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# Value Stream Mapping for Small Scale Industry with Make to Order Manufacturing Strategy

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**Abstract** *"Uday Engineering and Scaffolding" in Sinnar, Maharashtra. Is a manufacturing company which produces a variety of scaffolding products, including wall forms, centering plates, wheel barrows, etc. Scaffolding is a temporary platform that is used for providing support on height and provides materials during a construction process for constructing or repairing of a structure.*

*These products are used to provide a certain level of support to a standing structure throughout the phase of construction. From which we have chosen "centering plates" to do our study on. The lead time for making one batch of centering plate is two days, where on first day only first half of the factory works and other all machines are kept idle as only cutting of raw material takes place. On next day workers starts assembly and welding processes.*

*Our project focuses on reducing lead time by creating a current and future state mapping of value stream. Which when implemented not only will reduce lead time but also provide recommendations to improve current operations within the company)*

***Key Words***: Bottle neck, Cycle time, Inventory, Inventory lead time, Lead time, Process efficiency, Takt time, Value-adding time, VSM

## 1. INTRODUCTION

Value stream mapping in the manufacturing environment has been discussed since the technique was used at the Toyota Motor Corporation, and was known as "material and information flows." Toyota focuses on understanding the flow of material and information across the organization as a way to improve manufacturing performance. Pictorial representations with process maps are ways to communicate with different parties in an organization. In this way, value stream maps can provide a whole view of how work are done through the entire systems.

In the book Value Stream Mapping: How to Visualize Work Flow and Align People for Organizational Transformation, Martin and Osterling [8] summarized the benefits of value stream mapping as the following.

- The visual unification tool can help in visualizing non-visible work, such as information exchanges. Visualizing non-visible work is a key step in understanding how work gets done.
- Value stream maps can create connections to the customer, which helps an organization focus more on the customer's perspective and deliver more value to the customer.
- Value stream maps can provide a holistic system view by connecting disparate parts into a more collaborative organization, with the objective of providing higher value to customers.
- Value stream mapping can help in visualizing and simplifying the work process at a macro level, which may help in making strategic improvement decisions better and faster.

Value stream maps are effective means to orient newcomers by helping them understand a holistic view and where they fit in an organization. To sum up, value stream maps provide a visual, full-cycle macro view of how work progresses from a customer request to the final fulfilment of that request. The mapping process deepens the understanding of work systems that deliver value to customers and reflect the work flow from a customer's perspective. As a result, the process of value stream mapping provides effective ways to establish strategic directions for better decision making and work design.

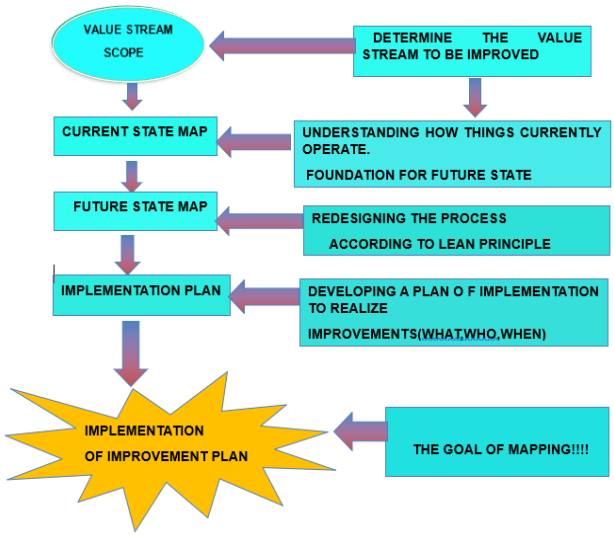


**Fig.1** Roadmap for Value Stream Mapping

## 2. Layout:

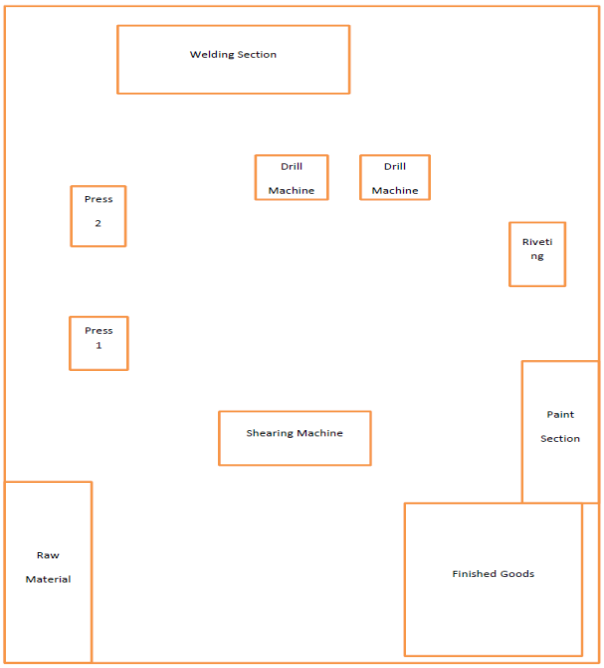


**Fig.2 Layout of Plant**

## 3. Problems Identified:

1. **SHEET CUTTING:**

**Problem:** During sheet cutting operation five to six workers are required. Three people to handle the sheet on one side of the machine and other two on the other side to align the sheet and rotate it to give multiple cuts. Table 1 shows the time taken for sheet cutting operation.

Table-1: Sheet Cutting

| In Time (sec) | Out Time (sec) | Total Time (sec) |
|---|---|---|
| 0 | 30 | 30 |
| 30 | 63 | 33 |
| 63 | 98 | 35 |
| | | Avg Time = 32.66 |

2. **ANGLE CUTTING**:

**Problem:** While observing angle cutting, we noticed that three workers were working. One was providing the angle to the operator cutting the angle and the third one was aligning and releasing the angle.

Table-2: Angle cutting

| In Time (sec) | Out Time (sec) | Total Time (sec) |
|---|---|---|
| 0 | 13 | 13 |
| 13 | 27 | 14 |
| 27 | 39 | 12 |
| | | Avg Time = 13 |

3. **ANGLE STRAIGHTENING**:

**Problem:** In angle straightening operation two workers are needed. One to check the bend and other one to straighten the angle by hammering. This operation is carried out manually where both workers have to sit uncomfortably on the ground and carry out the process. This causes too much fatigue and the process consumes lot of time.

Table-3: Angle Straightening

| In Time (sec) | Out Time (sec) | Total Time (sec) |
|---|---|---|
| 0 | 36 | 36 |
| 36 | 86 | 56 |
| 86 | 156 | 70 |
| | | Avg Time = 162 |

**4. BENDING**:

Table-4: Frame Bending

| In Time (sec) | Out Time (sec) | Total Time (sec) |
|---|---|---|
| 0 | 17 | 17 |
| 17 | 29 | 12 |
| 29 | 43 | 14 |
| | | Avg Time = 14.33 |

**Problem:** This process is carried out by one worker and takes usual time but this process causes lot of fatigue and also sometimes leads to misalignment of the angle.

5. **PRODUCTION FLOW**:

**Problem:** After observing the complete production, we observed that the making of complete product requires three days which could be reduced by making necessary changes

**4. Methodology:**

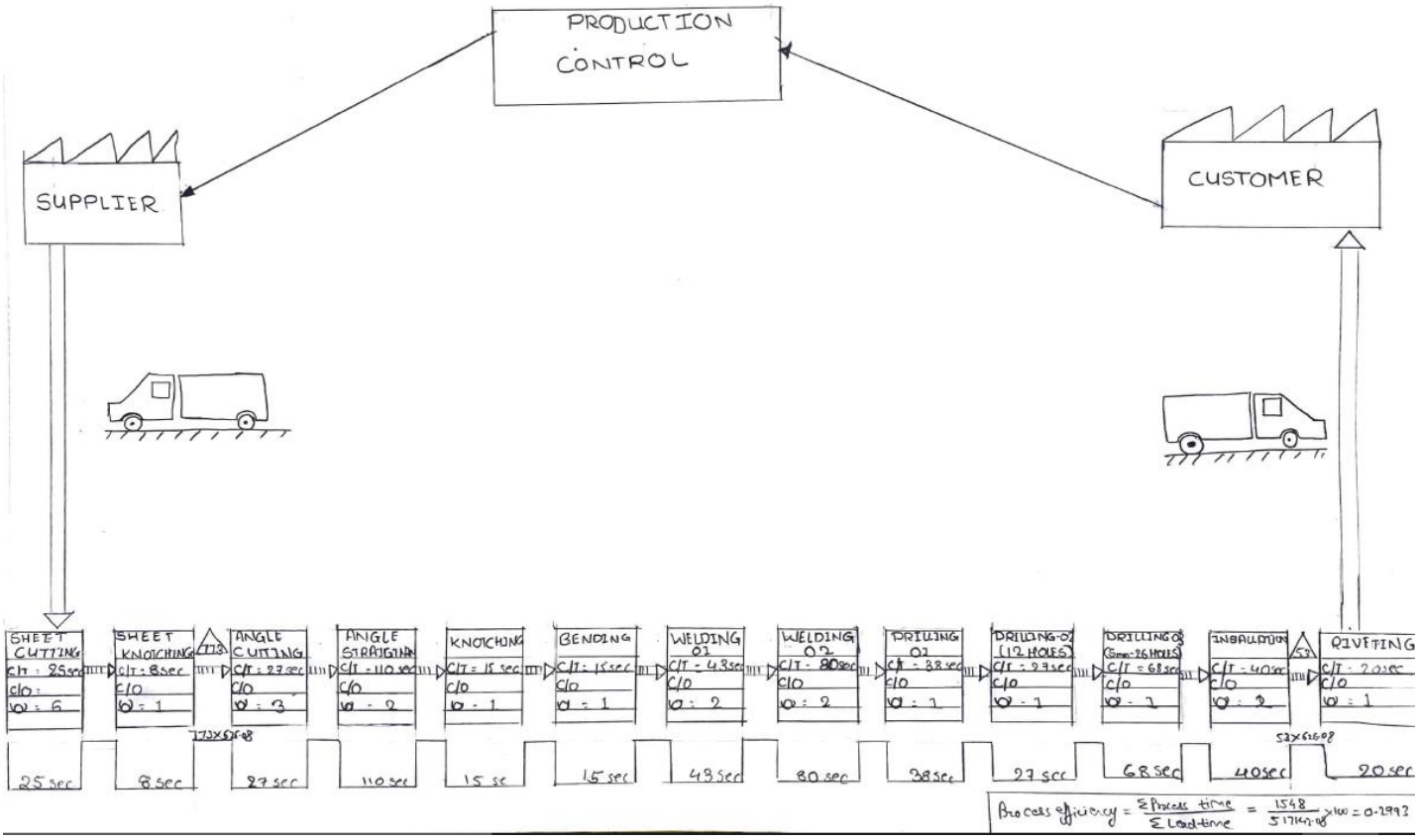


**Fig.3** Current state map

- **Current state**

Takt time = (Available time/customer Demand) 86400/138 = 626.08s

- **Day-1** Time = 28800s

Process = Sheet cutting (25s) + Sheet Notching (8s) = Process Time (33s)

No. of Sheets manufactured is 28800/33 =872.72 i.e**872 units.**

- **Day-2** Time = 28800s

Process= Angle cutting (27) + Angle Straightening (110) + Notching (15) + Bending (15) + Welding-1 (43) + welding-2 (80) = Process time (290s)

No. of Frames manufactured 28800/290 = 99.31 i.e., **99 units.**

- **Day-3** Time = 28800s

Process = Drill-1 (38) + Drill-2 (23) + Drill-3 (68) + Installation (40) + Riveting (20) = Process Time (189s)

No. of processed units 28800/189= 152.38 i.e., **152 units.**

So, during 3 days of manufacturing (Day 2) is the bottleneck 99 plates are produced on that day, so during the 3 days of manufacturing in total only 99 complete finished products.

For Day 1 (773 Sheets) are WIP 773 X 626.08 = 483959.84s lead time

For Day 3 (53 Sheets) are WIP 53 X 626.08= 33182,24s lead time.

Now process efficiency % = process time/Lead time

Here, for the lead time, we have only considered lead time inventory which is 483959.84s + 33182.24s =517142.08s

Now process time for all three days is 516s X 3 = 1548s

Process efficiency % = (1548) / (517142.08) X100

Process efficiency for current state = 0.2993%

**Future State Map:**

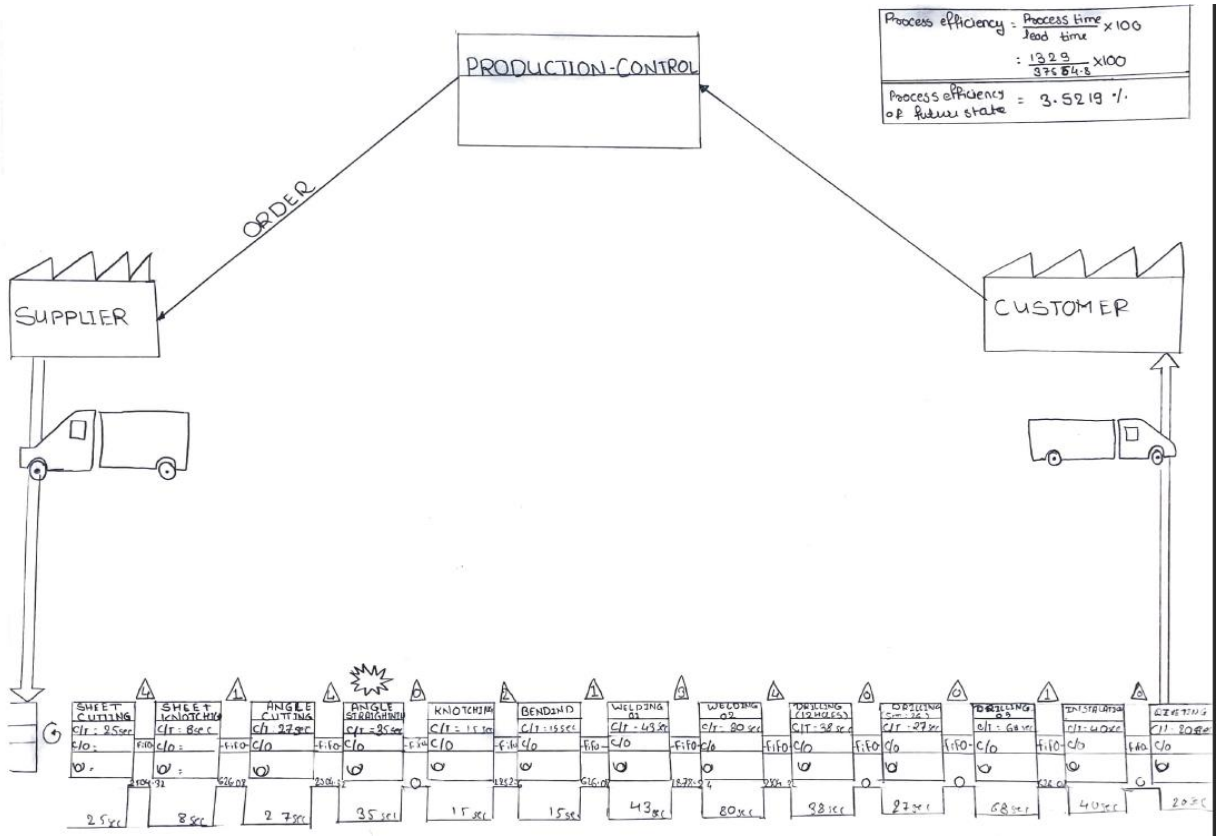


**Fig.4** Future State Map.

In future state mapping, we have introduced continuous streamline production flow

Time available= 8hrs x 60m x 60sec

=28800

For 3 days so as to compare it with Current state ratio must remain same = 28800x3

So 3 days are taken into account= 86400 seconds.

Now using various VSM methods like Kaizen, FIFO, Pull, Supermarket, streamline flow process, time is brought down by 73 seconds that is 441 seconds is a new time.

So total process time= 441x3=1323

Total Lead time - so now in the future state when the mock test was done it was observed that including all the process 20 work in progress inventory was observed in total cycle time

So, 20 x 3 = 60 - lead time = 60 x taken time = 37564.8

So, process efficiency = process time/lead time x100 = 1323/37564.8 x100

Process efficiency of future state = 3.5219% Now, customer demand was 138 plates in 3 days.

In the current state map, it was only able to provide 99 plates and was deficient by 39 plates so during this time company either had to outsource the required amount or they had to delay the shipping.

In the future state map, the available time is 86400 sec, and the processing time is 441

i.e., 86400/441=195.91, Therefore 195 plates can be manufactured.

So, using future state maps manufactured is able to cater to the demand and has the capability to provide over 195 plates which are 96 plates more than current state mapping.

**Capacity analysis for production of centring plate (Before and After):**

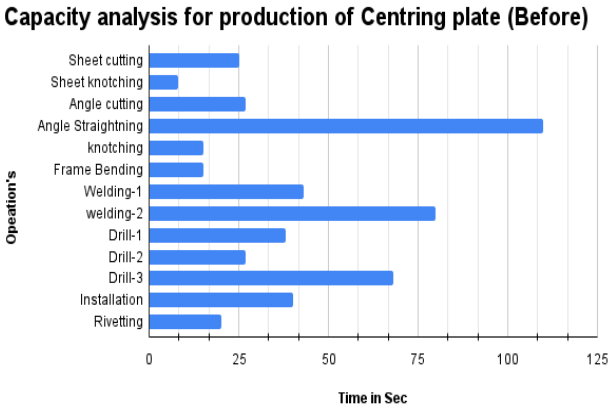


**Fig.5** Capacity analysis for Current state

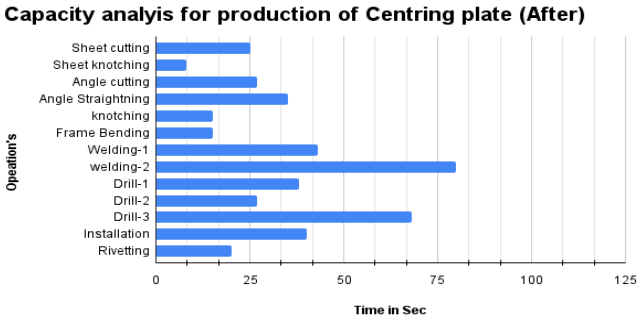


**Fig.6** capacity analysis future state

**Time analysis (Before and After):**

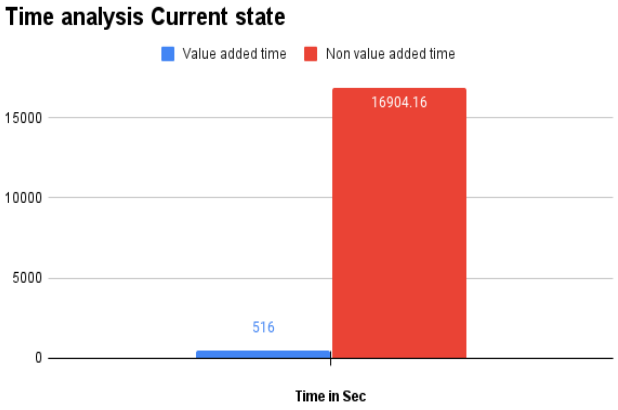


**Fig.7** Time analysis Current state

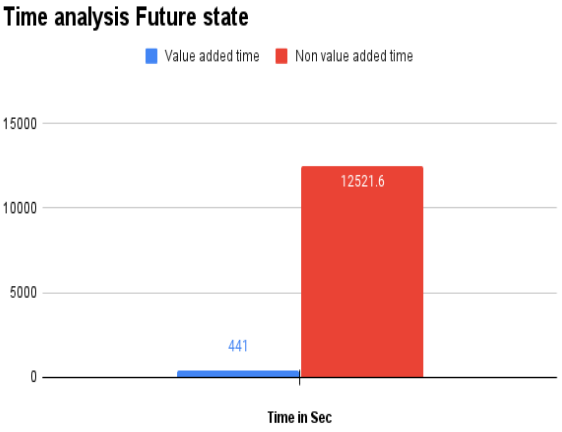


**Fig.8** Time analysis future state

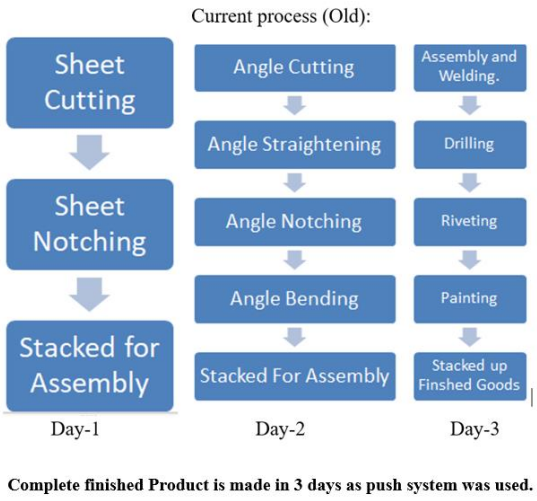


**Fig.9** Flow of Material Current state

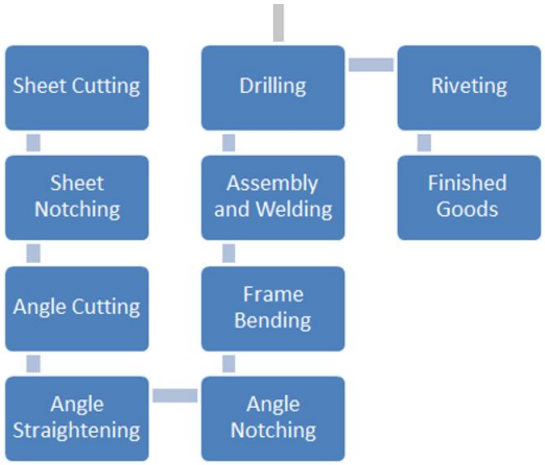


**Fig.10** Flow of Material Future state

Recommended New Flow of Material and Process, Complete Finished Product is made in a shift as pull system is implemented.

## 5. Results and Conclusions:

1. By controlling WIP inventory, reduction in production lead time by 92.73% is achieved. we can say VSM is effective way to control the inventory and reduce lead time by implementing modifications in the existing manufacturing conditions. VSM deals with overall, integrated optimization of enterprise processes at every level. VSM can be utilized in following manner.

- VSM is utilized to identify and then eliminate sources of waste applying variety of lean tools.
- Main purpose is to establish continuous flow of material/product through entire supply chain process.
- Goals for VSM are shortest lead time, zero inventories with lowest cost and highest quality of product.

Addressing enterprise level VSM with Extended "Value Stream Mapping" is future scope for the study.

2. Total process efficiency of the plant is increased by 3.22% by application of lean principles like Pull, FIFO, Kaizen.

3. Process efficiency of future state > process efficiency of the current state

(3.5219%) > (0.2993%)

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