

# Analysis of Industrial process Implementing VSM with software simulation based approach

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**Abstract-** This study is conducted at industry manufacture earth moving bucket. Earth moving Bucket is used as reference part for this study. This study starts from visiting the company and then the study of the plant and data collect for the bucket manufacturing process. Then on basis of collected data, process analysis is done and current state value stream map is draw. Value stream mapping used for identified value added and non-value added activity. The information's at individual station is collected for cycle time, utilization, setup time, work in process, and raw to finish work flow using VSM. Types of wastes are also identified at individual stations and remedies are suggested for each waste and at each station. After process study and analysis, results data of process study put on the arena software. Model creation, simulation, visualization of process and software analysis is performed using Arena software simulation. In the third step we used lean manufacturing tools for processes improvement and after process improvement again process analysis done and results of process are analyzed. We simulated the model of bucket manufacturing process on arena software and in last finally draw future state value stream map. In results comparison between present state of process and future value stream mapping is presented in terms of cycle time comparison for individual and overall cycle times, lead time comparison, work in process comparison, simulation result comparison and TAKT time comparison is presented in the form of histogram and line diagrams or graphs.

**Keywords:** Value Stream Mapping, Arena Simulation, Process Study and Analysis, Lead Time, WIP, productivity Value-added and Non-value-added activities.

## Introduction

Although Lean was initially introduced by the automobile industry, its principles have more recently spread into other industries. There are a variety of companies that have experienced the advantages of applying Lean in their manufacturing area [1]. Value stream mapping (VSM) is a lean manufacturing technique and it has emerged as the preferred way to support and implement the lean approach. Value stream mapping (VSM) focuses on the identification of waste across an entire process [12]. A VSM chart identifies all of the actions required to complete a process while also identifying key information about each action item. Key information will vary by the process under review but can include total hours worked, overtime hours, cycle time to complete transaction, error rates, and absenteeism [2]. VSM can serve as a good starting point for any enterprise that wants to be lean and describe value stream as a collection of all value added and non-value added activities which are required to bring a product or a group of products using the same resources through the main flows, from raw material to the hands of customers.

Every important part of value stream mapping process is documenting the relationships between the manufacturing processes and the controls used to manage these processes, such as production scheduling and production information, unlike most process mapping techniques that often, only document the basic product flow, value stream mapping also documents the flow of information within the system, where the materials are stored (raw materials and work in process, WIP) and what triggers the movement of material from one process to the next are key pieces of information. Value-added activities are considered the actions and the process elements that accomplish those transformations and add value to the product from the perspective of the customer (e.g., tubing, stamping, welding, painting, etc.). Non-value-added activities are the process elements that do not add value to the product from the perspective of the customer such as setting up. An alternative branch of artificial intelligence, neural networks, has appeared as a viable alternative for estimating manufacturing cost. Which too suggest the use of lean manufacturing tool to improve productivity [9-11].

## Objectives

For accomplishment of goal following objectives are identified:

- Implement lean manufacturing philosophy.
- Study of present process and analysis of process.
- Draw the present VSM map for identify the value added and non-value added activity.
- Identify waste and implement all suggesting for eliminate waste involve in manufacturing of bucket.
- Compute Plant lay out simulation using Arena for process improvement.
- Reduce time for production for increasing productivity.

## Methodology

Then a well reputed manufacturing organization was selected based on judgmental sampling techniques to carry out the implementation study. As the first step site tour was conducted in order to get a clear idea about the existing products and the overall

process of the company. A style was then selected to draw the current state VSM by collecting the relevant data. In order to carry out this tasks groups were formed which were responsible for analyzing the current process. Then the current state VSM has been analyzed and various improvement proposals were identified to reduce the non-value adding waste in the process. After that future state value stream map was drawn. After the development of future state VSM, the conclusion was made [3-4]. The first input the surface model of the contour generated in the CAD based application of calculation tool VFC and second input data is the milling head. Based on the input data system executes two steps. At first step each surface part is examined locally order to verify which of the available head and second the compound of all surfaces is analyzed to detect potentially collisions between the head and a surface part while another part is machined [8].

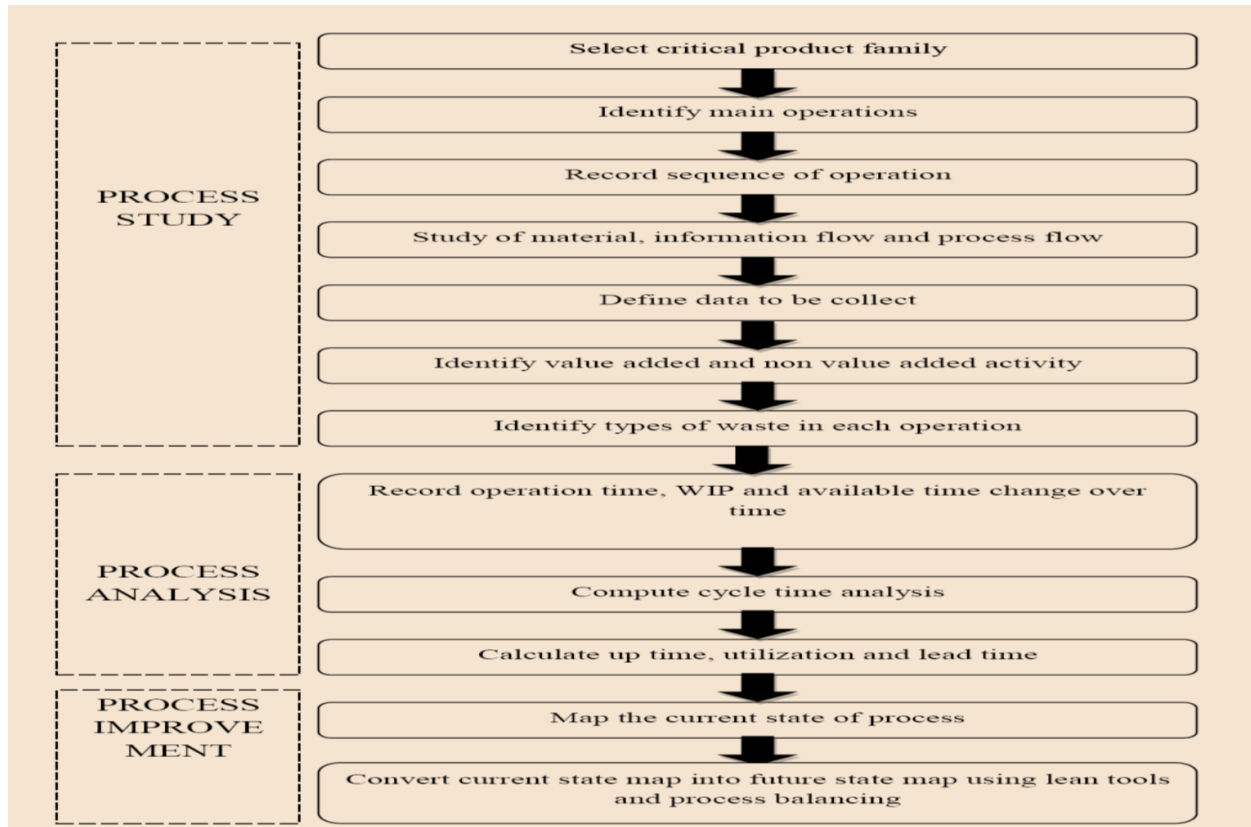


Figure 1.1: Flow chart Implementation of VSM

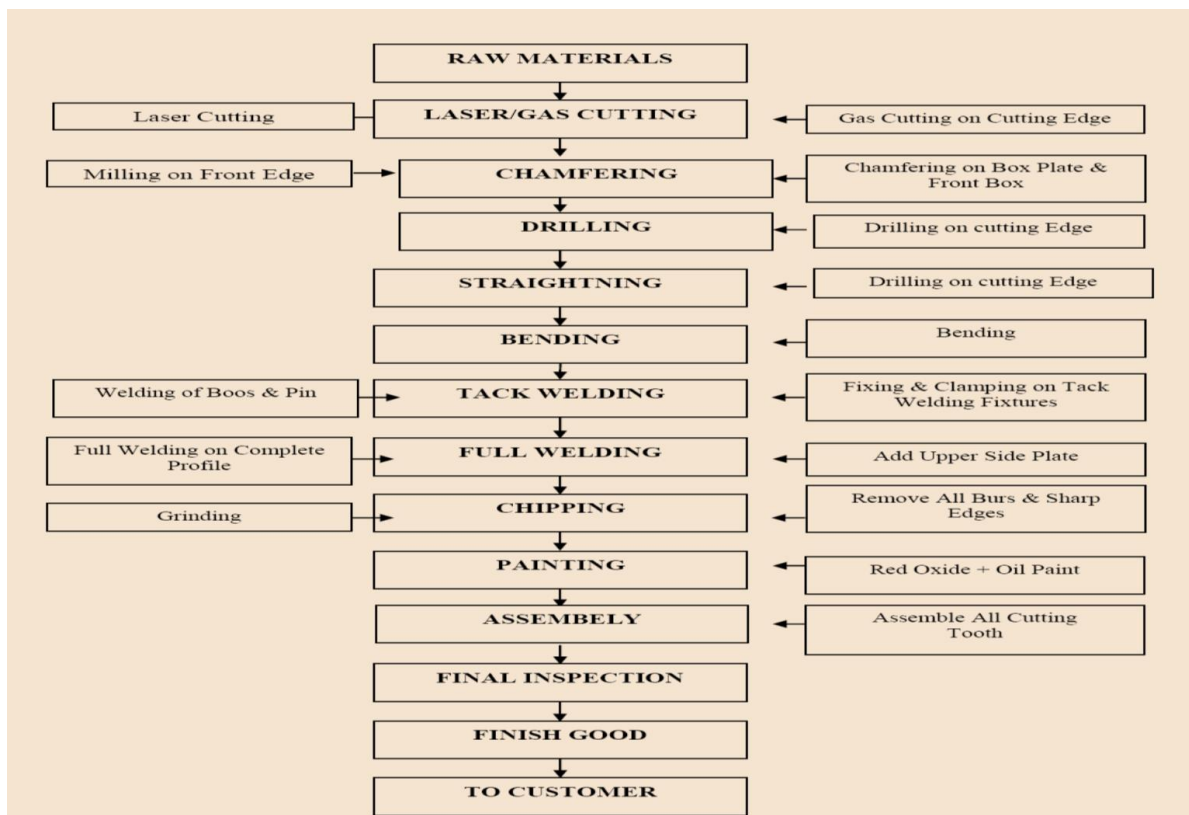


Figure 1.2: Sequence of operations

### Calculations:-

Product life cycles today are typically less than half of those in the 1980s, owing to the frequent entry of new products with more features into the market. Manufacturing competitiveness is measured in terms of shorter lead-time to market, without sacrificing quality and cost. One way to reduce the lead-time is by employing near net shape (NNS) manufacturing processes. In the analytical cost and time estimation, the entire manufacturing activity is decomposed into elementary tasks, and each task is associated with an empirical equation to calculate the manufacturing cost and time [5-7].

Table 1.1: WIP between processes in terms of bucket

Process	Day1	Day2	Day3	Day 4	Average
Cutting and Straightening	20	0	16	22	19
Cutting and Bending	25	27	21	24	24
Straightening and Bending	21	5	26	19	19
Milling and Drilling	36	9	0	30	25
Milling and Bending	36	9	0	30	25
Bending and Tack Welding	25	29	28	22	26
Tack Welding and Full Welding	25	29	28	22	26
Full Welding and Chipping	20	21	19	20	20
Chipping and Painting	20	21	19	20	20
Painting and Assembly	20	21	19	20	20
Assembly and Finish good	20	25	22	23	22

Table 1.2: Number of operators, operation time and change over and handling time

Processes	No. of operators	Operation time in min	Changeover time in min	Handling time in min
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<b>Laser Cutting</b>	3	9	2	6
<b>Milling/Chamfering</b>	-	-	-	-
<b>Drilling</b>	-	-	-	-
<b>Straightening</b>	2	4	-	-
<b>Bending</b>	3	25	30	6
<b>Welding</b>	4	150	25	10
<b>Chipping</b>	1	30	-	-
<b>Painting</b>	1	30	-	-
<b>Assembly</b>	1	30	-	-

Table 1.3: Result of process analysis of all operations

Process	operation time in min	Batch time in min
Cutting	15	90
Bending	32	197
Tack welding	55	330
Full welding	115	690

Table 1.4: Cycle time, WIP, Lead Time and over all cycle time of all Processes

Sr. No	PROCESS	Cycle Time In min	WIP In Piece	Lead Time In Days	Over all cycle time In min
1	Laser Cutting	15	12	2	975
2	Bending	32	24	4	1952
3	Straightening	4	19	3.17	1512
4	Milling/Drilling	-	13	4.34	2084
5	Tack welding	55	26	4.34	2183
6	Full welding	115	26	4.34	2190
7	Chipping	30	20	3.34	1635
8	Painting	30	20	3.34	1635
9	Assembly	30	20	3.34	1635
10	Finish Good	-	22	3.67	1760
11	total	311		36	17561

Total non-value added time is 36days.

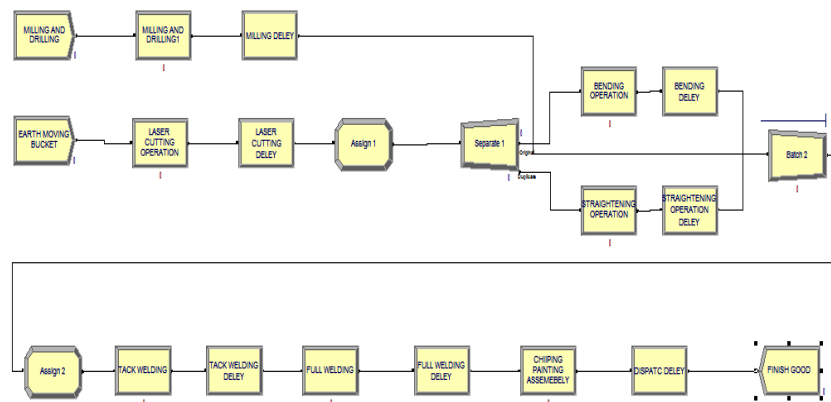


Figure 1.3: Arena simulation based on current state map

Table 1.5: Operation time, WIP, Lead time and Overall cycle time for FVSM

Sr.No	Process	Operation Time in min	WIP In Piece	Lead time in days	Overall cycle time In min
1	Laser cutting	9	7	1.16	780
2	Bending	24	18	3	1464
3	Straightening	4	10	1.67	805

4	Milling/Drilling	-	13	2.17	1040
5	Tack welding	45	15	2.5	1248
6	Full welding	90	15	2.5	1290
7	Chipping	30	12	2	990
8	Painting	30	12	2	990
9	Assembly	30	12	2	990
10	Finish Good	-	10	1.67	800
11	Total			21	10397

Table 1.6: Result of process analysis of all operations

Process	Cycle time in min	Batch time in min
Cutting	12	72
Bending	24	144
Tack welding	45	288
Full welding	90	564

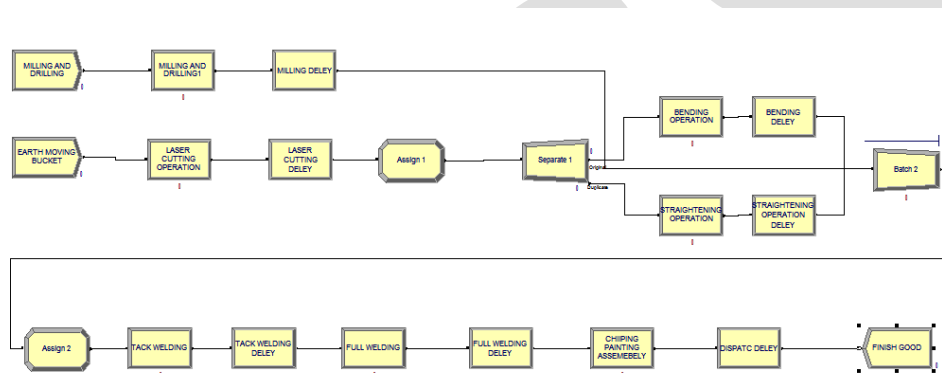


Figure 1.4: Modal of manufacturing process of bucket in arena software for FVSM

### Comparison between CVSM and FVSM for Cycle Time in min

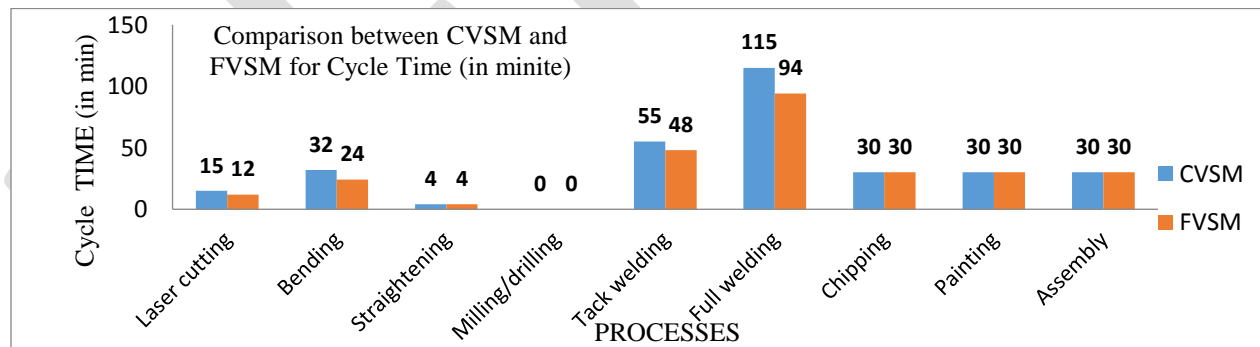


Figure 1.5: Comparison of result between CVSM and FVSM for Cycle Time in minute (bar chart)

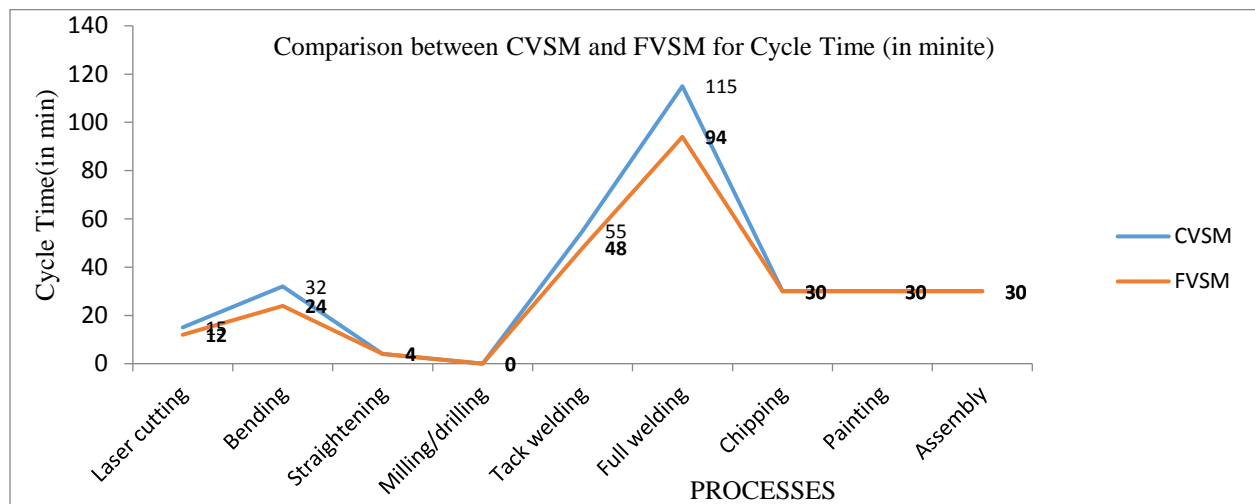


Figure 1.6: Comparison of result between CVSM and FVSM for Cycle Time in minute (Line chart)

#### Comparison between CVSM and FVSM for Overall Cycle Time

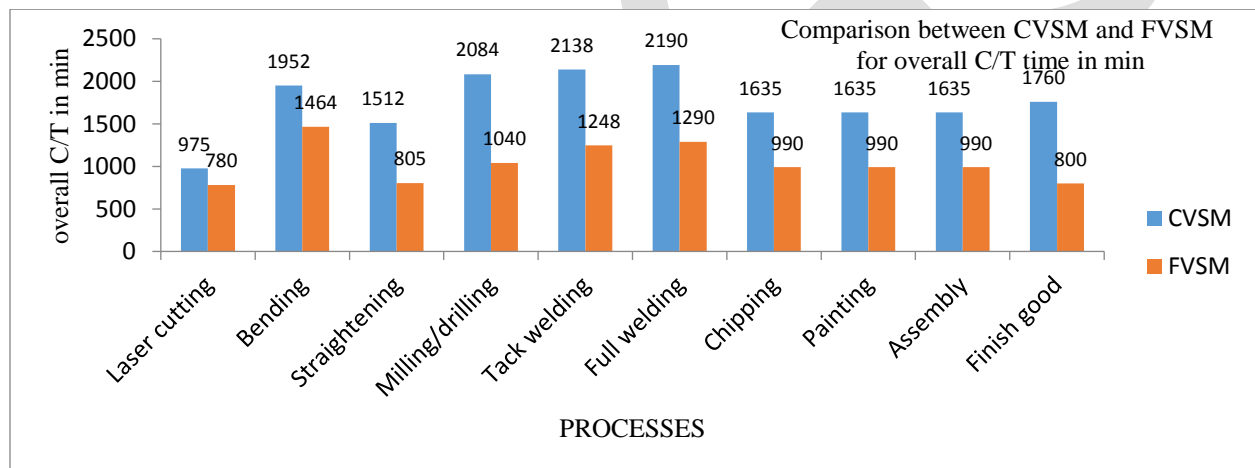


Figure 1.7: Comparison of result between CVSM and FVSM for Overall Cycle Time in minute (bar chart)

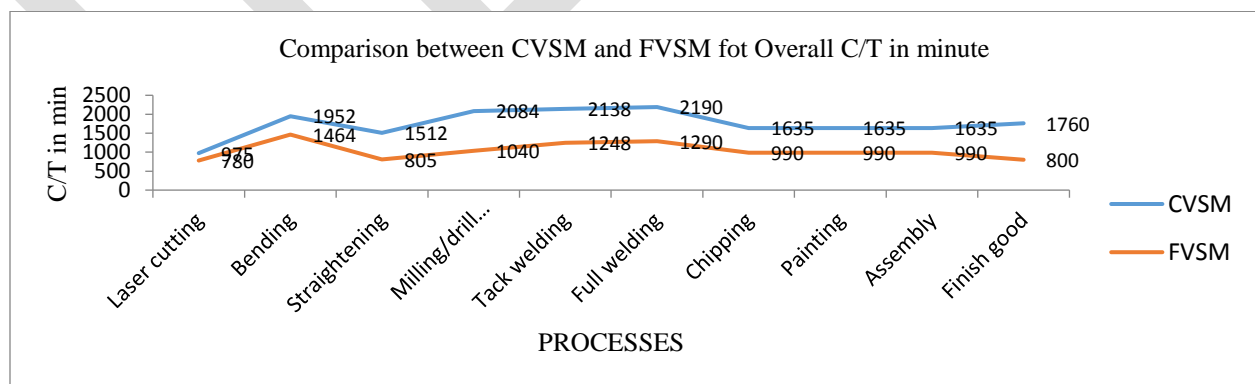


Figure 1.8: Comparison of result between CVSM and FVSM for Overall Cycle Time in minute (Line chart)

#### Comparison between CVSM and FVSM for Lead Time

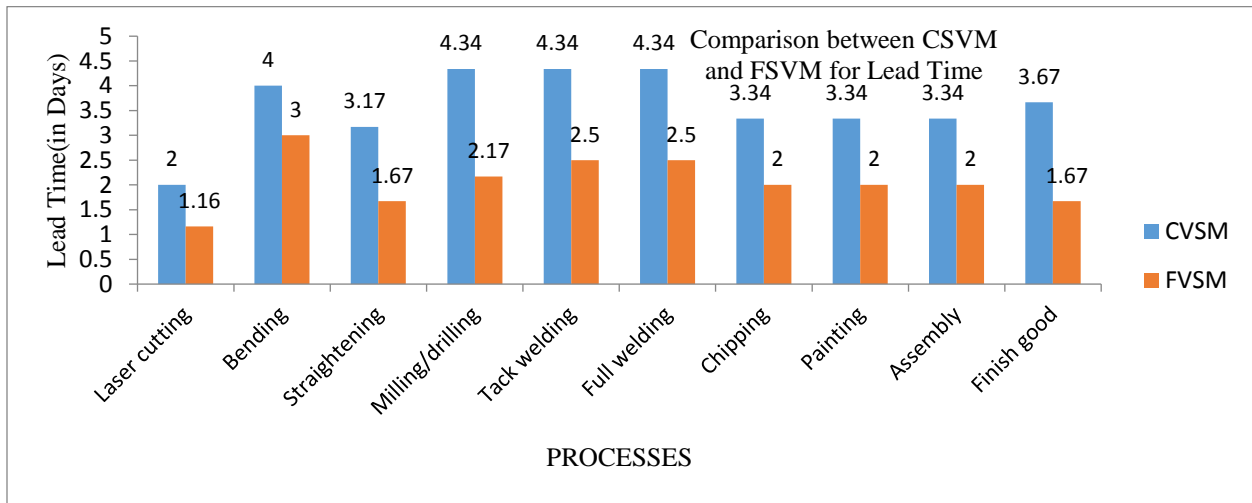


Figure 1.9: Comparison of result between CVSM and FVSM for Lead time in Days

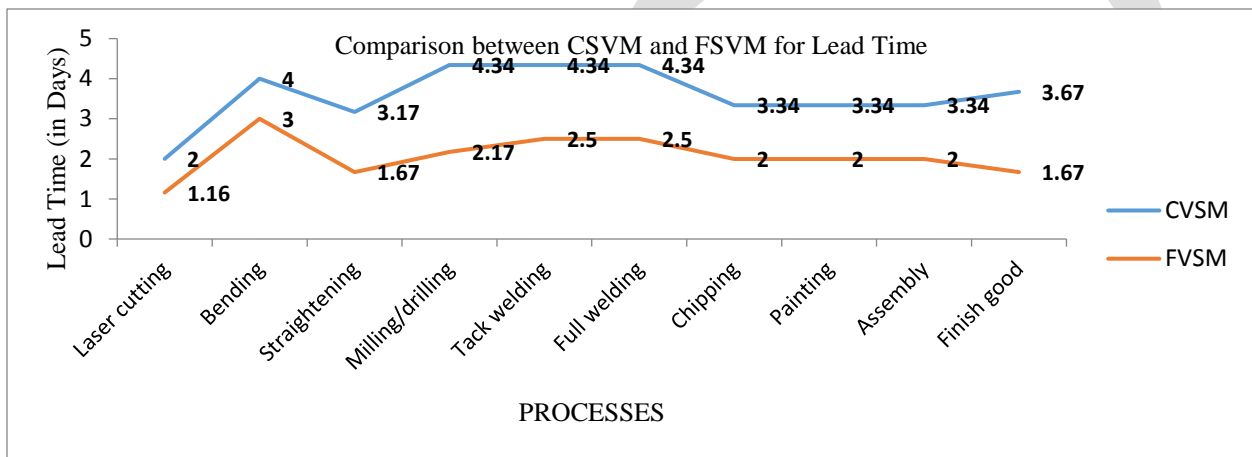


Figure 1.10: Comparison of result between CVSM and FVSM for Lead Time

Comparison between CSVM and FSVM for WIP

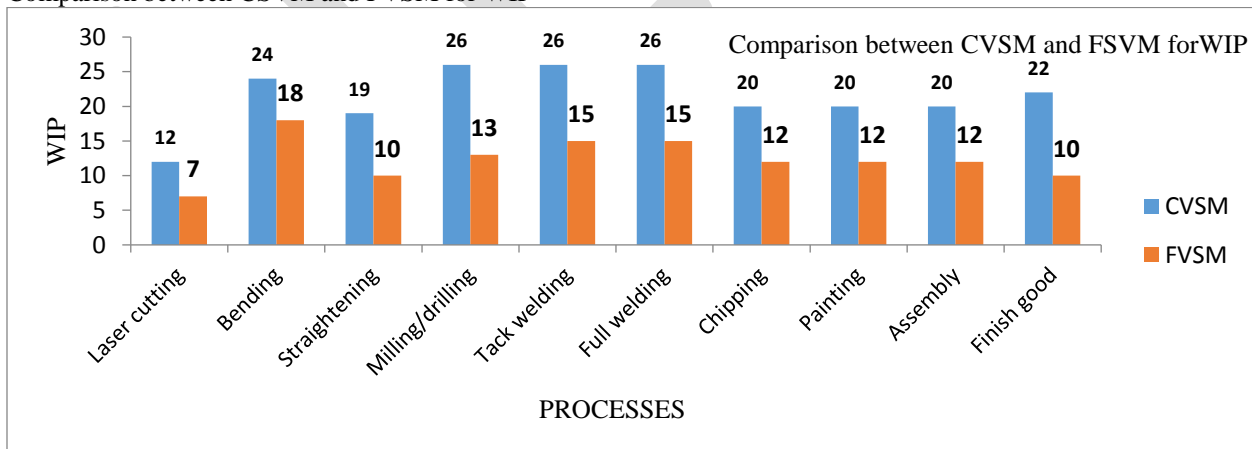


Figure 1.11: Comparison of result between CVSM and FVSM for WIP

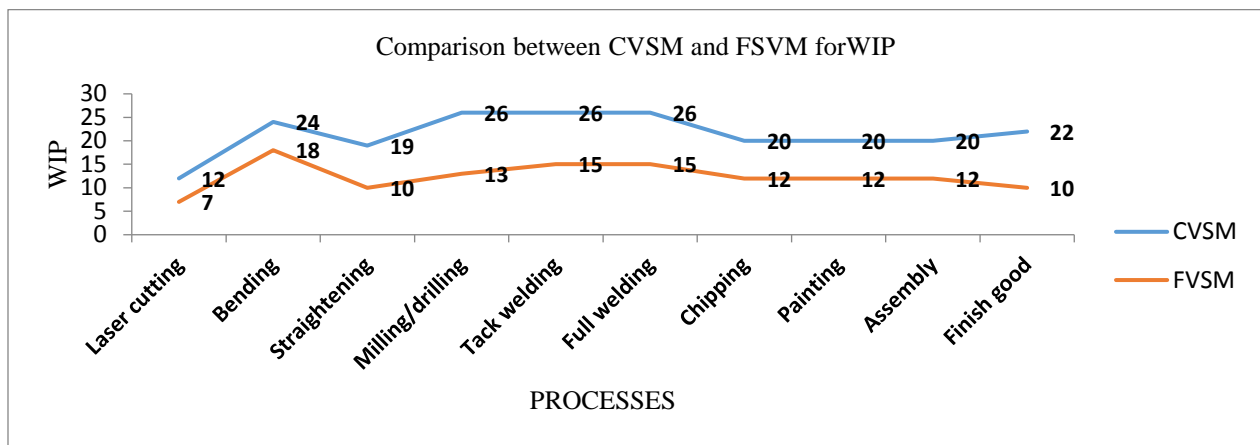


Figure 1.12: Comparison of result between CVSM and FVSM for WIP

#### Comparison of Output in CVSM and FVSM

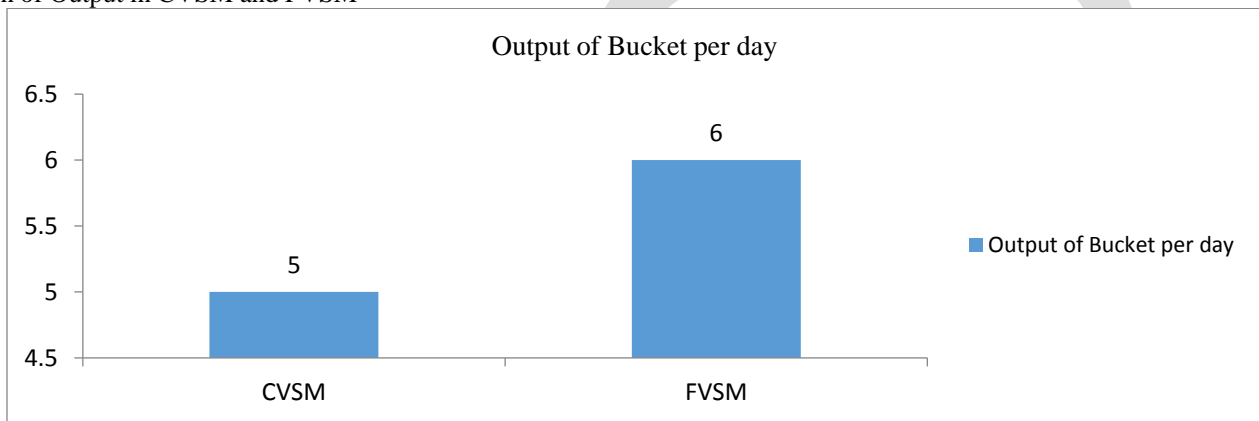


Figure 1.13: Comparison of result between CVSM and FVSM for Output per Day

#### Comparison of result between CVSM and FVSM for TAKT time

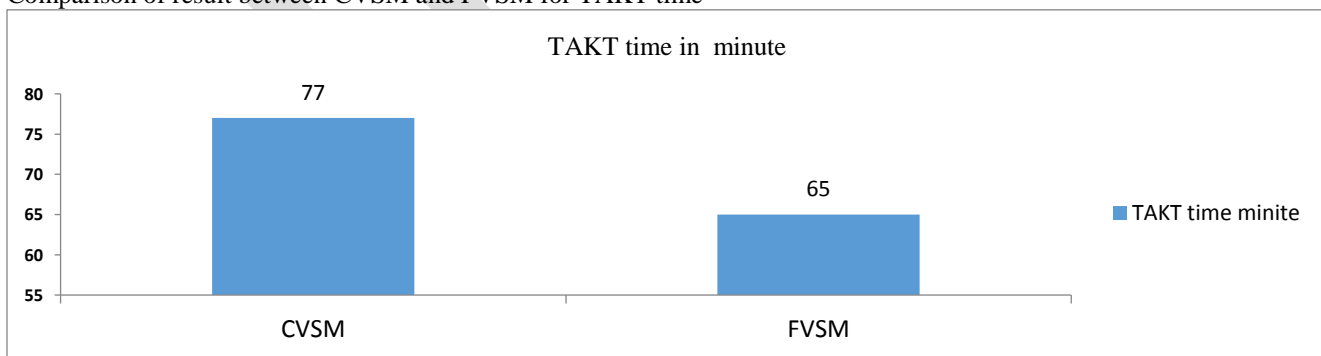


Figure 1.14: Comparison of result between CVSM and FVSM for TAKT time

#### Conclusion:-

On the Shop floor, time is money. On the shop floor the need to eliminated of wastages and delays. It helps in mapping the process it manifests itself as the objective of designing a process for which manufacturing is a low cost process. To start improving productivity by identifying waste and then removing it by implementing lean principle in the industry there is no better tool than Value Stream Mapping. Value stream mapping used for identifying value added and non-value added activity. The non-value added actions are identified in each step and between steps.



The integration of VSM with simulation software will help to analyze the system properly. Simulation using arena helps in finding value added and non-value added time of complete process and also for finding output per day. By applying VSM in bucket manufacturing process, a current state map is devolved.

A future state value stream map is created by eliminating waste non value added activities and future state map is showing the improvements in process. Final results show that after improving process using lean manufacturing and value stream mapping, WIP in manufacturing of bucket is reduce by 36 %, lead time reduced from 36 days to 21 days resulting improving of 41% total cycle time reduced from 17516 minute to 10397 minute resulting improving of 42%, output increased from 5 bucket per day to 6 bucket per day resulting improving of 20%, cycle time reduced from 311 minute to 272 minute resulting improving of 12.5%, TAKT reduce from 77 minute to 65 minute per bucket resulting improving of 15 %.

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