

# **Implementation of Lean Manufacturing in Centrifugal Pump Assembly**

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**ABSTRACT:** In recent days global competition is prevailing between the manufacturers. The key to competing in the international market place is to simultaneously improve both quality and productivity on continual basis. Lean production gives reduced lead time, continuous process flow, reduced cycle time, eliminates wastes and over production. To achieve these, the lean production involves the use of lean tools such as KAIZEN, KANBAN, 5S, OEE, JIT, FIFO etc. Using these lean tools to identify, analyze, and eliminate the activities that are responsible for producing wastes. There are about 25 major lean tools which has its own benefits in reducing the wastes. This paper clearly explains the lean concepts, its principles, importance and benefits. This paper also addresses the approaches to implement lean practices to apparel industry.

**Keywords:** Lean Manufacturing, Lean tools, Waste reduction, lead time reduction

## **I.INTRODUCTION**

In this competing market industries are using some best techniques to produce good quality products at the pull of the customer. The major issue risen among manufacturers in competitive environment, is how to deliver their products or materials quickly at low cost and best quality. The application of lean management principles and techniques solves this issue. Lean management also called as lean is production practice, which reduces the wastes of production process and creates a continuous flow in the entire process. Lean manufacturing must set as a background of manufacturing industries so that they can quickly respond to the demand prevailing in the market and it satisfies them.

The manufacturing industries are with number of challenges in this market. They started to look for a technique to implement it in their production process to quickly meet and solve the demand with improved quality and reduced cost. Lean management provides better principles and techniques that help the industry to compete. In this paper, the literature survey findings such as types of lean tools and its benefits are studied, and improvement gained by the various manufacturing industries in their manufacturing process are discussed.

## **II.LITERATURE REVIEW**

The author said in order to handle the critical situation for competitive environment, manufacturers are trying to implement new and innovative techniques in their manufacturing process by making it more effective and efficient [1].

In this paper authors said that Lean manufacturing has a number of principles that mainly reduces cost by the process of identifying and eliminating non value added activities. The fiercely globalized and competitive markets of 21st century demand for increasing high variety of products at reducing cost, lesser lead time and perfect quality [2].

Authors in their paper have given lead time reductions will directly impact almost every contributor to costs within the company's operations. With its strategic importance Lead time reduction has become an important element of campaign to increase the competitiveness of manufacturing industry [3].

In this paper authors said that the success of the Japanese in the employment of just-in-time (JIT) production has received a great deal of attention in the past two decades. The underlying goal of JIT is to eliminate wastes, which can be achieved through various efforts such as shortening lead time and improving quality[4].

The authors of this paper have discussed Current state map was draw by defining the resources and activities needed to manufacture, deliver the product. The study of current state map shows the areas for improvement and identifying the different types of wastes [5].

This paper provides lead time is the time spent between the original customer order and final delivery of the product. Lean manufacturing is a production practice that considers expenditure of resources for any goal other than creation of value for the end customer to be wasteful and thus a target for elimination. Lead time is calculated by adding value added time and non-value added time [6].

Authors in their paper have given Lean manufacturing is now one of the most powerful manufacturing control systems in the current trend.. Lean manufacturing improves their quality also increase the profit for manufacturing over the international market [7].

In this paper authors said that Lead time is the time spent between the original customer order and final delivery of the product. Lead time is calculated by adding value added and other Non-value added time. Some of the major lean tools such as kanban, kaizen, 5S, assembly line balancing etc, which reduce the lead time and improve the cost of production.[8].

This paper provides the choice of tools is one of the crucial factors for the success or failure of the Lean application in organizations. Moreover, the maturity level and the goals only will be achieved, in fact if the tools and techniques have been well chosen and implemented [9].

Authors demonstrate a mathematical model to measure the contribution of lean strategies selected to reduce wastes. They also developed a methodology to select appropriate lean strategies so that they help achieve maximum benefit by minimizing wastes [10].

The author tells us how important is to line balance in the assembly process to improve the production and to reduce the lead time. Allocating equal amount of work in various departments is line balancing, and he also adds its significance[11].

The author demonstrates the assembly process of centrifugal pump assembly and how he implemented the lean tools to reduce the lead time. Reducing lead time gives a major advantage in assembly process[12].

Lean manufacturing is a systematic approach of identifying and analyzing the waste, the author tells us about the importance of lean manufacturing and a variety of lean principles to be implemented in the manufacturing process[13].

The author takes a survey of how lean manufacturing is used in pump industry and what are the wastes that are eliminated by the industry. Number of lean tools used by them in reducing the wastes and he explains it in detail[14].

Quality and production improvement is the major aim of manufacturing industries. The author tells us how to improve the production and quality in pump industry by implementing the lean technique and further explains lean technique in detail[15].

### III.OBJECTIVE

The research objectives have been defined as follows:

- To understand the current scenario of the manufacturing process in the pump assembly.
- To analyze and decrease process waste and inventory.
- To improve product and human resource utilization through simulation.
- To identify continuous process flow and improve material handling through layout modification.
- To reduce production lead-time.

### IV.METHODOLOGY

The methodology (as shown in Figure1) followed in this paper is based on lean concepts which includes a 5S implementation, time study, analyzing the non-value added time and wastes. The improvements achieved using this implementation of the lean tool. The implemented methodology listed below.

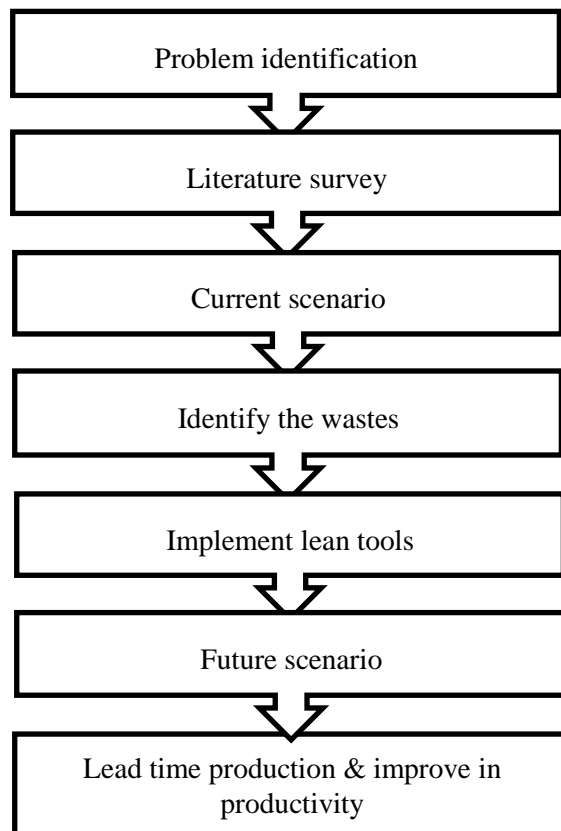


Figure 1: Lean Implementation Methodology

**V.COMPANY PROFILE**

BESTEN PUMPS is a pump manufacturing company where we done our project is one of the leading and famous manufacturer and supplier of pumps and their accessories. The pumps include the range of jet, submersible pumps and multistage self-priming pumps. The products are manufactured as per the specification of our customers and clients. It manufactures centrifugal jet pumps, mono-block pumps, centrifugal shallow well pumps centrifugal multi stage pumps, regenerative pumps and many more pumps of robust quality. The pumps are widely used in rural and urban drinking water installation, water supplies for high raise buildings, lawn and garden watering, BESTEN PUMPS is a pump manufacturing company where we done our project is one of the leading and famous manufacturer and supplier of pumps and their accessories. The pumps include the range of jet, submersible pumps and multistage self-priming pumps. The products are manufactured as per the specification of our customers and clients. It manufactures centrifugal jet pumps, mono-block pumps, centrifugal shallow well pumps centrifugal multi stage pumps, regenerative pumps and many more pumps of robust quality. The pumps are widely used in rural and urban drinking water installation, water supplies for high raise buildings, lawn and garden watering, water circulating systems, agricultural lift, sprinkler and drip irrigation and industrial service water supply schemes. The company has vast experience in manufacturing of high quality pumps and that has a long list of its clients. The pumps show distinctive features as they are the most modern and latest. The pump manufacturing company is famous for manufacturing pumps which are of robust quality. The pumps comprise components that are made of selective materials under strict quality control. The pumps are designed to save 25% of power which differentiate the pumps from other single staged pumps. Most modern and latest in design, silent vibration-free running, easy installation, high efficiencies-better than international values, leading to energy saving, superior design materials and manufacturing techniques.

**VI.ASSEMBLY OPERATIONS**

- Stator assembly and testing
- Rotor and bearing assembly
- Rotor in stator assembly
- Capacitor assembly
- Impeller and cooling fan assembly
- Terminal box and wiring
- Jet plate assembly
- Pump and motor assembly
- Testing
- Packing

A summary of data for each process of pump manufacturing is given in the table 1

Table 1: Process Data Summary

S.NO	Process	Timetaken (sec)
1	Coil winding and stator cover assembly	206
2	Stator testing	94
3	Bracket, studs and stator assembly	172
4	Rotor and bearing assembly	168

5	Rotor in stator assembly	175
6	Capacitor assembly	216
7	Impeller and cooling fan assembly	374
8	Terminal box and wiring	203
9	Jet plate assembly	207
10	Pump and motor assembly	320
11	Testing	370
12	Packing	195
Total time taken		2700 (45 mins)

## VII.CREATING CURRENT STATE

To create the current state is always start with the customer demand and the following steps are followed:

Step I- Understand Customer Demand

In this study customer demand is 125 pcs/shift or 250 pcs/day assuming 2 shifts.

Step II- Calculate Takt Time

TAKT TIME = Available working time per shift / customer demand per shift

Available working time per shift = operating time - breaks

Operating time = 8 hours = 8×60= 480 minutes.

Breaks = 40 minutes and 2× 10 minutes = 40 + 20= 60 minutes.

Available working time = 480 minutes- 60 minutes= 420 minutes

Customer demand = 125 pump / shift

TAKT time for one process = 3.36 minutes

No of process in the assembly= 12

TAKT time for total operation = 3.36×12 =40.32 minutes = 40 minutes for a pump

In TAKT time calculation the pace of operation should be 40 Minutes.

Step III- The process Flow

The process flow involves various processes which are in sequence to complete product manufacturing and calculate the cycle time, change over time and up time for each. In this research 12 processes are given to complete the products which are discussed earlier.

**Step IV- Detail Off-line Activities**

Activities like placing of order, supply of material, daily schedule, monthly forecast etc., involved are well executed by transportation, supplier icons and information flow lines.

**Step V- Identify Opportunities for Improvement**

Opportunities are identified and also to further improve throughput rate and to draw a future state map which shows changes in the process.

**VIII.ANALYSIS OF CURRENT STATE**

We analyzed current state and following gaps were identified for improvement:

- Uneven assembly line balancing
- Improper storage of components
- Unwanted motion
- No proper conveyor system
- Use of hammering in motor assembly

**IX.CREATING FUTURE STATE**

A summary of data for each process of pump manufacturing after implementing lean tools is given in the table 2

Table 2: Process Data Summary After Implementing Lean Tools

Activity	Possible Solutions	Tools to be used	Current Scenario Report	Future Scenario Report
Waiting online	Can be produced according to the requirements	Kanban card, FIFO,Continuous flow	2mins	1min
Total delay time	Identify which part of the process limits the overall performance	Bottleneck analysis	5mins	3mins 43secs
Stator testing	In order to reduce the product wastage	Heijunka (Safety stocks)	1mins	43secs
Defect in assembling	Frequent inspection	Source inspection, SOP	3mins	2mins 14secs
Lack of standard procedure	Providing standard procedure	SOP	3mins 43secs	2mins

Over production	Producing according to the customer demand	JIT	-	-
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### X.CONCLUSION

The following conclusions are drawn from the studies conducted.

- It is concluded and shows Lead time reduction is achieved by incorporating the lean tools in a pump industry.
- The methodology carried out in lean implementation could serve as a guideline for implementing lean concepts.
- The project carries genuine advantage of focusing on eliminating all kinds of non-value added activities in the shop floor.

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