32380	318	10200	243	5929	256	6606
Average	56,6	3238	31,8	1020	24,3	592,9	25,6	660,6

- A1 data sufficiency test

$$N' = \left[ \frac{\frac{k}{s} \sqrt{N(\Sigma X) - (\Sigma X)}}{\Sigma X} \right] = \left[ \frac{\frac{3}{0,01} \sqrt{10(32380^2) - (566)^2}}{566} \right] = 3.11$$

From the results of the calculation above, it can be concluded that  $N' < N$ , then the data is considered sufficient.

- A2 data sufficiency test

$$N' = \left[ \frac{\frac{k}{s} \sqrt{N(\Sigma X) - (\Sigma X)}}{\Sigma X} \right] = \left[ \frac{\frac{3}{0,01} \sqrt{10(102.000) - (101.124)^2}}{\Sigma X} \right] = 0.93$$

From the results of the calculation above, it can be concluded that  $N' < N$ , then the data is considered sufficient.

- A3 data sufficiency test

$$N' = \left[ \frac{\frac{k}{s} \sqrt{N(\Sigma X) - (\Sigma X)}}{\Sigma X} \right] = \left[ \frac{\frac{3}{0,01} \sqrt{10(52290^2) - (243)^2}}{243} \right] = 0.63$$

From the results of the calculation above, it can be concluded that  $N' < N$ , then the data is considered sufficient.

- A4 data sufficiency test

$$N' = \left[ \frac{\frac{k}{s} \sqrt{N(\Sigma X) - (\Sigma X)}}{\Sigma X} \right] = \left[ \frac{\frac{3}{0,01} \sqrt{10(6660) - (256)^2}}{256} \right] = 0.89$$

From the results of the calculation above, it can be concluded that  $N' < N$ , then the data is considered sufficient.

c. Up Time calculation

Up time is the percentage where the machine is used per the amount of time available per day. Here are the up times at each workstation:

Table 7. Calculation of UP Time

Workstation	Activity	Long use(s)	Available time(s)	Present
1	Moving the raw materials	622,6	23.400	3%
2	Measuring raw materials	349,8	23.400	1%
3	Transfer it to the mixer	267,3	23.400	1%
4	Materials	281,6	23.400	1%

d. Current State Value Stream Mapping

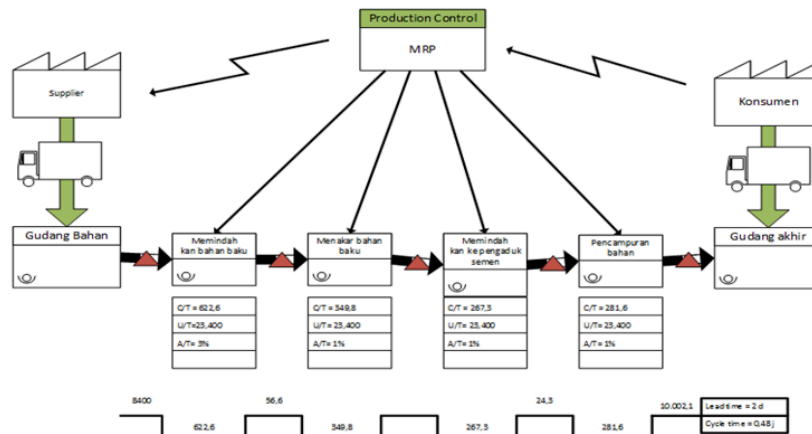


Figure 2. Current State Value Stream Mapping

#### e. Waste Identification

In the production of instant kencur rice in allfoil packaging, some waste was found in accordance with 8 types of waste, namely overproduction, waiting, transportation, ineffective processes, inventory, defective products, unnecessary movements, and resources that are not used properly.

##### 1) Over production

Overproduction occurs because of the imbalance between the amount of demand and the amount of production, where the production carried out is not proportional to the sales so that the products accumulate for a long time in storage. This is due to the lack of production forecasting, so the determination of the production schedule is done only by looking at the available product stock in storage.

##### 2) Waiting

Waste waiting occurs in the cooling of the powder that passes the filter which is generally still hot, so it needs to be left to sit until the temperature is cold enough and then packaging is done. Waiting activity also occurs in powders that do not pass the filter, collected to then be recooked along with the same product.

##### 3) Transportation

The transportation that occurs is the transfer of powder, passing the filter, to the warehouse of semi-finished materials to be cooled and the finished product is packaged to packaging and finishing.

##### 4) Ineffective Process (Inappropriate Processing)

An ineffective process occurs in the smoothing process using a blender, where there is repetitive work due to the large number of ingredients produced and not proportional to the capacity of the available tool. Repeated processing also occurs in the uleg process where the powder that does not pass the filter will return to the uleg process to be pureed.

##### 5) Inventory

Inventory occurs due to excess production that is not proportional to consumer demand.

##### 6) Defective product

Defective products occur in the imperfect uleg process, so there is still powder that clumps and does not pass the filter. Defective products also occur in the packaging process where there is a damaged packaging, two packages combined into one, overload or underload. Defective packaging due to lack of heating during engine setup, and irregular electrical voltage

fluctuations are also contributing factors. The occurrence of defective products makes the product have to be reprocessed, causing over-processing that is detrimental to the company.

### 7) Unnecessary Motion

Unnecessary movements occur during the packaging process where the operator must always supervise and control the operation of the machine because there are often defects in the middle of operation, so extra movements are needed to tighten the bolts and apply lubricant. Non-Utilized Resource A resource that is not used properly is the existence of a packaging machine that cannot be used because it has been damaged for a long time and has not been repaired.

### f. Current State Value Stream Mapping Improvements

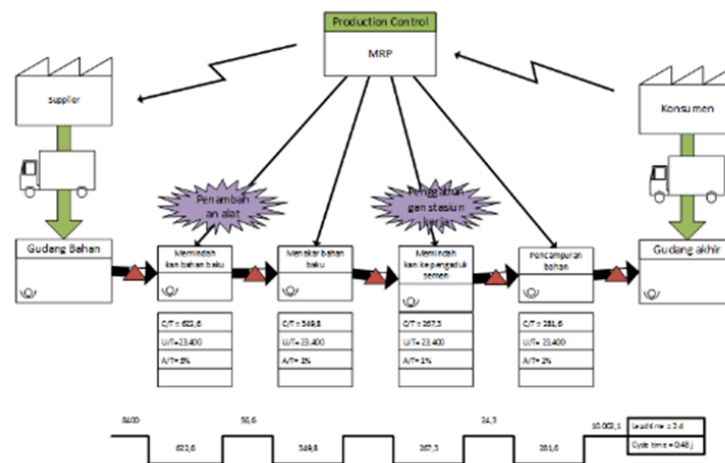


Figure 3. Current State Value Stream Mapping Improvements

From the Future State Value Stream Mapping above, it can be seen that there was a merger of work stations that originally had 2, namely the process of moving raw materials and the process of measuring raw materials, into 1 workstation with greater capacity and capabilities. The merger of workstations also saves time of 619.22 seconds from the original 3393.46 seconds to 2774.24 seconds, and reduces the operator by 1 person with an up time of 12%. The incorporation of workstations also eliminates the previous transportation process from milling machine to blender machine with a time of 16.99 seconds.

In the process of moving raw materials, there was an improvement in the process time which originally took 7046.37 seconds to 5747.6 seconds, this happened because the replacement of tools that were previously simple and done by 2 people, became a more effective tool so that in addition to saving time, it can also save labor for only 1 person. Using tools is also believed to produce a powder with a more even smoothness compared to the previous tool.

In the transportation process from the packaging machine to the packaging section, there was an improvement in time of 61.95 seconds from the original 261.45 seconds to 199.5 seconds due to the addition of tools in the form of hand trucks, where previously the transfer of products was only done with bare hands. By making the above improvements, the lead time can be reduced from the original 3.3 days to 2.5 days, and the cycle time from 7.65 hours to 7.12 hours.

## 5. Conclusion

Based on the Future State Value Stream Mapping analysis, the implementation of improvements showed significant results in improving the efficiency of the production process. The merger of two workstations (the process of moving raw materials and measuring raw materials) into one integrated workstation has succeeded in increasing production capacity while optimizing workflows. This

strategic change resulted in a production time saving of 619.22 seconds (18.24% more efficient) from the previous total time of 3,393.46 seconds, as well as reducing the need for operators from two people to one person with an increase in up time of up to 12%. An additional advantage of this workstation integration is the elimination of the transportation process between the grinder and the blender which previously took 16.99 seconds.

In the aspect of moving raw materials, innovations in the form of replacing conventional tools with more effective equipment have succeeded in cutting the process time from 7,046.37 seconds to 5,747.6 seconds (a decrease of 18.43%). In addition to time efficiency, this change also optimizes the use of human resources by reducing the need for operators from two to one person, while improving the quality of production results in the form of more consistent powder fineness.

The internal logistics aspect also shows significant improvements through the addition of hand trucks for the transportation process from the packaging machine to the packaging section. This simple intervention successfully reduced transportation time from 261.45 seconds to 199.5 seconds (23.69% faster) than the previous manual method.

The combination of these various improvements cumulatively has an impact on improving measurable production performance. The production lead time was successfully shortened from 3.3 days to 2.5 days (24.24% faster), while the production cycle time decreased from 7.65 hours to 7.12 hours (6.93% more efficient). These results not only demonstrate the effectiveness of the application of Value Stream Mapping in identifying and resolving production bottlenecks, but also prove that process optimization through a lean manufacturing approach can have a significant impact even with relatively simple interventions. These findings have important implications for small and medium-scale manufacturing industries in increasing productivity without large capital investments.

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