

# Implementing Lean Manufacturing Principle In Fabrication Process- A Case Study

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**Abstract** - Various manufacturing companies are facing the challenges because of changing global situation in terms of high quality expectation, reduced cost of production and increased productivity. All the companies are in the motive to solve these problems through the application of modern techniques. The production process in many companies are still exists several activities that cause waste. Non value added activity in the implementation is still widely found, so the cycle time generated to make the product will be longer. The aim of this case study to explore the possibility of improving production indicators By removing activities in the manufacturing process that were not adding any value to the product also to provide an effective solution for these problems through lean manufacturing techniques.

**Keywords:** Welding, Toyota Production System, Lean production system, Value stream mapping, Cycle time

## 1. INTRODUCTION

Lean production is an approach to management that focuses on cutting out waste, while ensuring quality. Lean production aims to cut costs by making the business more efficient and responsive to market needs. Lean manufacturing makes obvious what adds value, by reducing everything else (which is not adding value). This management philosophy is derived mostly from the Toyota Production System (TPS) and identified as "lean" only in the 1990s. TPS is renowned for its focus on reduction of the original Toyota seven wastes to improve overall customer value, but there are varying perspectives on how this is best achieved. The steady growth of Toyota, from a small company to the world's largest automaker has focused attention on how it has achieved this success.

The lean approach to managing operations is really about:

- 1) Doing the simple things well
- 2) Doing things better
- 3) Involving employees in the continuous process of improvement
- 4) ..and as a result, avoiding waste

'Lean' manufacturing, 'lean' enterprise, or 'lean' production, often simply called 'lean', is a production practice that considers the expenditure of resources for any reason other than the creation of value for the end customer, as waste. The main drive in 'lean' manufacturing is the elimination of waste in whatever form it exists. Working from the perspective of the customer who buys a product or service, 'value' is defined as any action or process that a customer would be willing to pay for. The focus on value for the customer is very similar to Six Sigma, but in the case of 'lean' manufacturing, the implementation is focused on 9 eliminating waste. Anything which is done which the customer is not willing to pay for is waste and must be eliminated. A number of tools and methods are used when implementing 'lean' manufacturing. The goal of 'lean' then becomes the creation and maintenance of a production system which runs repetitively, day after day, week after week in a manner identical to the previous time period.

**Value-stream mapping** is a lean-management method for analysing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer. A value stream focuses on areas of a firm that add value to a product or service, whereas a value chain refers to all of the activities within a company.

A value stream is the set of processes required to transform raw materials into finished goods that customers value (Womack & Jones, 1996). creating a value stream map will allow the company to document current production lead time, inventory levels, and cycle times in order to determine the ratio of value-added to total lead time of the product family being analysed, creating a vision of an ideal value flow. The goal is to identify and eliminate the wastes in the production process. The company will use these results in order to map the future state and implement lean manufacturing.

Although its typical purpose is eliminating waste, VSM can also be seen from the perspective of adding value. After all, that's what the customer cares about. Eliminating waste is the means to an end of creating value, such as a lower price and/or better-quality product or service.

### 1.1 Key lean principles:

1. **Perfect first-time quality** through quest for zero defects, revealing and solving problems at their ultimate source, achieving higher quality and productivity simultaneously, teamwork, and worker empowerment.
2. **Waste minimization by removing all non-value added activities** making the most efficient use of scarce resources (capital, people, space), just-in-time inventory, eliminating any safety nets.
3. **Continuous improvement** (reducing costs, improving quality, increasing productivity) **through dynamic process of change**, simultaneous and integrated product/process development, rapid cycle time and time-to-market, openness and information sharing.
4. **Flexibility in production** of different mixes or greater diversity of products quickly, without sacrificing efficiency at lower volumes of production, through rapid set-up and manufacturing at small lot sizes.
5. **Long-term relationships with suppliers** and primary producers (assemblers, system integrators) through collaborative.

## 2. LITERATURE REVIEW

The purpose of this study is to develop a value stream mapping and identify wastes and make recommendations for improvement. It is hoped that the company uses the value stream map for the future implementation of lean manufacturing, in order to increase productivity and improve the quality of goods produced by the company, while at the same time reducing costs, total lead time, human effort, and inventory levels.

The literatures provided wide information about the lean manufacturing principles and its applications at various business enterprises. The information gathered from the various resources was very useful in analysing the current production system and also gave useful information about the modifications that must be made to the processes to achieve flow by consistent elimination of wastes.

The company experiences problems such as low production rate, quality problems and late deliveries, on a daily basis. There are a number of reasons for these problems including breakdowns, operating problems, damaged parts and bad Management, to name only some. Production fluctuates from day to day. On days when supervision is strict, production is sometimes more than double the normal production as when there is little supervision. The manufacturing process seems smooth and sorted out when it is observed on the surface, but when studied closely, much inefficiency can be identified, all collectively adding to the problems named above.

Form a 'lean' Six Sigma point of view, many of these problems of the production process can be corrected by changing the process. A close look at the process reveals that almost all of the seven kinds of wastes that 'lean' manufacturing tries to eliminate, are present in the process. It is thus an ideal project for a 'lean' manufacturing transformation.

### 2.1 Types of Wastes

According to Tapping (2002) "the ultimate lean target is the total elimination of waste. Waste, or muda, is anything that adds cost to the product without adding value".

Wastes can be classified into seven categories (Tapping, 2002):

1. Waste of overproducing: Producing components that are neither intended for stock nor planned for sale immediately.
2. Waste of waiting: Refers to the idle time between operations.
3. Waste of transport: Moving material more than necessary.
4. Waste of processing: Doing more to the product than necessary and the customer is willing to pay.
5. Waste of inventory: Excess of stock from raw materials to finished goods.
6. Waste of motion: Any motion that is not necessary to the completion of an operation.
7. Waste of defects and spoilage: Defective parts that are produced and need to be reworked.

### 2.2 Purpose and objectives

The purpose is to develop a process, plan, material flow and layout, with a lean focus for manufacturing on a plant level, suitable for the products, processes and customer needs. The value stream map that will result from this study could reduce costs, improve lead time, increase productivity, and improve quality of the products.

## 3. METHODOLOGY

The procedures for this study have been chosen to meet each of the project objectives. To have first-hand knowledge of the production process and to be familiar with the activities being performed at the floor shop, we went through the facility and identified each operation process involved from first stage to last stage, identified all the processes like cleaning, setup, fabrication, welding etc. and observed how the material flowed from one operation to another.

To start improving productivity by identifying waste and then removing it by implementing lean principle in the industry there is no other tool better than VSM. It helps to understand and streamline work processes using the tools and techniques of Lean Manufacturing.

The data is collected using an interview and questionnaire survey. Cause effect diagram and brain storming session were conducted to identify the problem. Lean techniques were introduced to rectify the problems. Control chart was used to verify the results. Return for investment was also calculated to check the feasibility.

**3.1 Problem identification**

The currently using fabrication and welding process consumes more cycle time, more man power and gives more operative fatigue. Also it results with improper welding, poor aesthetic appearance and less productivity. This is resulting in rejection at inspection stage and reworking.

The data collected for welding operation performed by different operators is given below. The summary of report shows the cleaning, setup, welding and inspection time for each product.

**Table-1:** Time taken for welding (initial)

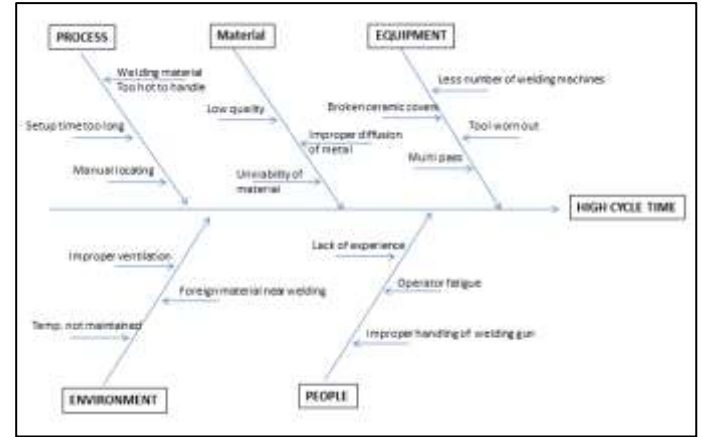
Sr. No.	Job	Time taken in (sec)			
		Worker 1	Worker 2	Worker 3	Worker 4
1	S1	410	425	439	411
2	S2	408	429	433	418
3	S3	415	419	413	408
4	S4	448	409	452	437
5	S5	418	436	441	453
6	S6	426	449	432	419
7	S7	436	431	417	445
8	S8	417	429	433	442
9	S9	442	419	429	410
10	S10	439	415	428	420
11	S11	440	401	414	414
12	S12	408	456	439	436
13	S13	419	403	409	436
14	S14	427	418	401	421
15	S15	437	451	410	420
Average time		426	426	426	426

**3.2 Development of lean techniques**

The tool cause and effect diagram was used for analysing the cycle time reduction. This diagram is graphical tabular chart to list and analyse the potential causes of the given problem. To find the various causes and their remedies brainstorming session was conducted. It was effective and creative thinking technique. It helps to get a large number of ideas from a group in short time. The following steps in a brainstorming session.

1. Announced the purpose of the meeting to everyone.

2. Encourage valuable ideas
  3. Wrote all the ideas suggested
- Once all the ideas have been mentioned and recorded, time was taken to answer to answer question and clarifies the suggestions.



**Fig-1:** Cause and effect diagram

Methods to improve above problems:

1. Process- Automation adopted at various stages, provision to cooling of material and tools, try to combine parallel activities which can be done at a time without affecting the output, increasing welding speed
2. Material- improving in forecasting method for unavailability of material, improves quality of material, change the vendor, change the welding parameters
3. Equipment- Maintaining standby for critical machines, preventive maintenance
4. Environment- Installation of new air conditioners, daily housekeeping of fabrication area
5. People- Training for new workers, proper work distribution of work

Based on the cause and effect diagram and the output of brainstorming value stream map were developed. The techniques of 5S, cellar manufacturing and single minute exchange of dies were introduced to the system. By using above techniques, the waste time like waiting time and processing time were reduced which lead to reduction in cycle time.

**Table-2:** Time taken for welding (Improved)

Sr. No.	Job	Time taken in (sec)			
		Worker 1	Worker 2	Worker 3	Worker 4
1	S1	310	311	314	319
2	S2	322	348	327	348
3	S3	320	319	324	347

4	S4	330	324	319	315
5	S5	348	322	314	320
6	S6	350	308	329	332
7	S7	319	334	334	341
8	S8	320	339	332	319
9	S9	320	324	309	309
10	S10	340	329	321	325
11	S11	318	331	331	338
12	S12	300	316	342	317
13	S13	314	341	333	309
14	S14	324	315	332	314
15	S15	340	314	314	322
Average time		325	325	325	325

**3.3 Control chart**

The following data shows the number of defects per lot in its successive lots of 8 welded assemblies each.

Table-3: control char for inspected samples

Lot number	Number inspected	Number of defects	Number of defects per unit
1	8	1	0.125
2	8	0	0
3	8	2	0.25
4	8	1	0.125
5	8	3	0.375
6	8	0	0
7	8	5	0.625
8	8	4	0.5
9	8	1	0.125
10	8	0	0
11	8	3	0.375
12	8	1	0.125
13	8	2	0.25
14	8	2	0.25
15	8	3	0.375
$\sum n = 120$		$\sum c = 28$	

Here U-chart is selected for analysis. Average number of defects per unit=

$$\bar{u} = \frac{\sum c}{\sum n}$$

$$\bar{u} = \frac{28}{120} = 0.2333$$

So control limits or center line, CLu =  $\bar{u}$  =

Upper control limit, UCLu =

$$\bar{u} + 3 \sqrt{\frac{\bar{u}}{n}} = 0.2333 + 3 \sqrt{\frac{0.2333}{8}}$$

$$= 0.7456$$

Lower control limit, LCLu =

$$\bar{u} - 3 \sqrt{\frac{\bar{u}}{n}} = 0.2333 - 3 \sqrt{\frac{0.2333}{8}}$$

$$= -0.2790$$

(Taken as zero)

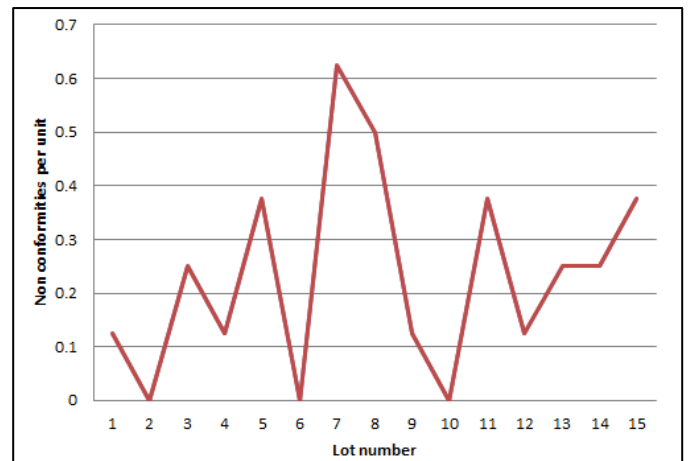


Chart 1- Control charts for different lot

The control chart shows that all the lots are under control.

**3.4 Calculation of return of investment**

Total cost for implementing the techniques = RS.10,000

Time saving by the new process = 101 sec

Total number of product manufacture per year = 5,000(approx.)

So, expected saving per year =  $\left(\frac{101 \times 5000}{3600}\right)$

Total time saved per year = 140 hrs.

Labour cost per hour = Rs. 180

Rol per year =  $\left(\frac{140 \times 180}{10000}\right) \times 100$

=252%

The above calculated improved productivity and role shows the new method is valid and feasible one.

**4. CONCLUSION**

This paper presented a research work on Reduction in process cycle time in manufacturing industry. By implementing lean manufacturing principle the unnecessary time for performing the welding operation

were drastically reduce, which leads to cycle time reduction of the above welding process . This reduction in the cycle time has significant impact on company's productivity. The quality control charts also shows that the process is under control. The value stream map developed gave a good idea of the process and the changes to be done.

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