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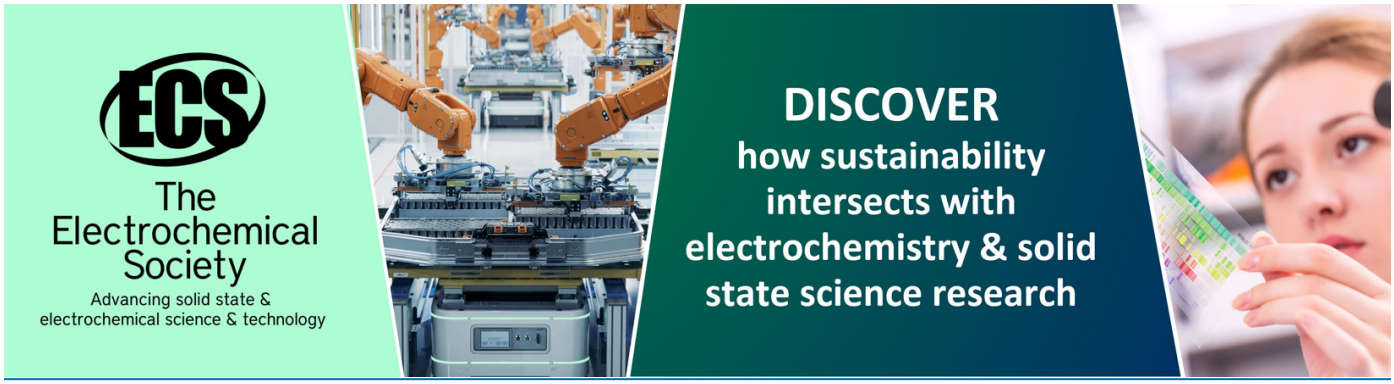

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Lean Manufacturing Implementation on Extrude Process with Value Stream Maping: Study Case in Tyre Manufacture

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Abstract. Lean Manufacturing has been known by all industries as one of the strategic tools adopted to compete in the tight market competition recently. This research will be focus on implementation of lean manufacturing at the one of the biggest local tire manufactures located in Tangerang which had a problem of production achievement was 92% to the schedule planned and the main caused by shortage building due to waiting material from preparation department. Value Stream Mapping (VSM) will be used to identify the waste at extruder since 55% problems was came from extruder. The method approach by started of identifying VSM current state, Gap analysis and action plan, and the last step is identify VSM future state and review the result. From VSM Future state, its resulted the reduction of lead time process extruder from 13.72 minutes/batch to 12.8 minutes/batch and WIP stock can be reduced from 12,8 hours to 10.6 hours. Finally the shortage at building has been reduce from 7% to 3.2% and OEE building is increasing from 61% to 64.8%.
Keywords: Lean Manufacturing, Value Stream Mapping, Production, Tyre Manufacturing

1. Introduction

Lean manufacturing for the industrial world is not stranger because it is one of a strategy that was adopted by all of industries to keep compete in todays market competition. The objectives of lean manufacturing is to always responsive to the customers demand on product manufacturing process with a good quality and efficently by reduce some waste on human activity, inventory, delivery time and waste in manufacture área [1]. This research will focus on lean manufacturing implementation in the biggest local tyre manufacture that located in Tangerang. From the PPC Department report in 1st smester 2019, production acheivement just reach 92% from the schedule that had been given and the main causes is 7% due to iddle process from materials preparation. This condition surely will affect to the plan delivery to customers and can reduce company opportunity revenue.

Table 1. Production Acheivement in 1st Smester of 2019

Items	UoM	Jan 19	Feb 19	Mar 19	Apr 19	May 19	Jun 19
Schedule	Pcs/day	44689	46017	46734	46738	45745	43469
Actual	Pcs/day	41098	42147	43320	42241	42595	40787
Acheivement	%	92.0%	91.6%	92.7%	90.4%	93.1%	93.8%
Loss Shortage Material	%	6.21%	10.49%	6.53%	7.36%	7.67%	5.45%

Value Stream Maping (VSM) is one of tools in lean manufacturing that was proved effective to identify some waste type due to VSM reflect a process flow dan information all product component on the manufacture process [2]. In this research VSM will be used to identify kind of waste that occured in extruder process due to 55% loss idle material is casued by extruder process and also improvement recommendation so hoped by lean manufacturing implementation will improve production acheivement performance to the schedule given.

2. Method and materials

Womack, et.al (1990) states the definition of “lean production” on his book “The Machine That Changed The World. Lean Production” refers to the manufacturing paradigm that is based on its fundamental purpose of continuously minimizing waste to maximize flow [3]. Schonberger (1982) in his book Japanese Manufacturing Technique "Nine Hidden Lessons in Simplicity" states that they have had successful experiences using VSM to increase productivity in automotive industry suppliers, where they report drastic improvements on the achievement of each person's production and also the reduction in Work in Process and finished good inventory [4]. Bhim and Sharma (2009) have implemented lean concepts in a manufacturing company using VSM [5]. The current state and future state results are compared with the results of 92.58% in the reduction in lead time, 2.17% in the reduction in processing time, 97.1% reduction in WIP, and 26.08% reduction in the number of manpower requirements. According to Jeyaraj et.al (2013) the following are the steps for implementing lean manufacturing using VSM according to the flow chart below:
Methodolgy which is used on this research as follow:

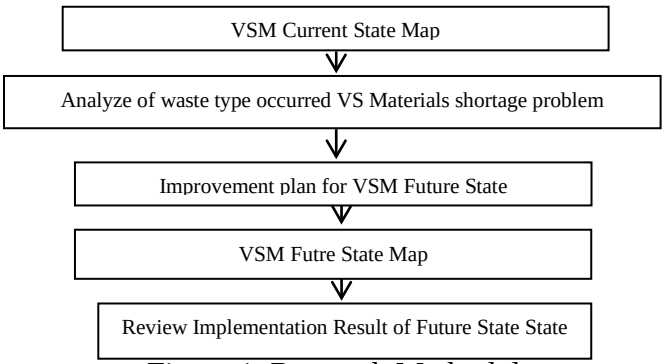

Figure 1. Research Methodology

3. Results and discussion

3.1. VSM: Current State

To create VSM current state started by create tyre manufacturing flow process as follow:

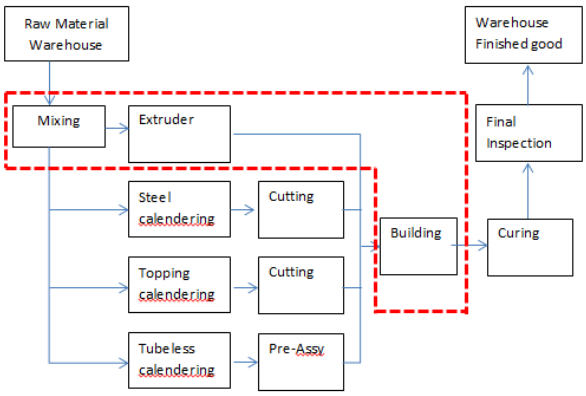

Figure 2. Tyre Manufacture Flow Process

The focus of improvement in this research is the extruder area so that the VSM current state only focuses on Mixing (Supplier), Extruder (Process), and Building (Customer) in accordance with the red line above. For VSM information data is measured based on the reference size of production with the largest volume in the extruder process and the following is the VSM current state extruder process

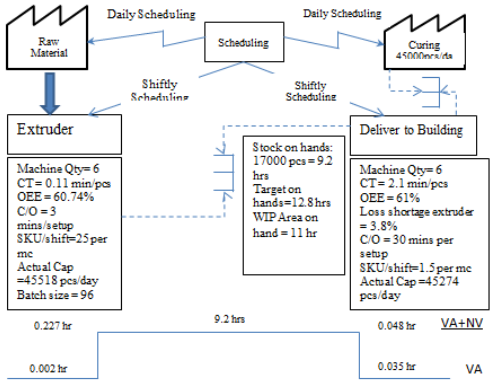

Figure 3 Scheduling Flow Process

Table 2. Value Added & Non Value Added Time

Benchmarking	VA (hours)	NVA (hours)	% PCE (VA/NVA)
PTGT	0.037	9.47	0.4%
World Class (batch system)			15%-35%

3.2. Analyze of waste type occurred VS Material Shortage Problem

Based on the VSM current state above, it can be seen that the scheduling system between extruders to the building uses a make to stock system with a supermarket system and the cause of material shortage in the building is because the available buffer stock is only 72% of the target stock on hands and the root of the problem is the stock area available is not enough if the stock on hands can be reached 12.8 hours because the layout is available only 11 hours. Under these conditions the solution that must be done is to reduce the target stock of WIP on hands, and to reduce the stock target on hands it is necessary to review the calculations to see

opportunities the improvement [6]. With a supermarket system, the following are the calculations:

Formula Re Order Points with variations on lead time [7]:

ROP = (Process Lead Time* Demand)+ Safety Stock (Demand*σLT) …….(1)

Process Lead Time = Setup + Process + Put to the lay out + Aging + Deliver to Building

= (3.1 min)+(0.11 min/pc* 96) + (15min/(15000/6) + (120min/(15000/6) + (20 min/15000/6)

= (3.1+10.56+ 0.006+0.048+0.008) = 13.72 min/batch

σLT = 2.5Hr every shift each machine (breakdown machine, put to the lay out, deliver to building, etc) so the Re-order Point is:

= (13.72*(15000/6/96)+((15000/6)* (150/(15000/6)) = (354.68 + 150) = 504.68 min = 8.4 Hr

To Calculate Balanced on Hands the formula is [7] :

Balance on Hand = ROP + (0.5* Cycle Time Interval*Demand) ……..……(2)

So, Balanced on hands (Average of WIP Stock) is

= 8.4 + (0.5*1.5*354.68)/60) = 8.4 + 4.4 = 12.8 Hr

Look at from the above calculation, the potential to reduce amount of stock on hands without adding lay out because it is already not possible is to reduce the lead time of the process. The reduced lead time process focuses on the type of waste that occurs, namely:

1. Speed up setup
2. Reducing the time to put WIP on the layout
3. Reduce time delivery WIP to Building

3.3. Improvement plan for VSM Future State

Improvement plan is done by reducing setup time for each working step. There are three improvement that is done Install recipe management in machine; so setup only call the menu, Convert to external, done when the machine run before the size; Install the system camera measuring width and feedback control system to the extruder. From the reduction setup we get a time reduction from 188 seconds (3.1 minutes) to 132 seconds (2.2 minutes).

3.3.1. Reducing Set-up time.

To reduce setup time, the method used is Single Minutes Exchange Dies according to Cakmakci (2008) the steps are as follows:

1. Identification of internal and external processes
2. Converting internal to external processes
3. Streamline the adjustment process after setup

By doing thus method we get a time reduction from 188 seconds (3.1 minutes) to 132 seconds (2.2 minutes).

3.3.2. Reducing time to put on the lay out

After making several samples to calculate the time to put WIP from the extruder into the layout, the average time is 15 minutes with a standard deviation of 2.99 minutes.

From the measurement data above, it is necessary to do a system overhaul to eliminate the variation of time put and the following is the improvement plan, namely:

Table 3. Improvement of reducing time to Put on the lay out

No	Issues	Plan Improvement	Before	After
1	Long time for looking for lay out empty	Creating visual management for location updates and WIP layouts with the FIFO system	22 min	14 min

No	Issues	Plan Improvement	Before	After
2	Lay out blocked by antoher WIP	Relay out and standardize the layout in FIFO and easy to access	19.5 min	14 min

By making improvements above, the time to put WIP into the layout can be reduced from 15 minutes to 14 minutes with a standard deviation of 0.89 minutes.

3.3.3. Reduce time delivery WIP to Building

From the measurement results of the WIP shipment sample to the next process, namely building and the result is an average of 20 minutes with a standard deviation of 4.25 minutes. To improve the conditions, a work plan is made as follows,

Table 4. Improvement of Delivery WIP to Building

No	Issues	Rencana Perbaikan	Before	After
1	Long search for stocks	Creating visual management for location updates and WIP layouts with the FIFO system	28 min	21 min
2	Lay out blocked by other WIP	Relay out and standardize the layout in FIFO and easy to access	24 min	21 min
3	Fastest delivery	Re-arrange the production plan for the closest path between each extruder to the building machine	28 min	21 min

By taking corrective actions, the lead time for sending can be reduced from an average of 20 minutes (standard deviation: 4.25 minutes) to an average of 18.7 minutes (Standard deviation 2.18 minutes).

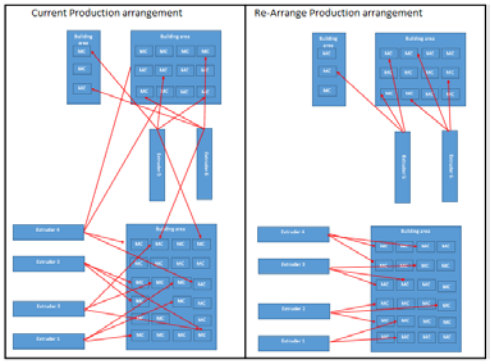

Figure 4. Re-arrange production plan for the nearest track

Process Lead Time
= Setup + Process + Put to the lay out + Aging + deliver to Building
= (2.2 min)+(0.11 min/pc* 96) + (14min/(15000/6) + (120min/(15000/6) + (19 min/15000/6)
= (2.2+10.56+ 0.0056+0.048+0.0076) = 12.8 min/batch
σLT = 0.75 hours per shift per machine (breakdown machines are considered the same but the deviation put to layout and sent to the building is reduced)
Then the Re-order Points are:
= (12.8*(15000/6/96))+((15000/6)* (60/(15000/6))= (333.9 + 45)= 378.9 min = 6.3 Hr
To calculate the Balanced on Hands formula (Heizer & Render, 2011):

= ROP + (0.5 * Cycle Time Interval * Demand)
So Balanced on hands (average WIP stock) is =6.3+(0.5*1.5*333.9)/60)=6.3+4.2=10.5 hours

3.4. VSM: Future State

The following is a vsm future state in accordance with the corrective actions above

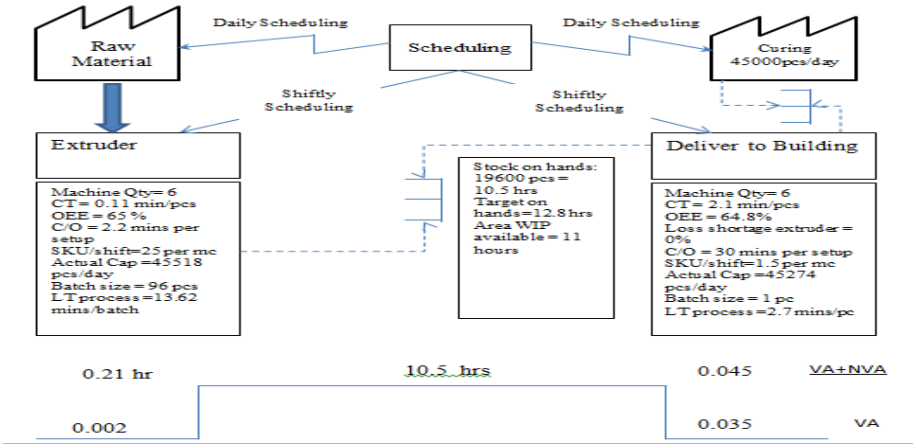

Figure 5. VSM : Future state

Table 5. Value Added and Non Value Added for Future State

Benchmarking	VA (hours)	NVA (hours)	% PCE (VA/NVA)
PTGT	0.037	10.75	0.34%
World Class (batch system)			15%-35%

3.5. Review Implementation Result of VSM: Future State

By looking at the results of the VSM Future state, the WIP on hands can be reduced from 12.8 hours to 10.5 hours and still below the WIP supermarket layout capacity of 11 hours, so it is expected that by setting stock on hands to 10.5 hours, the material shortage in the building can be reduced, and the following are the results of the improvement:

Table 6. Comparison Improvement Result

Items	Before	After
Reducing Lead Time Process	13.72 min/batch	12.8 min/batch
Reducing Buffer stock on hands	12.8 Hr	10.6 Hr
Shortage reduction extruder in building	3.8%	0%
Shortage all material in Building	7%	3.2%

4. Conclusion

By implementing lean manufacturing using Value Stream Mapping, it can produce a reduction in process lead time from 13.72 minutes / batch to 12.8 minutes / batch and WIP stock buffer can be reduced from 12.8 hours to 10.6 hours so that without adding to the WIP layout problem shortage in the Building can be reduced from 3.8 % to 0% and OEE Building increased from 61% to 64.8%. But when viewed from the value of% PCE (Process Cycle Efficiency) there was a decrease from 0.4% to 0.34% and this indicates that there are still

many other wastes that need to be improved so that the value of% PCE can reach the world class target of 15%.

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