A

REPORT

ON

"REDUCTION OF LEAD TIME BY APPLICATION OF VALUE STREAM MAPPING"

Submitted in partial fulfilment of the requirement for the Degree of Bachelor of Production Engineering course of Savitribai Phule Pune University

Submitted By

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Under the Guidance of
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K.K. WAGH INSTITUTE OF ENGINEERING EDUCATION & RESEARCH

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CERTIFICATE

Department of Production Engineering

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This project report entitled

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In partial fulfilment of the requirement for the award of Degree of Bachelor of Production Engineering course semester-1 of Savitribai Phule Pune University, during the academic year 2020-2021

Prof. A. S. Kamble	**Dr. P. J. Pawar**	**Dr.K. N. Nandurkar**
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1.Examiner__________

2.Examiner__________

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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, centring 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 "centring plates" to do our study on.

The lead time for making one batch of centring 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.

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Definition of terms

Bottle neck: The operation or function with the lowest capacity, usually the operation with the longest cycle time per unit. The bottle neck sets the limit for the production pace and thus the capacity of the entire process.

Buffer: Inventory between operations. Compensates for differences in cycle time (lack of synchronization) between operations.

Changeover: Activities that are required to prepare an operation or process for another type of product. The time allocated for this is called *changeover time*. Also known as *setup time*.

Customer demand: The number of products that the customers are expected to buy or order during a certain time period.

Cycle time: The time required to complete one cycle of an operation; or to complete a function, job, or task from start to finish. For automated or compound processes, the cycle time is the time between each output from the process.

Downstream: Parts of the production process or value stream (or operations) that occur after an arbitrary point or operation. See *upstream*.

Downtime Time: when equipment is unavailable for production due to e.g. equipment breakdown or planned maintenance. See also *uptime*.

FIFO: Abbreviation for *First-In-First-Out*. Queuing system in which the products are handled in the order that they arrive in the queue. Flow Continuous production process with no buffers between operations.

Inventory: A collective term for stored goods. Inventory can be placed before (incoming goods), within or after a process (finished goods).

Inventory lead time: Waiting time that the products spend in inventory or buffers. Calculated by multiplying takt time and average number of items in inventory.

Lead time: Number of minutes, hours, or days that must be allowed for the completion of an operation or process, or must elapse before a desired action takes place.

Non-value-adding time: Time spent on activities that do not directly add value to the product. These activities are usually needed to support value-adding activities.

Operation time: Total time that is dedicated to a in a product specific operation. Equals changeover time plus process time.

Process efficiency: In VSM, the ratio of process time (value adding time) to lead time. Calculated by dividing the total process time by total lead time. Also known as flow-time efficiency.

Process lead time: An alternative term for *Process time*

Process time: Total time required to properly handle an item within a process step. This includes order preparation time, run time, move time, inspection time, and put-away time. For simple processes, the cycle time and the process time can be used interchangeably. See *value-adding time*.

Pull: The principle in which production is triggered by customer demand. If there is no customer demand, the process or operation waits. Opposite of *push*.

Push: The principle in which production operates at full capacity regardless of customer demand. Opposite of *pull*

Takt time: Frequency or pace of production required to meet customer demand. Defined as available time divided by customer demand. Sometimes the term *customer takt time* is used to mark the difference from the production pace (*production takt time*).

Upstream: Operations in earlier parts of the production process or value stream. See *downstream*.

Value-adding time: Time spent on activities that add value to the product, i.e. what the customer is prepared to pay for. Usually indicated by the process time.

VSM: Abbreviation for Value Stream Mapping. Sometimes also used for indicating the Value Stream *Map* itself.

Waiting time: Time when products or people are idle. Waste Anything that slows down the value stream without benefit. Usually defined as unnecessary transportation, inventory, motion, waiting, over processing, over production, and defects.

Work in process: Often abbreviated WIP. Indicates products that are somewhere in the production chain, usually before the finished goods inventory. Also: Work in progress.

1. Introduction

1.1. Overview

We live in a world that is becoming smaller every day. No, the earth is not shrinking but with the continuous advances in communications and world commerce, parts and products can and are being sourced from all across the globe. Reducing cost is imperative if an organization is going to remain competitive and not only survive but also thrive. We must look for ways to do things more efficiently with less waste. We must make sure that everything we do adds value to our products or services. Lean initiatives are currently active in various industries and organizations. In order for a lean initiative to be successful, we must be able to measure and quantify improvement. Value Stream Mapping (VSM) is an indispensable tool in the Lean toolbox that can bring a new level of clarity to your processes. By mapping a process, we can gain a better understanding of the work being performed, which processes or process steps are actually adding value, and which are creating waste.

1.2. History of value stream mapping

Value stream mapping became a popular practice with Lean's rise in the second half of the 20th century. It was one of the foundations that made the Toyota Production System a manufacturing sensation, although, by that time, the term VSM was not present. However, it is a common misconception that Toyota invented the practice associated with visually mapping a workflow. There are records of diagrams showing the flow of materials and information By the 1990s, the value stream mapping process became part of the lives of many western managers. Its popularity started to outgrow manufacturing and eventually spread into knowledge work industries such as software development, IT operations, marketing, and many others.

1.3. What is Value Stream Mapping (VSM)

Value Stream Mapping is a form of process mapping used to document, analyse and improve the flow of materials and information required to produce a product or provide a service. Value Stream Mapping defines and illustrates the sequence of activities, and the flow of materials and resources required to produce a product or provide a service. There is some confusion between Process Mapping, or Process Flows, and Value Stream Mapping. While both are useful, there is a significant difference in their format, level of resolution, focus and application. Process Mapping and Value Stream Mapping differ in that Value Stream Maps:

- Are developed at a much higher level than process maps / flows.
- Display a broader range of information that looks at the entire manufacturing process from receiving raw material and purchased components all the way through to the finished product and delivery to the customer.
- Include the flow of data and other information through the process.
- Include information regarding cycle times and resources required at each operation
- Allows the team to calculate the value added by the process.
- Can identify waste in the overall process and determine where to focus future improvement projects (or Kaizen events).

Value Stream Mapping is most often associated with manufacturing processes. In reality, it is currently being utilized in logistics applications, software development, office processes, health care and other service-related industries.

1.4. Why Implement Value Stream Mapping (VSM)

In almost every process, there is a certain amount of waste in some form or another. The challenge can be identifying where it is in a process and in what form it exists. The primary benefits of implementing value stream mapping are to help organizations:

- Take an objective look at the overall process, eliminating opinions or conjecture.
- Identify and eliminate wasteful activities and learn to prevent waste in future processes
- Gain a new perspective of their operations by examining them at a higher level

1.5. Purpose for choosing "Uday Engineering and Scaffolding" and problems identified

For this project, we choose Uday Engineering and Scaffolding's best and high sales in volume product called centring plate. This plate has a high requirement in the market and the company is manufacturing the product with traditional methodology and their scheduling was based on history and assumption. when we visited the pant, we saw various inefficiencies and we saw the scope of development. To cope up with all those inefficiencies in manufacturing and to tap all this wastefulness we applied the concept of value stream mapping and with the collected data lots of things were quantifiable and there was immense scope for improving the process and make sure the production line gets into the streamline flow.

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.

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.

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 process is carried out by one worker and takes usual time but this process causes lot of fatigue and also sometimes leads to misalignment.

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

So to solve all these problems Value stream mapping was the convenient method which could be adopted effectively.

2. Literature Review

The term value stream was first used in the book The Machine that Changed the World (1990) by Womack, Jones and Roos, and further discussed in Lean Thinking (1996) by Womack and Jones [13]

In a later book by Martin and Osterling [8] the authors defined: “a value stream is the sequence of activities an organization undertakes to deliver on a customer request.” (Martin and Osterling, 2013). More broadly, “a value stream is the sequence of activities required to design, produce, and deliver a good or service to a customer, and it includes the dual flows of information and material.”

The activities in a value stream can be the work performed by the organization itself, as well as the work performed by outside parties; even the customers can be a part of a value stream. There are different types of value stream. The main type is one that a good or service is requested by and finally delivered to an end customer. A value-enabling or support value stream is a value stream that supports the delivery of value (e.g., IT support, hiring, product design).

Rother and Shook (2003) [9] describe a method, “Learning to see”, for mapping value streams. The method separates material and information flow. Rother and Shook (2003) [9] discuss also the importance of having a process owner, a value stream manager, who will be responsible for the value stream, and the development of the value stream. The method is divided into mapping the current state, mapping the future state and implementation in what they define as Yearly Value Stream Plan. During the process of mapping the current state value added activities and non-value-added activities are revealed.

Rother and Shook (2003) [9] state that the practitioner should start with an overall picture and later detail the process map where necessary. The future state or to-be scenario is then described, where the objective is to create value stream where every individual process is connected to a customer by preferably continuous flow and a pull system. Each process should strive for a single piece flow. The Yearly Value Stream Plan is a break-down of the future state into goals, objectives, activities and responsibilities, which represents the implementation plan.

Wilson (2009) [14] argues that value stream mapping can be applied to any business process including service, product development, manufacturing and office processes. When doing the value stream map, it is important to choose team members carefully. A common mistake is to choose the wrong members. Another critical aspect is that everyone must understand the purpose of the value stream mapping activity. It is important to have vision with customer-focus with a three-four-year perspective. Lean includes both kaizen and kaikaku, where kaizen is small changes and kaikaku is a radical change. Value stream mapping is focused mainly on kaikaku. Takt time must be implemented to reach the vision to even out waste and overproduction. PDCA, as a follow-up plan, is a good tool to incorporate the vision. A vision without a plan is a dream according to Wilson (2009) [14].

To understand and solve the problem Uday Engineering and Scaffolding is facing so as to manufacture a quality product, TAKT Time is to be adjusted with Cycle time so as to speed -up and complete the task in time. A proper procedure is to be followed to solve the problem.

3. Value Stream Mapping

3.1. Value Stream Mapping

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 (2013), Martin and Osterling 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.

3.2. How to Implement Value Stream Mapping (VSM)

We can describe the VSM methodology as a sequence of five steps as shown in Fi, in which the initial four are all leading up to the actual improvement of the process.

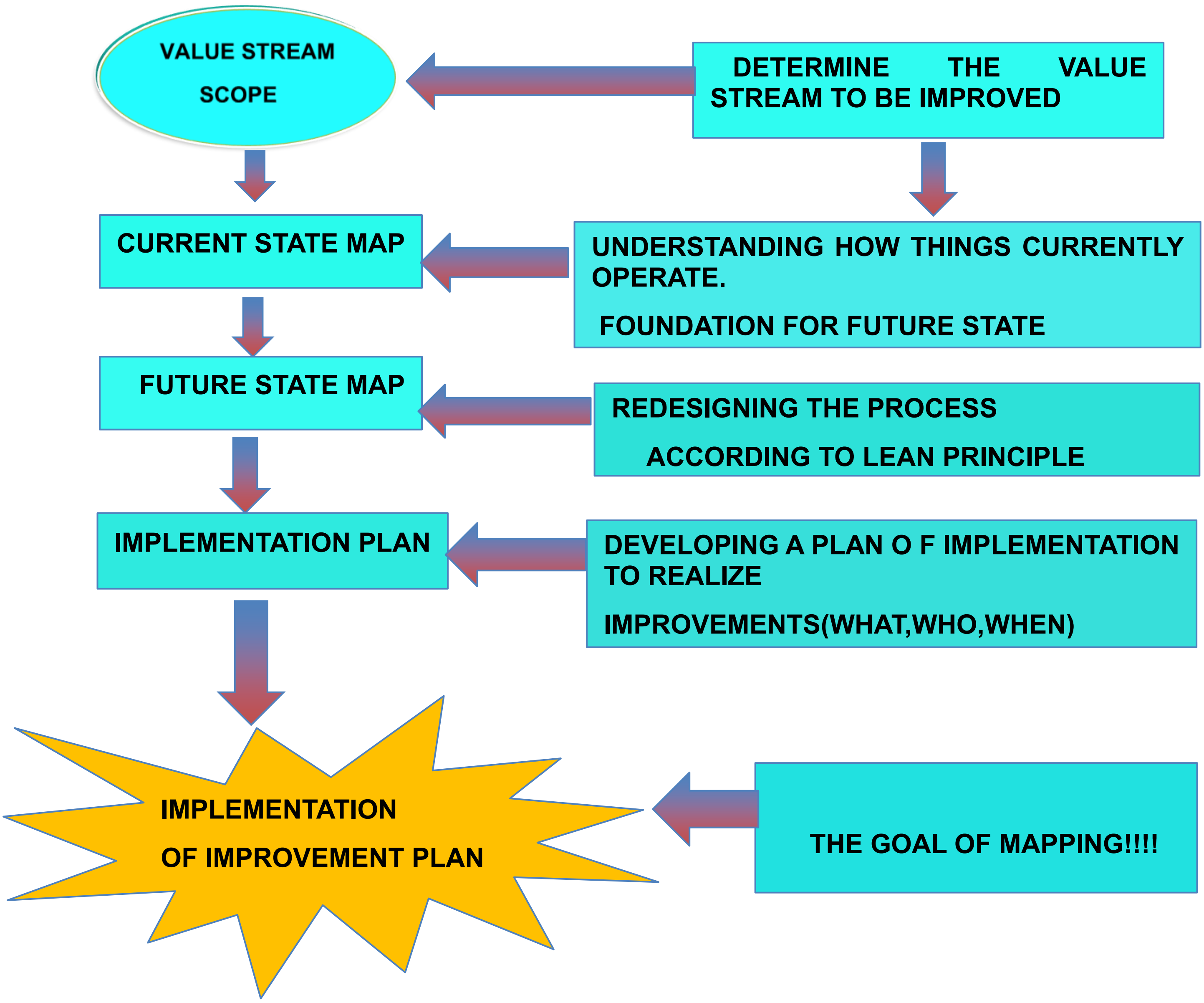


Figure 3.1 The main steps of the value stream mapping methodology

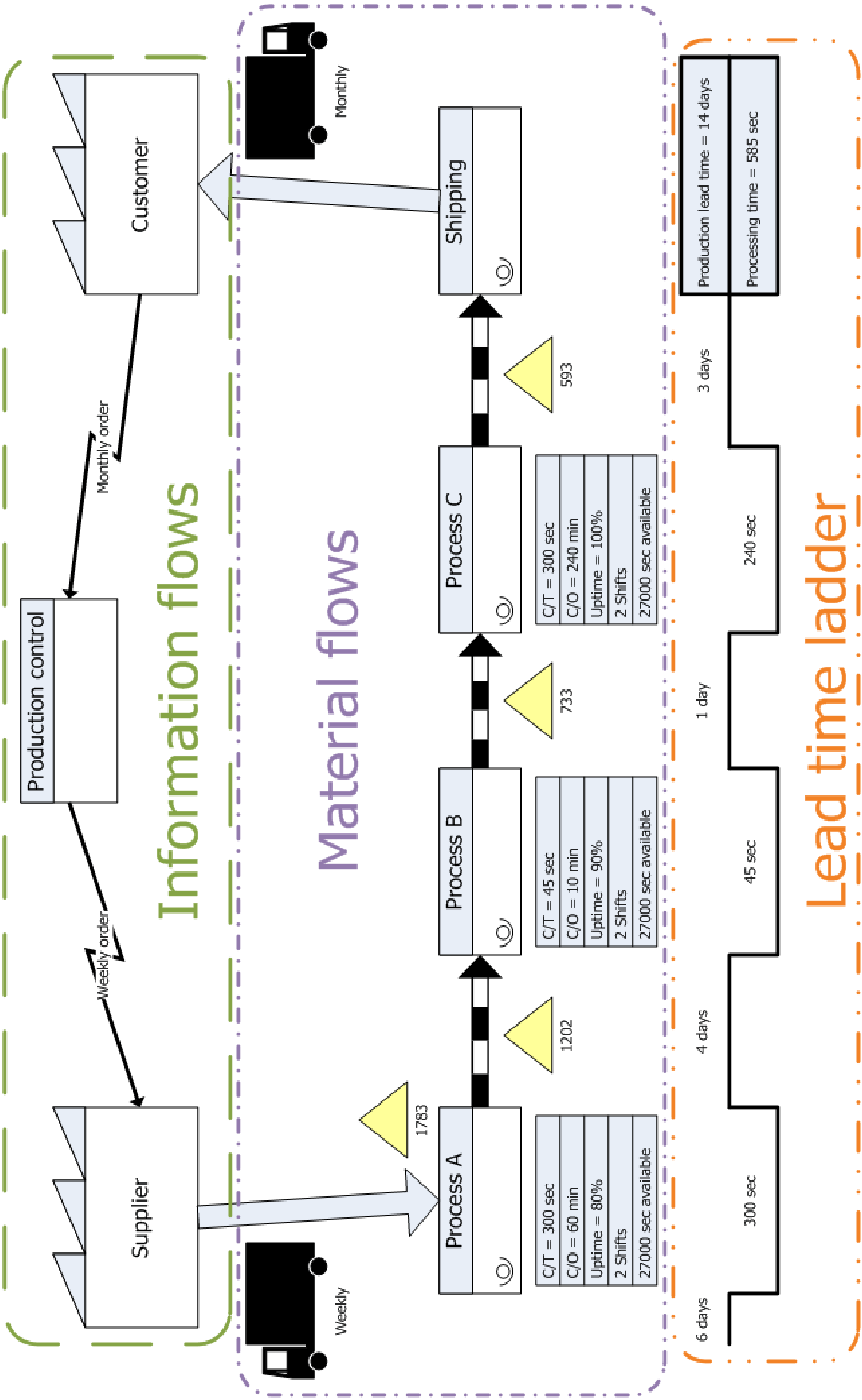


Figure 3.2 Sample Value Stream Map [10]

3.3. Create a Value Stream Map

Drawing a value stream map is the result of implementing a VSM tool. In the pioneering work of Rother and Shook (2003), the landmark book Learning to See provided the first way to "see" the value streams that Womack et al. introduced. According to Rother and Shook, the process of creating a value stream map can be briefly summarized as:

- **Identify the target product, process family or service**.

The process family is a group of products or services that go through the similar or same processing steps or the most problematic process family that needs to be improved.

- **Draw the current state value stream map.**

The current state map should illustrate how the exact activities are performed in a real working context. To create a current state map, collect data and information by walking the flow and interviewing the people who perform the tasks. With the information gathered through the process, the current state value stream map can be created using pre-defined symbols representing different elements in the value stream, which shows the information, process steps required and current delays to deliver the request product or service to the customer.

- **Analyse the current state value stream map.**

After the current state map is completed, the team may go through the process of assessing the current state value map in terms of creating flow by eliminating waste. In this step, there are several lean principles that can facilitate the improvement of the value stream (e.g., takt time, continuous flow, etc.).

- **Draw a future state value stream map**

The purpose of value stream mapping is to highlight sources of waste and eliminate them within a short period of time. The future state map should be based on an assessment of the current state map and make improvements that can be achieved. Through implementing a future-state value stream, the goal can become a reality. 5) Work toward the future state condition. A plan for achieving the future state is crucial; otherwise, value stream maps are pointless. The plan for achieving the future state value stream can be a future state map, detailed process map, a yearly value stream plan or a combination of those documents.

4. Problem Definition

4.1. Background of the Company

Uday Engineering and Scaffolding was established in the year 2012. The industry is located in MIDC Sinnar, district Nashik, in Maharashtra. Before 2012, they used to perform engineering job work and then started their own manufacturing of scaffolding materials in 2012, after looking at the changes in the market and the growth in infrastructure.

This well-known establishment acts as a one-stop destination serving customers both local and from other parts of Nashik. Over the course of its journey, this business has established a firm foothold in its industry. The belief that customer satisfaction is as important as their products and services, have helped this establishment garner a vast base of customers, which continues to grow by the day. This business employs individuals that are dedicated towards their respective roles and put in a lot of effort to achieve the common vision and larger goals of the company.

In the near future, this business aims to expand its line of products and services and cater to a larger client base. In Nashik, this establishment occupies a prominent location in Musalgaon.

Uday Engineering and Scaffolding manufactures a range of scaffolding products including wall forms, centring 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.

4.2. About Product

4.2.1. Centring Plate

Centring plate is the part of the formwork that supports the horizontal surfaces like slabs, beam bottoms etc. By using this plate, the slabs can be casted by scientific procedure. Centring plate should be strong enough to support the weight of wet concrete mix and the pressure for placing and compacting concrete on the top of the plate. It should be rigid to prevent any deflection in surface after laying cement concrete and be also sufficient tight to prevent loss of water and mortar form cement concrete. Centring should be easy in handling, erection at site and easy to remove when cement concrete sufficient hard.

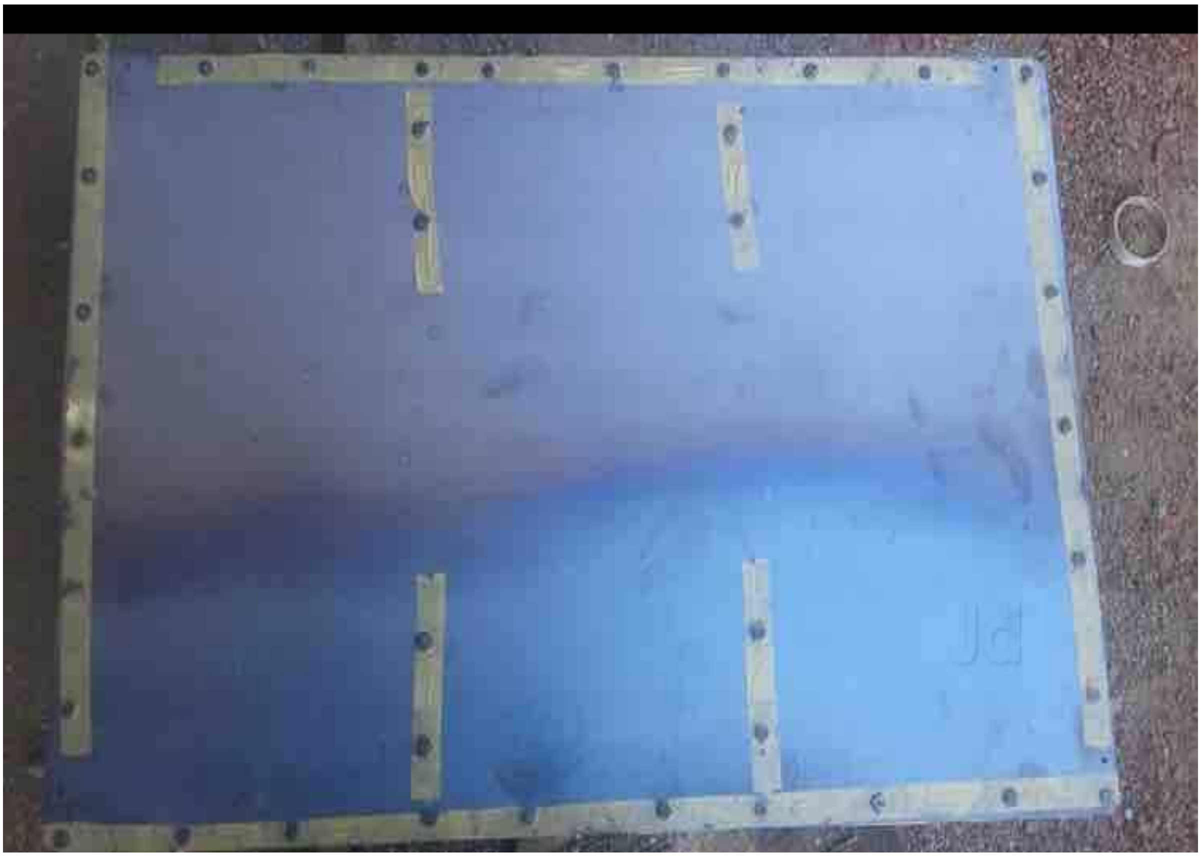


Figure 4.1 Centring plate

Centring plates are available in different sizes including:

- 900*600*25 mm
- 1200*800*25mm
- As per customer requirement.

Centring plate is made from 25*25*5mm fabricated angle and 1.6mm or 2mm thick steel sheet by riveting on it.

Size: 2*3 feet.   Weight:15.5 kgs.

Raw Materials (for 1 plate) : MS HR sheet 2mm , MS Angle 25*5 mm, Rivets(size 6) 38 nos.

Time Required: to manufacture 150 plates approx. 2 days required with 8 hours shift . One day frames are made and the other day assembly is carried out.

Workers: 12 workers (2 welders, 4 press operators, 4 helpers, 2 technical Supervisors).

Figure 4.2 Stack

4.2.2. Machines:

- 50 tones press for angle cutting.
- 30 tones press for angle notching.
- Shearing machine for sheet cutting.
- 10 tones press for sheet edge cutting.
- 2 Co2 Welding machines used.
- 4 Fixtures for plate and Fame assembly during welding.
- 4 Drilling machines.
- 10 tones press for hammering(riveting).
- Compressor (Spray Painting).

Figure 4.3 Press for angle cutting

Figure 4.4 Press for knotching

Figure 4.5 Hammer for Riveting

Figure 4.6 Shearing machine for sheet cutting

Figure 4.7 Welding Machine

Figure 4.8 Drilling machine

4.2.3. Procedure:

- Frame is made by cutting 10 feet angle by using the operations cutting, notching and bending.
- Sheet cutting is done in the sizer 2*3 on shearing machine and followed by sheet edging on press machine.
- Assembly of sheet and frame is done and two centre supports are provided of 2 feet in the plate.
- Drilling is performed by making 46 holes. (38 holes for rivets and 8 holes for nails during fitting of plate during application)
- Riveting is performed.

4.3. Layout:

Company has a 500 square meter plot with state-of-the-art infrastructure which includes a factory, a shed, an office for administration, and a tool room and storage space for raw materials.

The plant layout consists of around 10 different machines. The various departments include:

- Raw Material Section.
- Shearing machine.
- Press work.
- Welding and Assembly Section.
- Drilling.
- Riveting.
- Painting.
- Finished Goods.

A schematic representation of the layout is shown below:

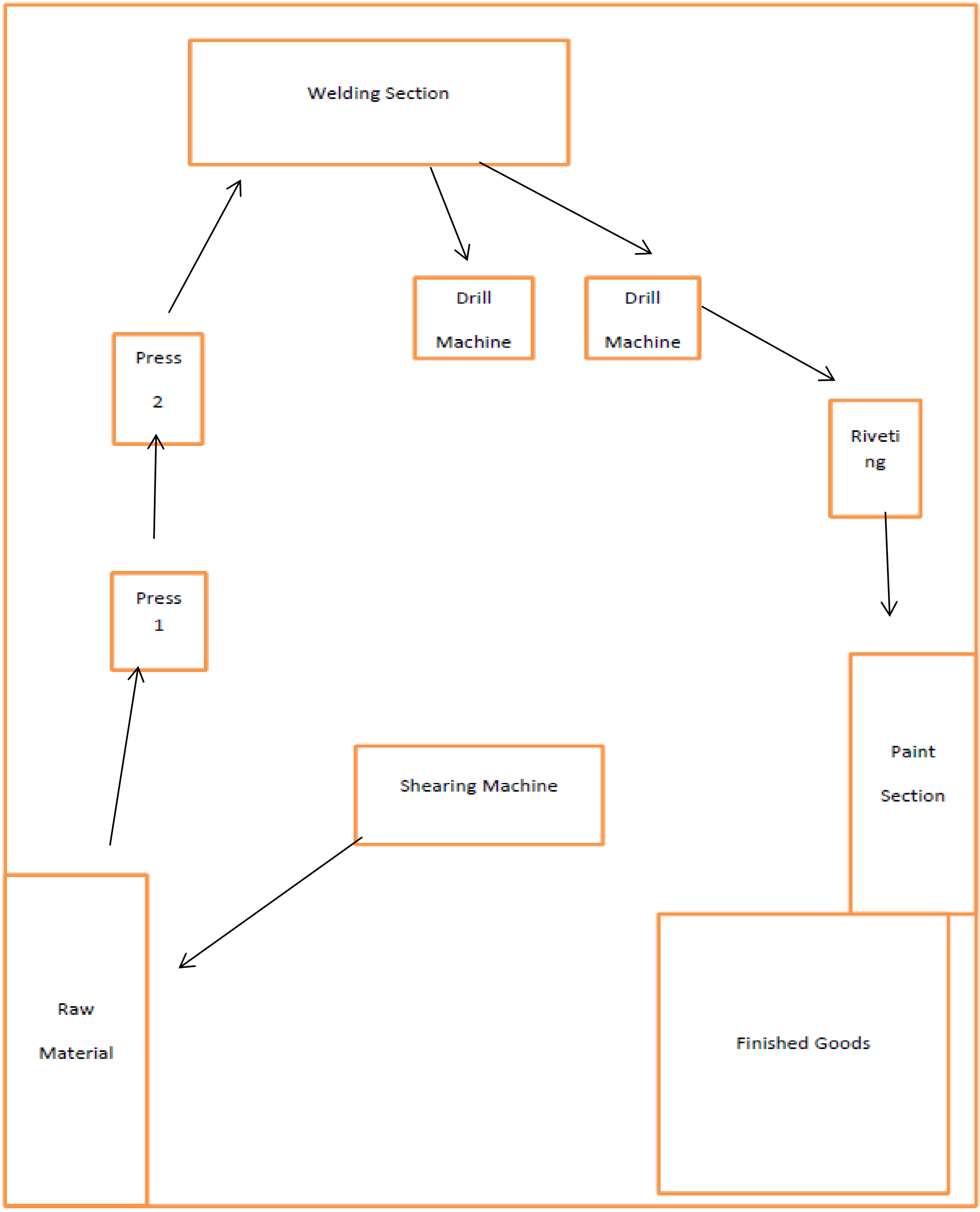


Figure 4.9 Company layout

4.4. Problems Identified and Implementation Ideas

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 4.1 shows the time taken for sheet cutting operation.

Table 4.1 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 4.2 shows the time taken for angle cutting operation.

Table 4.2 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 4.3 shows the time taken for angle straightening operation.

Table 4.3 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**:

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. Table 4.4 shows the time taken for angle straightening operation.

Table 4.4 Frame Bending

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

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.

5. Methodology

The biggest problem for the industry operations was long lead times. In order to improve these times, the team set up several project goals. One of the main goals of our project was to create a future state VSM that illustrated the ideal material and information flow for Uday Engineering and scaffolding. With the creation and implementation of our VSM, the company's current lead time should be reduced.

· Collected data

· Created a current state VSM

·Analyzed the current state VSM

· Identified non-value added time that increases the lead time

· Created short term and long term future state maps In order to accomplish these objectives we applied the following strategies:

· Obtained information from various employees

· Conducted time studies

· Observed processes during different times of the day, on different days of the week .

5.1. Collecting Relevant Data

An essential part in creating the VSMs was to obtain existing data. There were a few ways in which we gained information. The first, we acquired data directly from the company. To do this we talked with the operation managers as well as the floor managers. We met with the managers and remained in contact. The operation manager respectively provided us with production data as well as quality data. When we visited the production lines, it allowed our team to record observations as well as conduct time studies on each specific line. We split our team and carried out the allotted observation and recording of data.

5.1.1. Interviews with Uday Engineering and Scaffolding

We obtained a large amount of information when conducting our initial research within the factory. A.P. Sonawane the operation manger as mentioned before, provided us with such information as production and quality data. Along with providing data spreadsheets, floor layouts and operation instructions, the operation also answered many important questions we had concerning the VSMs and flow of operations. We also obtained information when we visited the factories ourselves. The floor manager answered questions we had concerning the machines used, cycle times, and problems he had encountered in the past. The floor answered questions as well as walked us through the presumed floor layout and the flow of materials. When visiting the factory, we were able to see how the machines operate and we were able to acquire time data, as well as inventory data. Visiting the factory in person gave our team valuable data which includes how the factory operates on a regular basis and gave us many ideas for finding areas fit for improvement.

Figure 5.1 Data collection

5.1.2. Time Studies

While we received production and work instruction data from the company, as well as observed the factories in motion, we had to conduct our own time studies to get exact information on the cycle times within each factory. The time studies gave us the observed cycle times for each of the productions lines where we found many areas of improvement, as well as recorded the cycle times. A time study is a structured process of directly observing and measuring human work in order to establish the time required for completion of that work. We recorded the cycle times for individual operations using a stop watch and pre-made tables. These cycle times gave us important information, which we used in our VSMs. The average cycle time told us how well the current operation is doing . For our data to be comparable, we had to establish a standard way of recording the cycle time. This is not always easy since each process is different; sometimes the cycle times are hard to distinguish. We found the best way was to start and end the observed cycle time, was to start when the operator pushes the 'cycle' button. Another way we recorded cycle times, was to start the stopwatch when the operator inserts a piece into the machine, and then stop the watch when the operator inserts the next piece into the machine. For each operation the number of operators and pieces produced in each cycle was recorded. For data analysis this is important. This is necessary since not all machines can do two pieces at a time. The number of samples for each operation had to be established as well. In order to show the cycle times and other obtained information in a meaningful manner, the data is portrayed on VSMs.

Figure 5.2 Recording of observation

OPERATIONS	IN-TIME	OUT-TIME
SHEET CUTTING	0	25 (sec)
SHEET KNOTCHING	25 (sec)	33 (sec)
MATERIAL CUTTING	33 (sec)	1 (min)
ANGLE STRAIGHTING	1 (min)	2:50 (min)
KNOTCHING	2:50 (min)	3:05 (min)
FRAME BENDING	3:05 (min)	3:20 (min)
WELDING STATION-1	3:20 (min)	4:03 (min)
WELDING STATION-2	4:03 (min)	5:23 (min)
DRILLING (5mm-10holes)	5:23 (min)	6:01 (min)
DRILLING (12holes)	6:01 (min)	7:28 (min)
DRILLING (5mm-26)	7:28 (min)	8:36 (min)
INSTALLATION	8:36 (min)	9:16 (min)
RIVETING	9:16(min)	9:36 (min)

Table 5.1 Recorded time

5.2. Value Stream Maps

VSMs are used to map work processes, material flow, and information flow. They have a multitude of uses and are generally easy to create and understand. Our first objective was to create a current state VSM for the factory. To do this we initially created multiple current state VSMs. These current state VSMs included a high level VSM and various factory's individual VSMs for the specific members and assembly lines. For the future state VSM, we created multiple scenarios, which were used to make a final decision program. We then listed all the processes included for the corresponding production line. As shown below, we used the different symbols to create our VSMs. Symbols for: waiting time and cycle time Inventory Production Flow Total Cycle Time Total Time. After inserting the appropriate symbols, we inserted the data we collected, as well as the correct names for each operation. After we finished inserting the correct cycle times, we calculated the total cycle time for the specific VSM by adding up the individual cycle times together.

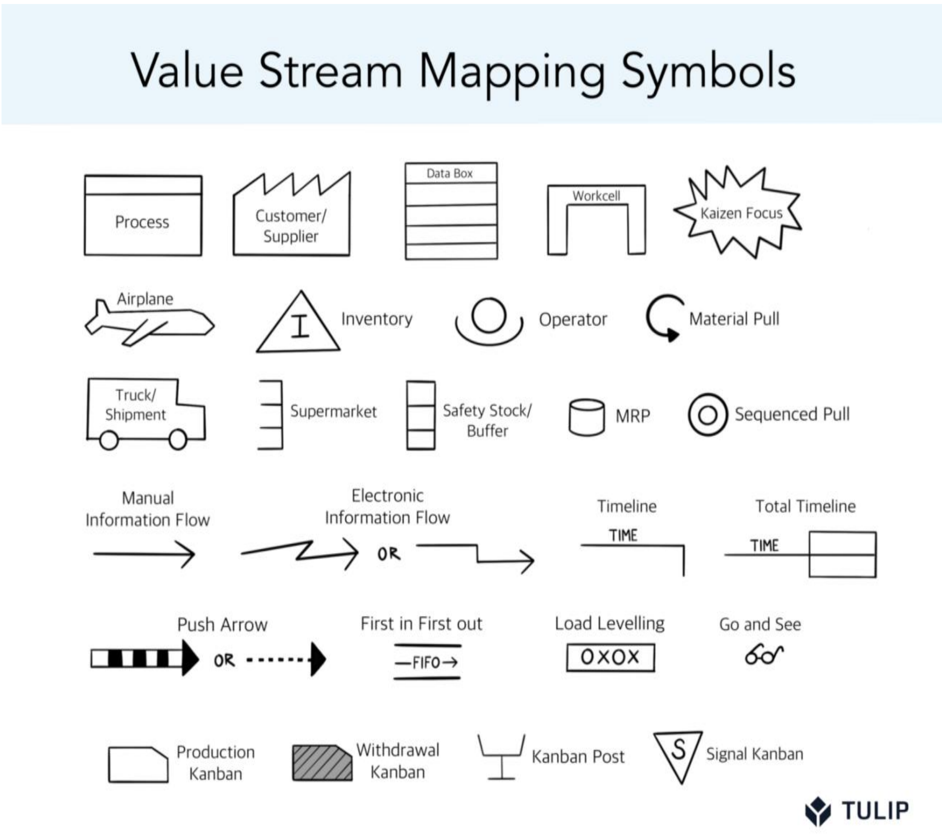


Figure 5.3 symbols used in VSM

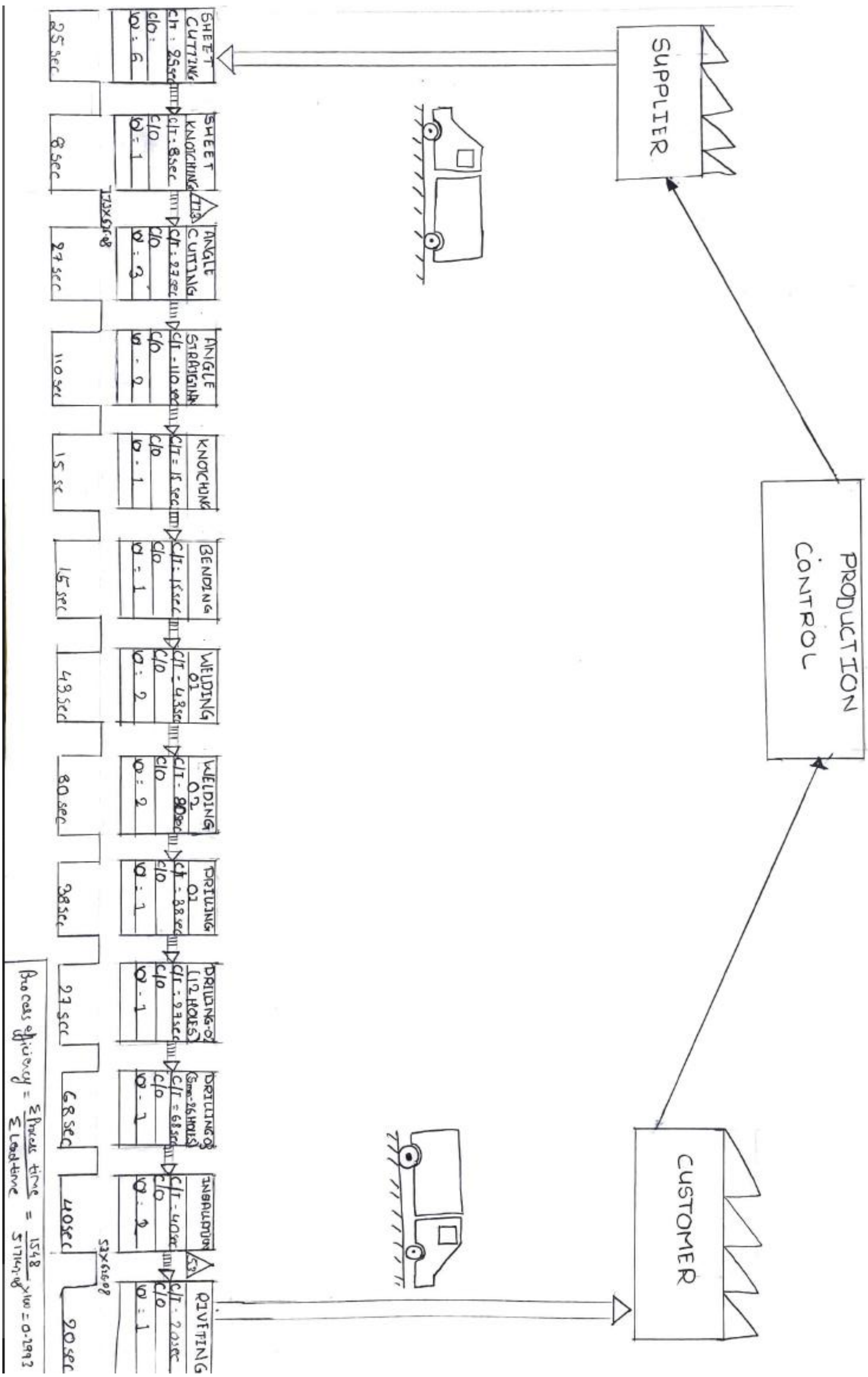


Figure 5.4 Current state map

- **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%

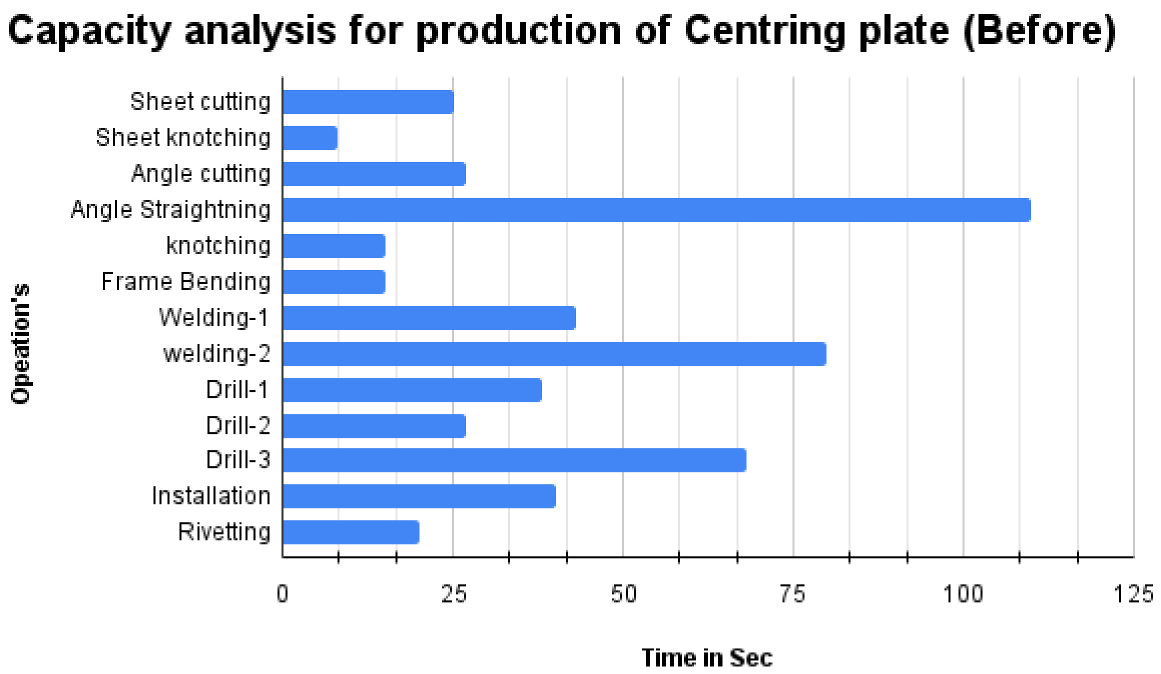


Figure 5.5 Capacity analysis for production of centring plate (Before)

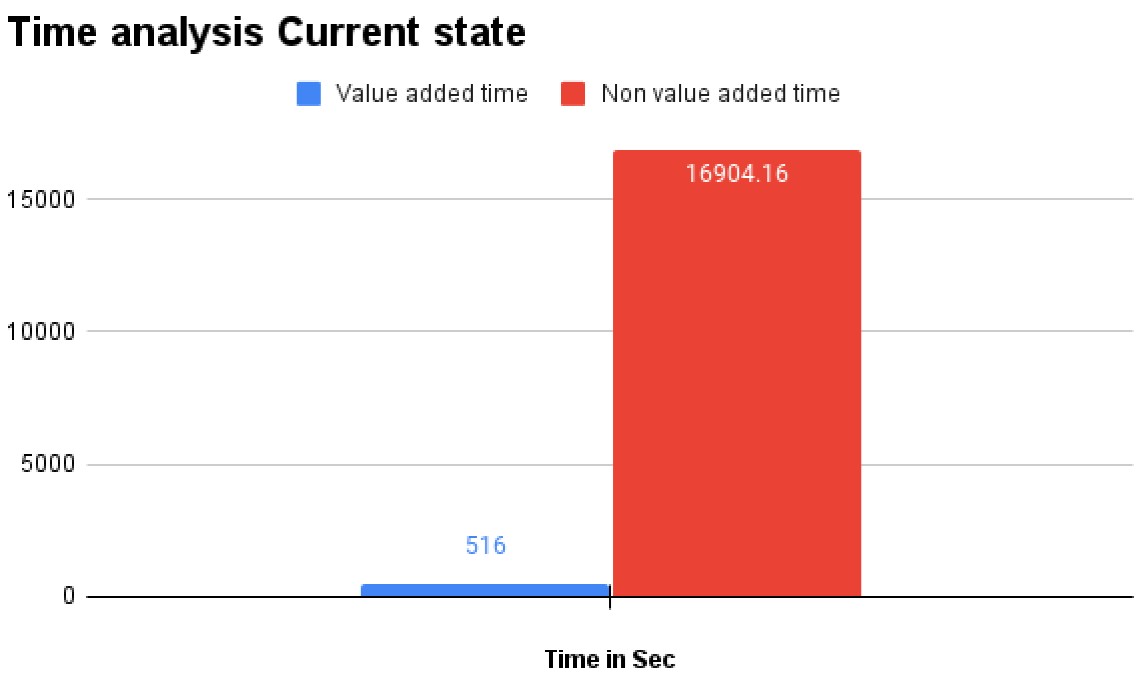


Figure 5.6 Time analysis current state

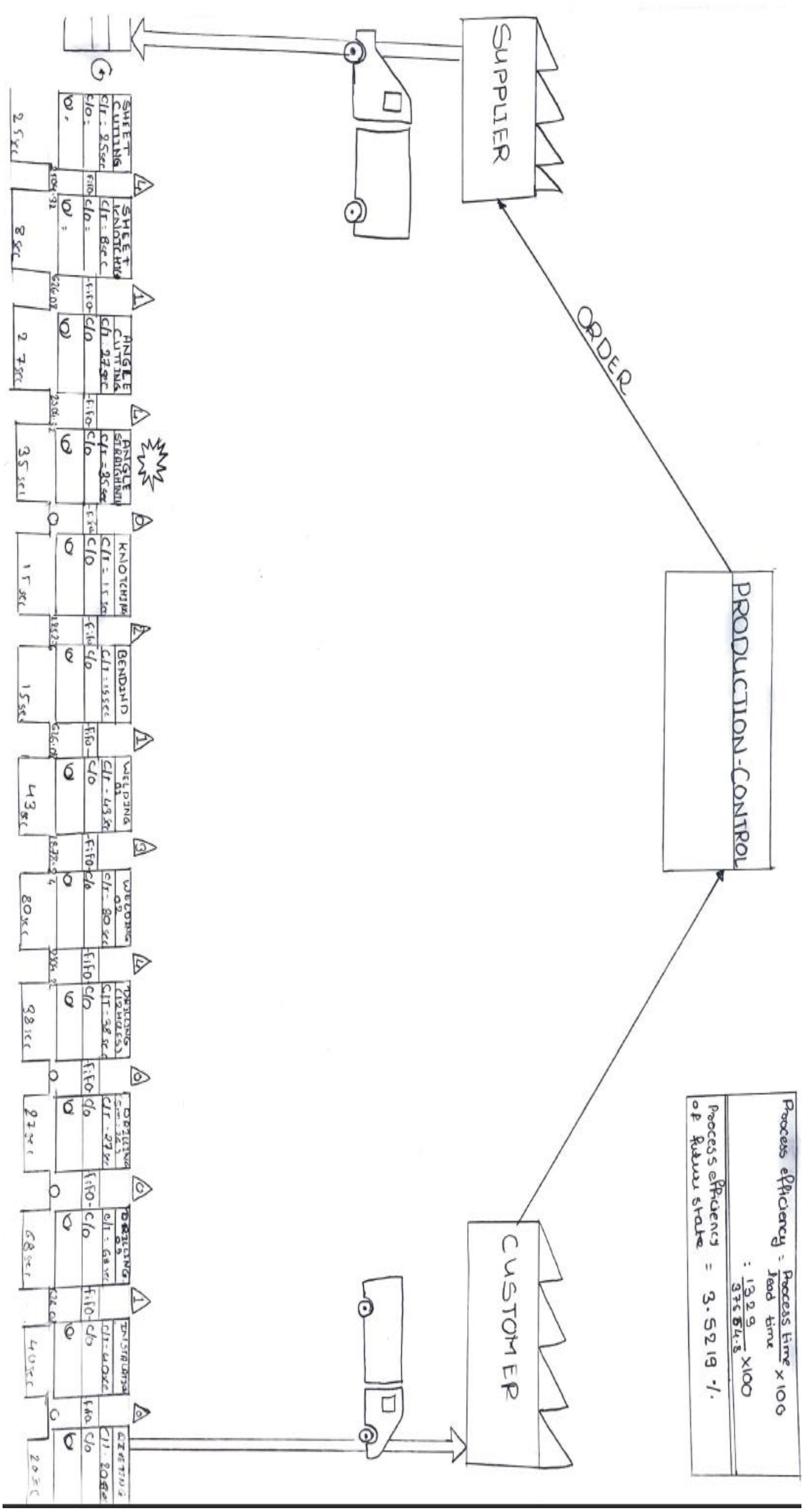


Figure 5.7 Future state

- **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 takt 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.e86400/441=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.

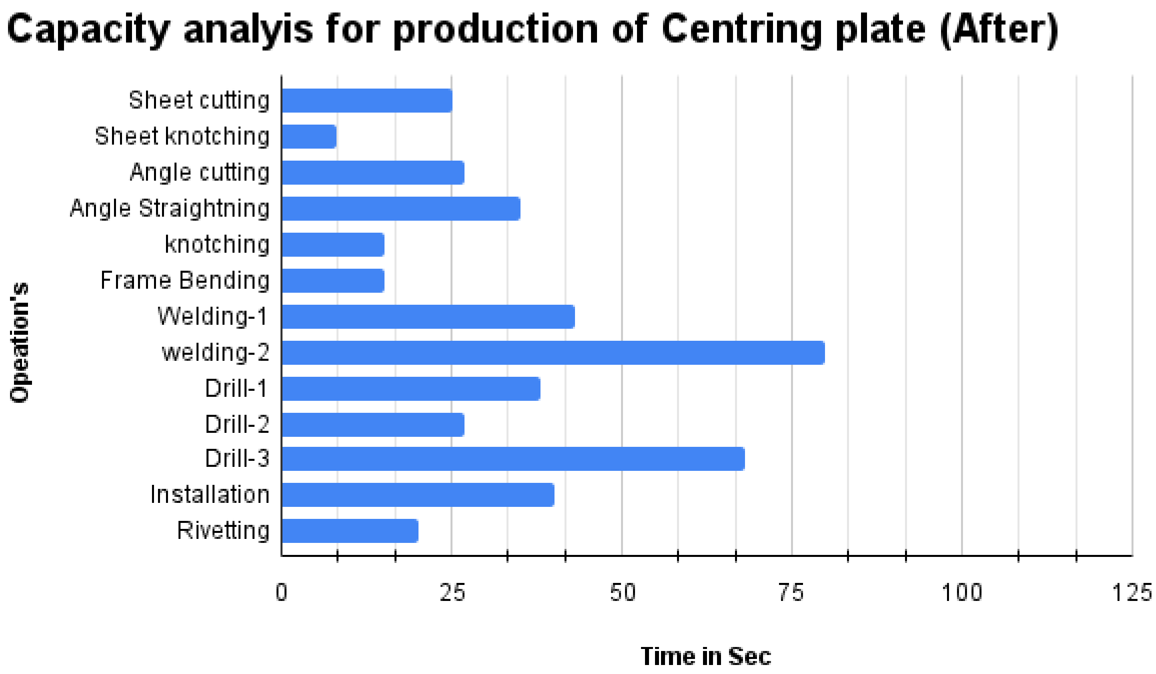


Figure 5.8 Capacity analysis for production of centring plate (After)

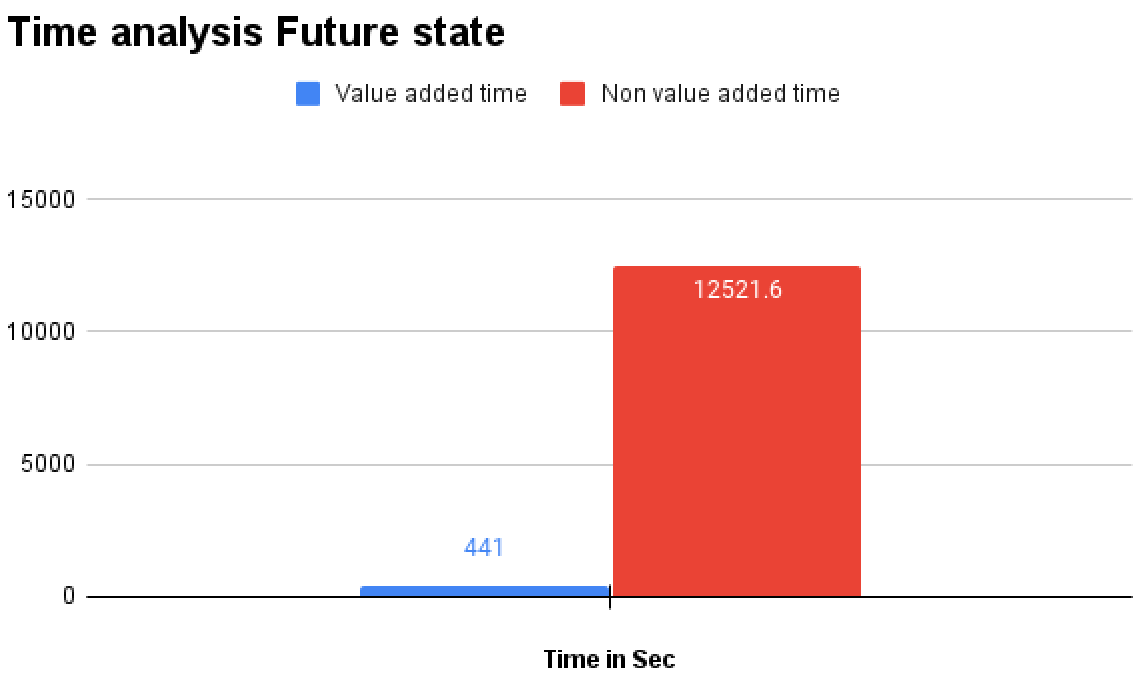


Figure 5.9 Time analysis Future state

6. Recommendations

Recommendations

Kaizen: Angle straightening was an bottle neck operation in process, so measures were taken to improve its efficiency. It was done manually using hammer and human judgement so accuracy was also compromised and three operators was engaged in the activity. To counter this new machine was installed which is an semi-automatic machine can be operated with single operator which brings down the process cycle time drastically to 35s from 110s.

Figure 6.1 Manual Angle straightening

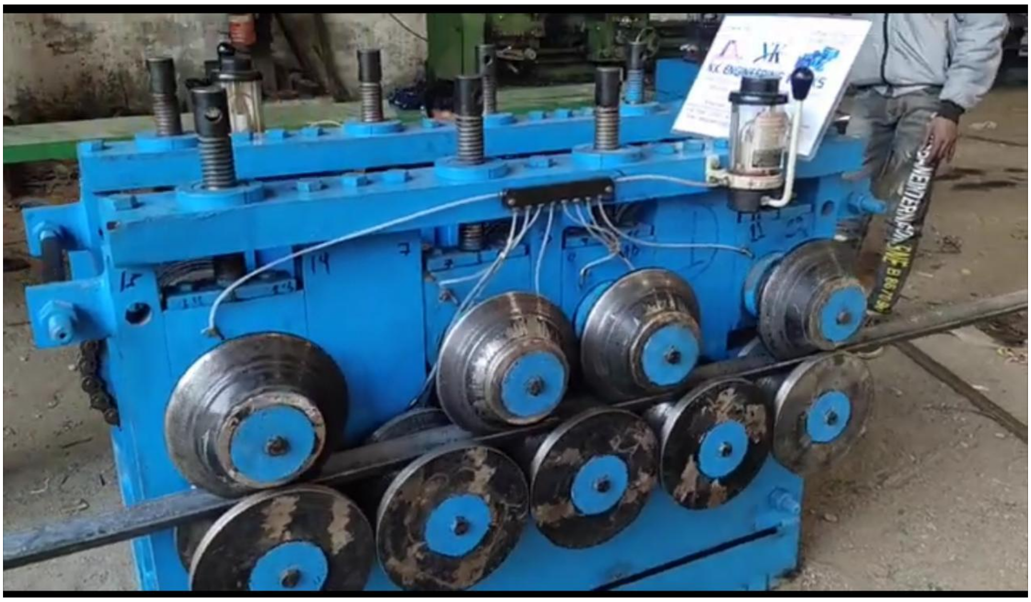


Figure 6.2 Semi-Automatic angle straightening machine

Single and continuous flow of material:

As observed during the visit in the industry the flow of material and processes conducted was not continuous due to which some machines were idle for the complete day and which resulted in increase of the lead time.

This increase in lead time and idleness of the machines could easily be decreased by carrying out single and continuous flow of material and process and also with the help of proper allotment of the workers for each process.

So to overcome this we mapped the layout of the company on a paper and tracked the movement of material so as to observe it properly and propose a new flow for reduction of idleness and lead time.

Current flow of material and processes is shown in below diagrams.

Day 1:

As seen in the below diagram and indicated by arrows only sheet cutting and sheet notching processes are carried away and rest all the machines are idle. The rest of the machines are idle for the complete shift and only sheets are made the complete day.

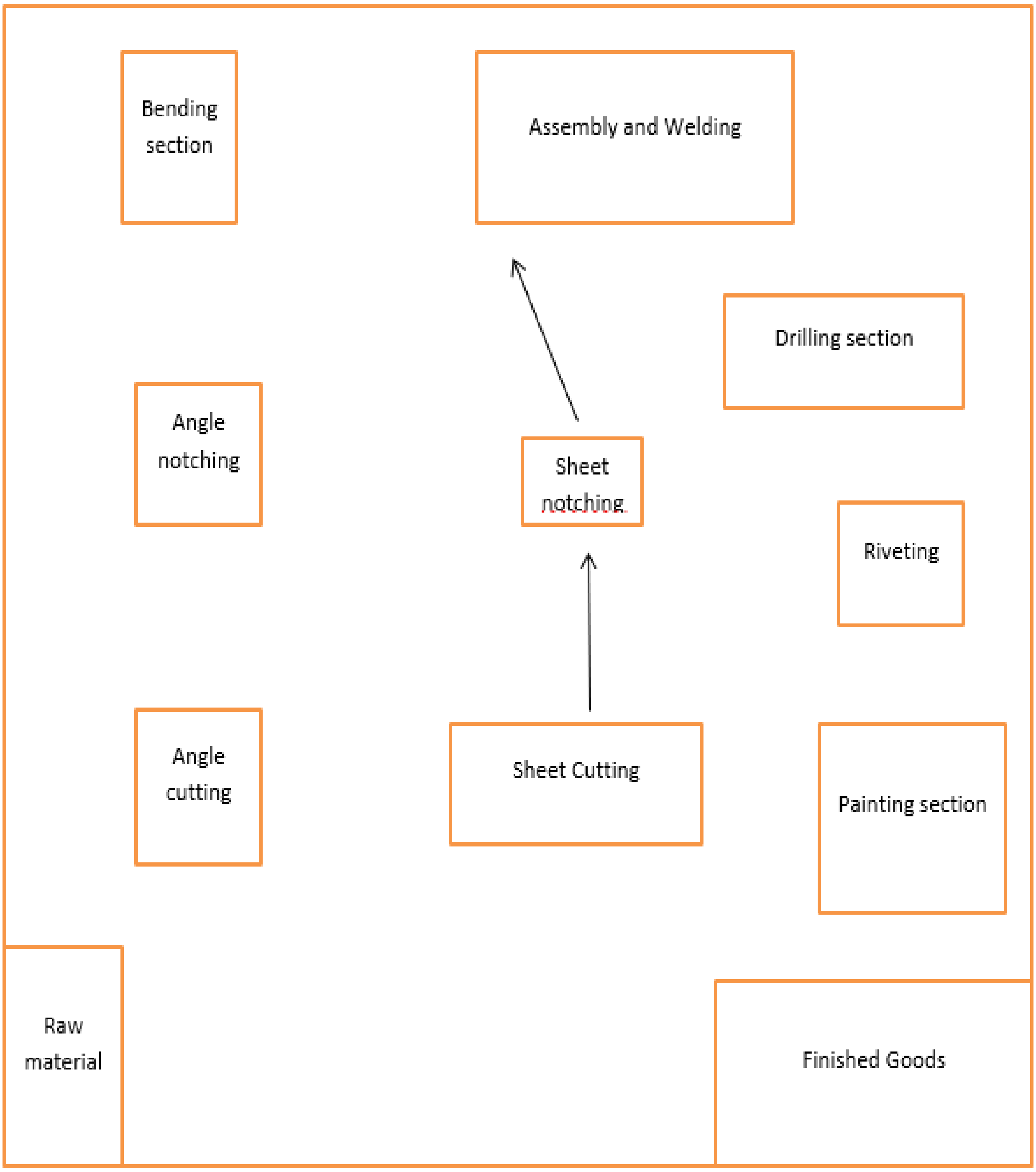


Figure 6.3 Flow of material on day

Day 2:

In the second day the frame is made. The machines and flow indicated by the arrows are working while the rest of the machines are idle at this time.

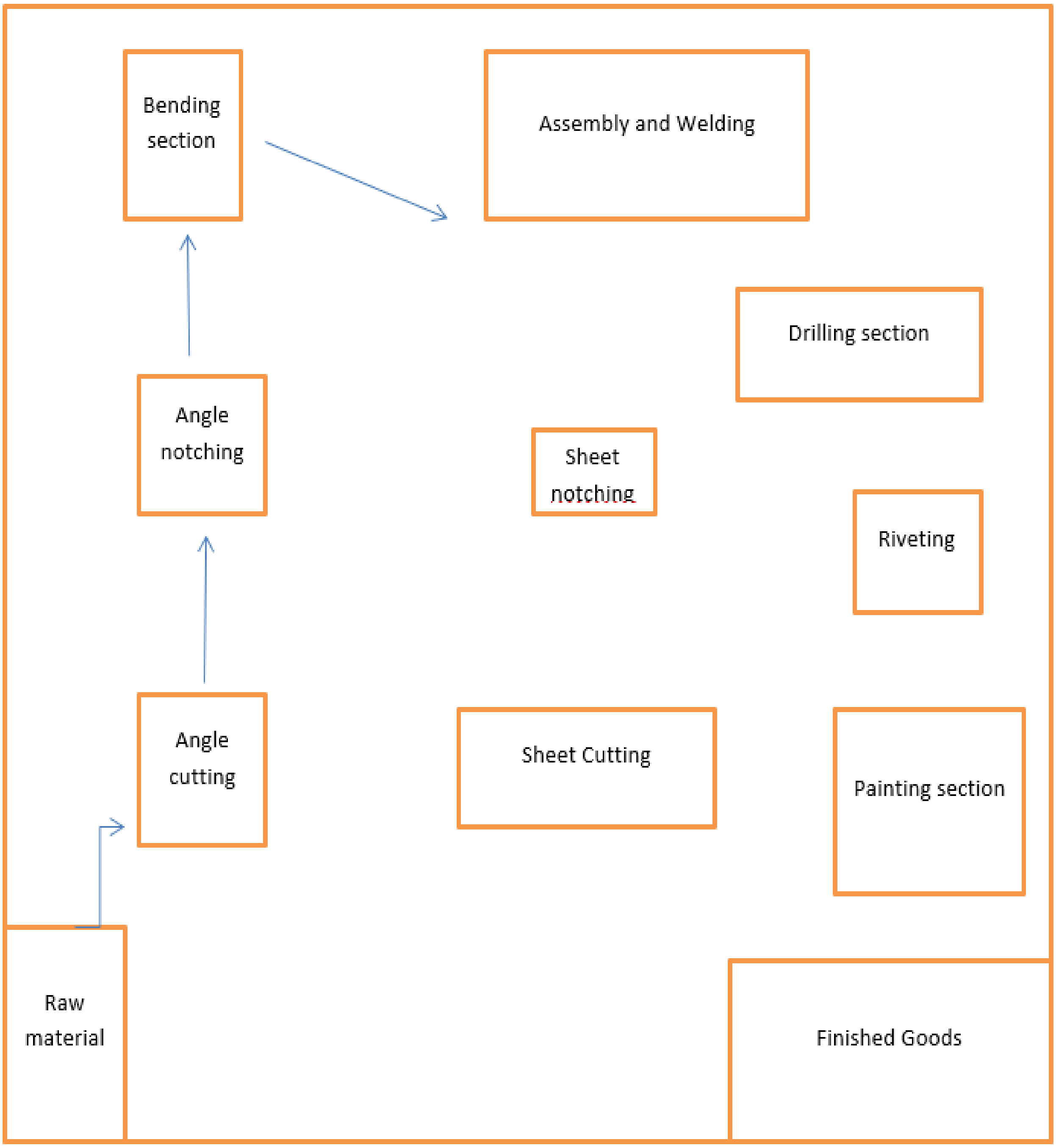


Figure 6.4 Flow of material on day 2

Day 3:

On day 3 as seen in the below figure assembly of sheet and frame is done and the flow and machines indicated by the arrows are working while the rest of the machines are idle.

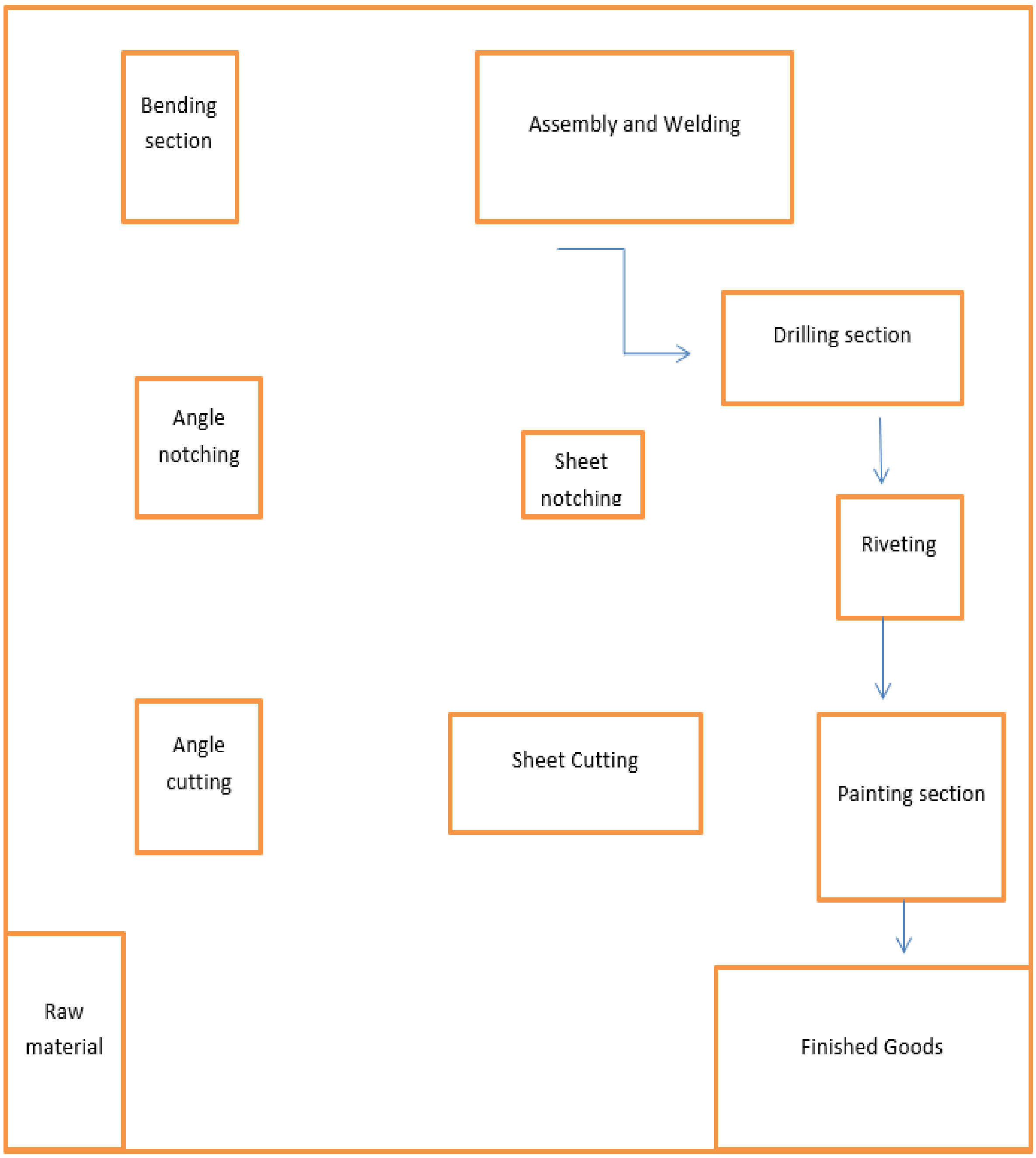


Figure 6.5 Flow of material on day 3

After observation of all three days and flow of material we could see there was huge amount of idle time of machines and the same number of plates could be produced in lesser time by reducing the lead time and idleness of machine with the implementation of single and continue flow of material.

Proposed plan and flow:

- As observed in the current flow of process carried out by the company in a shift of 8 hours 600 nos of sheets are made which results in more work in inventory than required as only 200 angle frames can be made in a single day.
- To reduce the idleness of machines and workers we proposed to cut only 200 sheets and simultaneously starting the making of frame.
- After cutting the sheet the workers working on the shearing machine could start working on angle straightening, notching and bending operations to make the frame due to which the machine ide time dropped from 8 hours to 2 hours. According to the proposed plan the current flow is:

Day 1:

Now as seen in the below diagram on day one both frame and sheet making processes are completed which previously took almost two days.

Also the inventory is properly managed and idleness of the machine and workers is reduced drastically.

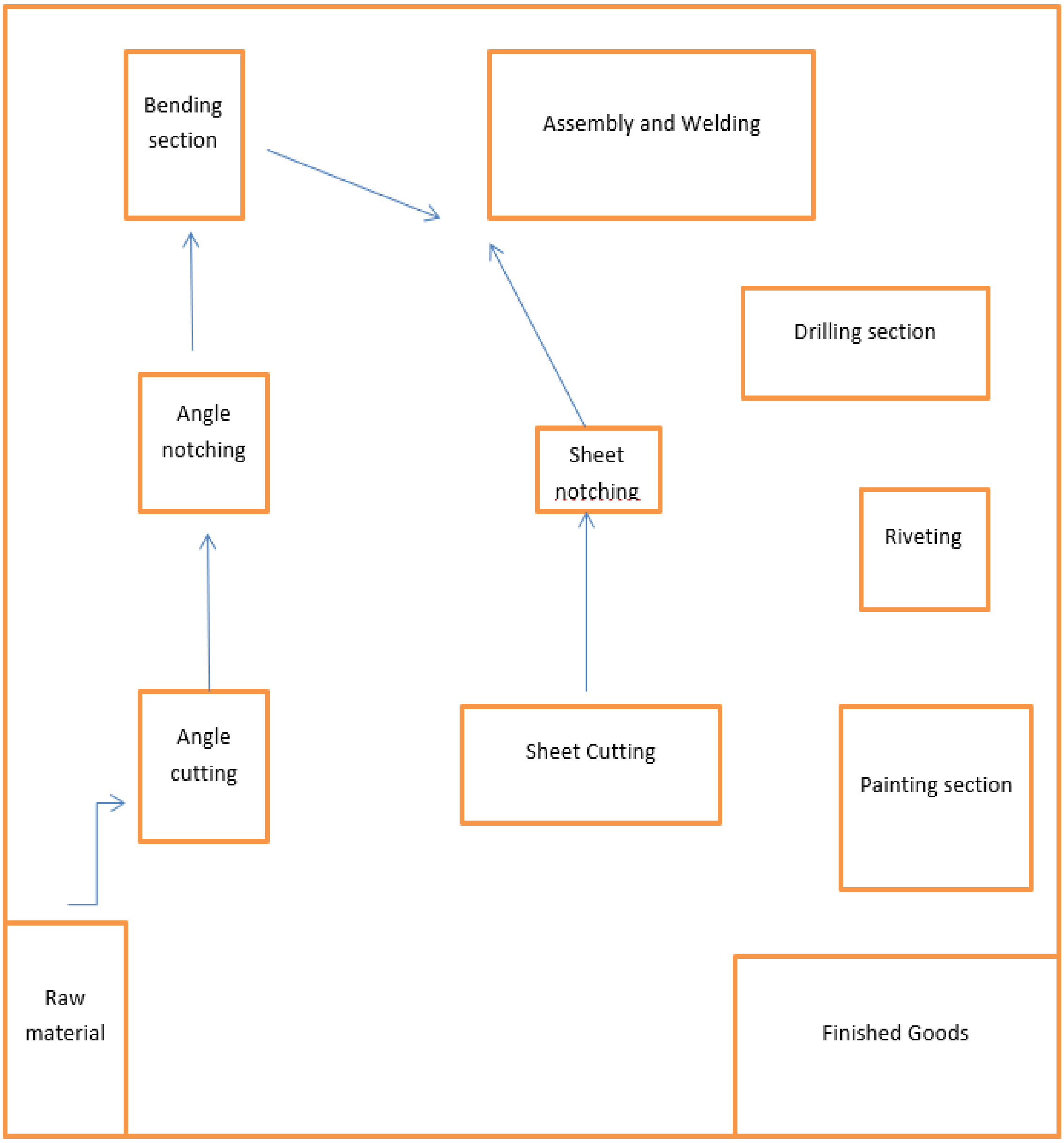


Figure 6.6 Proposed plan Flow of material on day 1

Day 2:

On day two assembly of sheets and frame is done and the centering plate is completely manufactured and stacked up in the finished goods section which previously was performed on the third day. Flow of material and working machines can be observed in the below diagram.

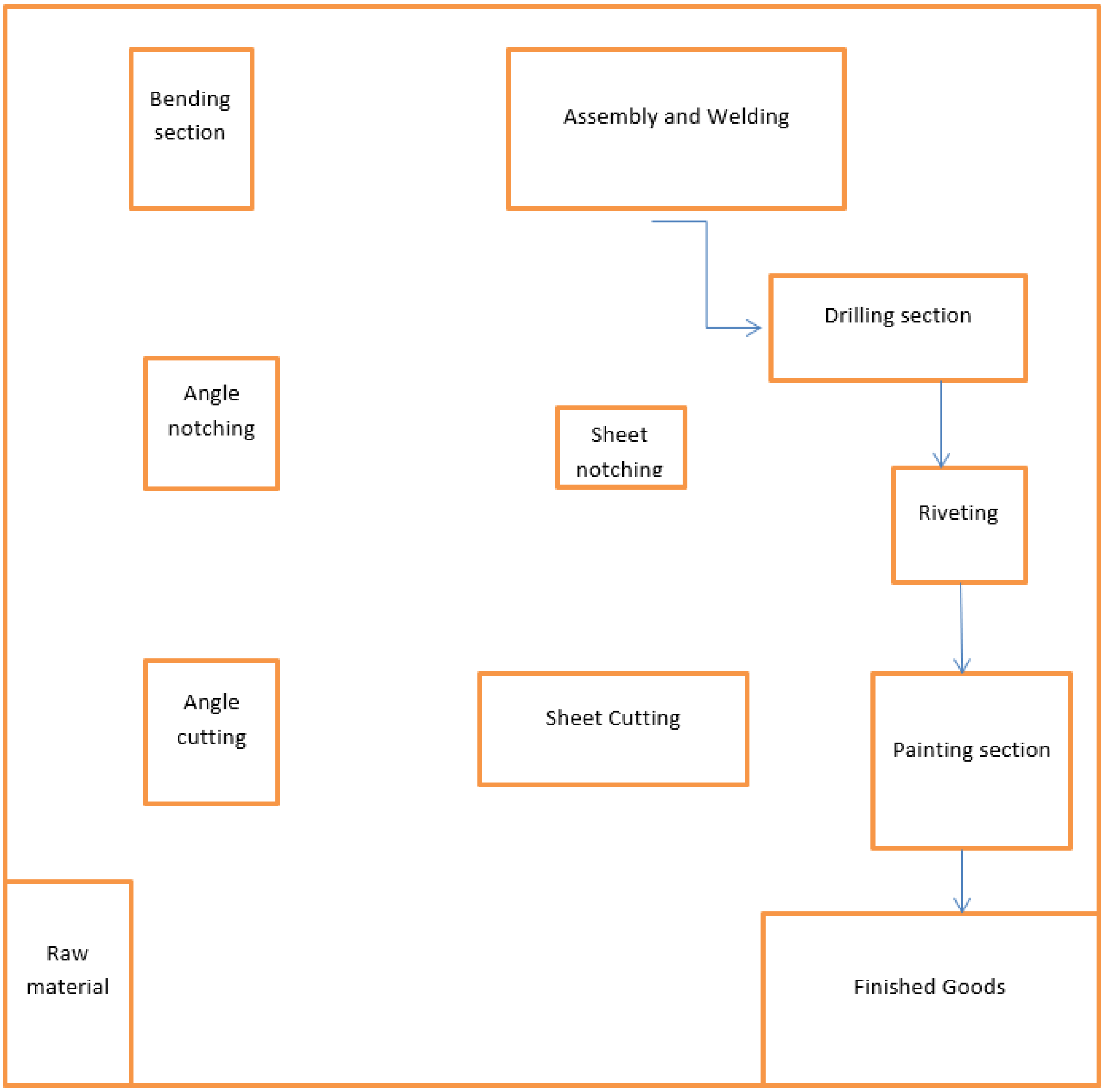
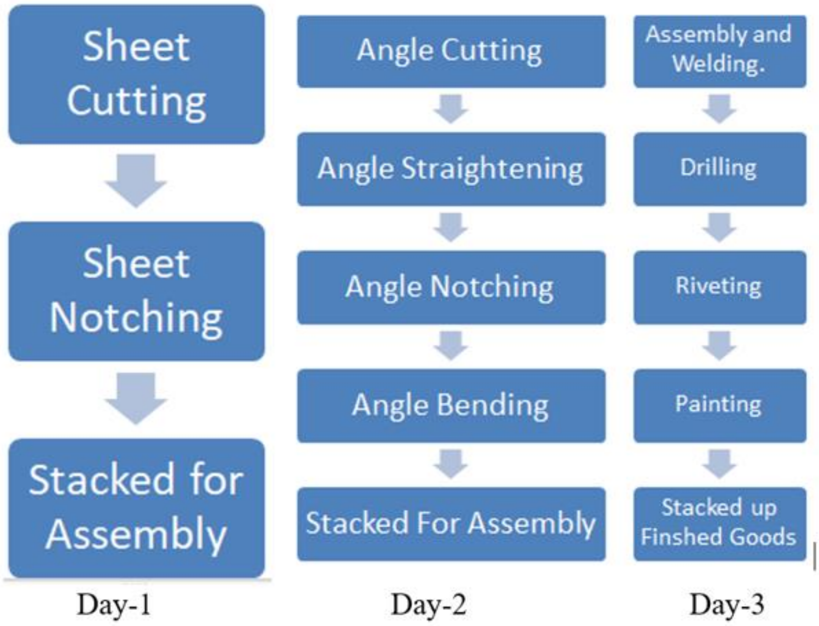


Figure 6.6 Proposed plan Flow of material on day 1

So this was the proposed plan recommended and discussed with the company which will definitely help them to reduce the lead time and idleness of the machines and hence resulting in increase in efficiency of the process.

Current process (Old):



Complete finished Product is made in 3 days as push system was used.

Figure 6.8 Old Flow of Material and Process

Future state (New):

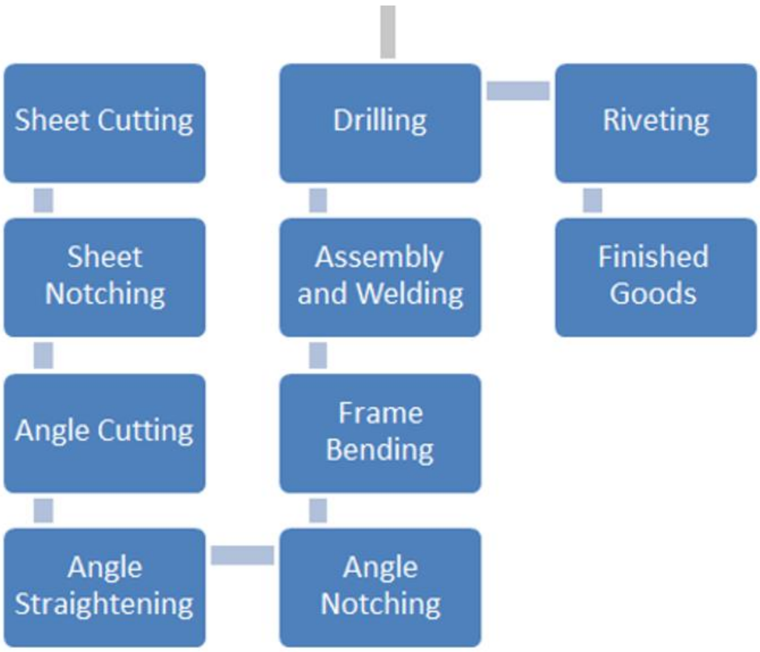


Figure 6.9 Flow Chart of Recommended New Flow of Material and Process, Complete Finished Product is made in a shift as pull system is implemented

Table 5.2

Process flow Chart Current State:

	Flow chart process		Equipment Type						
	Operation Centering Plate (Current state)								
Opn. no	Elements	Day	Operation Time						
				■	→	D	●	▽	Remarks
1	Sheet moved to shearing machine	1			●				
2	Sheet Cutting	1	25				●		
3	Cut Sheet Moved to Sheet notching press	1			●				
4	Sheet Notching	1	8				●		
5	Angle Moved to angle cutting press	2				●			
6	Angle Cutting	2	27				●		
7	Inspection if angle is straight	2		●					
8	Angle Straightening	2	110				●		
9	Angle Notching	2	15				●		
10	Frame Bending	2	15				●		
11	Frame moved for assembly	2			●				
12	Welding of sheet and frame	2	123				●		
13	Drilling Operation	3	133			●			
14	Plate moved for inserting Rivets	3			●				
15	Riveting operation	3	60				●		
16	Plate moved to stack of finished goods	3						●	
	Total	3	516 seconds	1	5		9	1	

Table 5.3

Flow Process Chart Future State:

	Flow chart process								
	(Future state)								
Opn. no	Elements	Day	Operation Time						
									Remarks
1	Sheet moved to shearing machine	1			●				
2	Sheet Cutting	1	25				●		
3	Cut Sheet Moved to Sheet notching press	1			●				
4	Sheet Notching	1	8				●		
5	Angle Moved to angle cutting press	2			●				
6	Angle Cutting	2	27				●		
7	Inspection if angle is straight	2		●					
8	Angle Straightening	2	35				●		
9	Angle Notching	2	15				●		
10	Frame Bending	2	15				●		
11	Frame moved for assembly	2			●				
12	Welding of sheet and frame	2	123				●		
13	Drilling Operation	3	133				●		
14	Plate moved for inserting Rivets	3			●				
15	Riveting operation	3	60				●		
16	Plate moved to stack of finished goods	3						●	
	Total	3	441 Seconds	1	5		9	1	

7. 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 varietyof 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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