

Lean Manufacturing System for Manufacturing Industries

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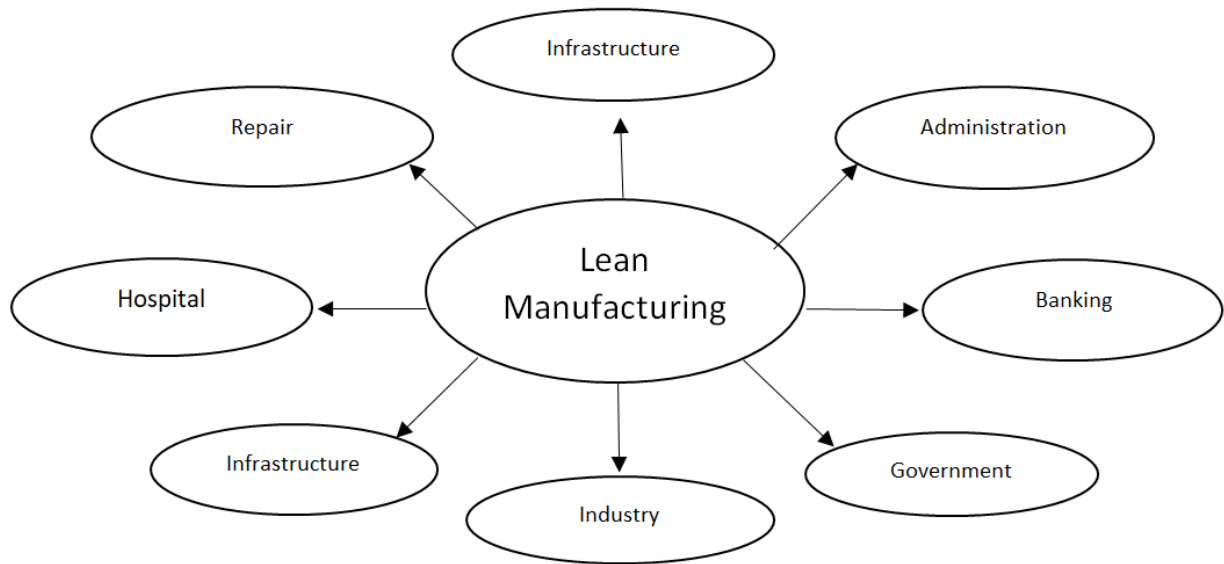
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Abstract –As the need for manufacturing rises, so does the waste of basic materials. There are numerous strategies to decrease wastage in order to reduce waste. We will investigate a new idea known as "lean manufacturing" in this article. This idea considers every aspect of manufacturing and devises a method for saving time and money with less wastage. It is utilized in nearly every manufacturing firm to reduce waste and make the business more efficient and cost-effective. As a result, we can state that it is one of the most advanced and effective methods for reducing waste that can be used in any manufacturing or industrial engineering facility.

Introduction- Manufacturing that is lean it is a rapidly expanding procedure that is used in all manufacturing industries. The fundamental goal of lean manufacturing is to eliminate waste and run a business efficiently. It also improves product quality, lowers total costs, and prevents breakdowns. Lean manufacturing is applied in the following fields:



Problem statement-

1. Can the oil used in heat treatment be reused and how it can be reused?
2. What happens to the electroplating water as it is harmful to the environment?
3. What happens to the raw materials wastage?

Objectives-

1. To study lean manufacturing for a particular industry.
2. To study the type of lean manufacturing used in this company.
3. To study and analyze the wastage of this company. Prevent it from minimum wastage.

4. Analyze the company techniques used for lean manufacturing.

Literature review-

1. **A Review on Lean Manufacturing Implementation Techniques**-In this paper the concept of lean manufacturing was created to maximize resource usage by reducing waste; however, lean was subsequently evolved in response to the changing and competitive business environment. Organizations are obliged to face problems and complexities as a result of the quickly changing business environment. Any business, whether it's manufacturing or service-oriented, needs to exist may ultimately be determined by its capacity to adapt to these changes in a methodical and consistent manner in order to improve product value. To reach this perfection, a value-adding process is required; as a result, adopting a lean manufacturing system is becoming a key skill for every type of business.
2. **An empirical review of lean manufacturing and their strategies**-This paper the lean manufacturing philosophy ensures product quality at a low cost while also ensuring customer satisfaction. Because the level of competition is so great now, and every business is attempting to provide high-quality products at a low cost, lean is the most recent technique to achieve this. The purpose of this article is to investigate several lean ideas in the context of various lean methods. This research aids in determining the current state of lean manufacturing and the methods for implementing it. There is also a discussion of the lean manufacturing idea, lean waste, lean solutions, lean obstacles, and the lean implementation cycle in this article. With the aid of a collection of important articles, this study offers a literature review to clarify the status of lean manufacturing and their techniques.

About Lean manufacturing- Lean manufacturing, often known as lean production, is a production strategy that aims to reduce waste and enhance product quality while decreasing costs and system breakdowns. It was initially used by the Japanese automobile manufacturer "TOYOTA." It was well-known at the time, and it was developed from the "Toyota Way" operating model.¹ When these two are broken down, we obtain the five Lean Manufacturing principles, which are as follows: "Precisely specify value per particular product, identify the value stream for each product, make value flow without interruptions, allow customers draw value from the manufacturer, and strive perfection." The idea is somewhat similar to efficiency based on flow. When lean manufacturing is followed in any industry in a systematic and a proper way there is a good growth in the quality and the output productivity plus it leads to reduction in the wastes.

When lean manufacturing was a new idea in the industry, the primary concern and difficulty that the firm faced was whether methods would be more effective in implementing this idea for improved quality and output. After the different firms studied lean manufacturing, it was discovered that the system could be utilized on the basis of the company's production, and so the outcome was formed of the number of strategies which can be used here. So lean concept becomes a flexible system in which the strategies can be added, merged and be further explored as per requirement. Some lean strategies are:

1. 5S (5-Sigma)
2. Automation
3. Continuous Flow
4. Continuous Improvement
5. Kaizen
6. Single Minute Exchange to Die (SMED)
7. Six Sigma
8. Team Development/Training
9. Total Productive Maintenance
10. Total Quality Management (TQM)
11. Visual Management
12. Work Standardization
13. Flexible manufacturing System (FMS)
14. Production leveling
15. Zero Defect Concepts
16. WIP (Work in Process)
17. Lean Thinking
18. 8-D

¹ <https://searcherp.techtarget.com/definition/lean-production>

In this paper, the main focus is on understanding the meaning of lean manufacturing and its relative terms. Lean manufacturing is very important and a major turnover in today's market for manufacturers because this is one of the most important method to survive in this competition. Lean manufacturing also tries to focus on zero waste concept and provides better quality and benefits to customers as well as the company. That's why, this paper tries to give a good review of lean manufacturing for those industries that are following Lean manufacturing.

As this paper is based on completely industry based research paper and we are really thank full for the company people and the staff who cooperated with us and spending time with us for this particular research.

About the Company- The PURA Auto Comps Pvt. Ltd firm is situated in Aurangabad and specializes in manufacturing. This business was founded in 1995. For many years, this firm has been producing spring lock washers. We conducted study on Lean manufacturing at this firm, and found that waste management, waste handling procedures, and waste handling needs all play a critical role.

Analyzing the data of this company we have come up with a different ways to improve the waste management and the waste procedure. This may also help the particular company to increase the efficiency and the quality of the products.

Methodology -In this research we tend to find out the procedure used in this company about the lean manufacturing. How this company has adopted the procedure about lean manufacturing. To achieve this particular task we have collected some data via question survey. This survey was divided into two parts.

The first part of the survey was the amount of waste from the company. In this survey we have taken the data for the past 10 years and tallied it with the current year. The reason behind this is to see whether there is reduction in wastage and improvement in quality. The wastage which we found in the data was not as much as we expected. So in this data we have found that the total waste produced in this company was about 600kg material an annum this data was from the year 2011. We then compared the wastage with the amount of washers produced. The amount of washers manufactured in this company was about 600 tons annually. So if we calculate the wastage data along with the washers produced we can find that the total wastage as compared to the production is almost as 4% in a year. Now if we compare the 4% with the total production the wastage is just negligible. So for better understanding we have created the given bar graph which shows the wastage is given in each particular year from 2011-2020.-

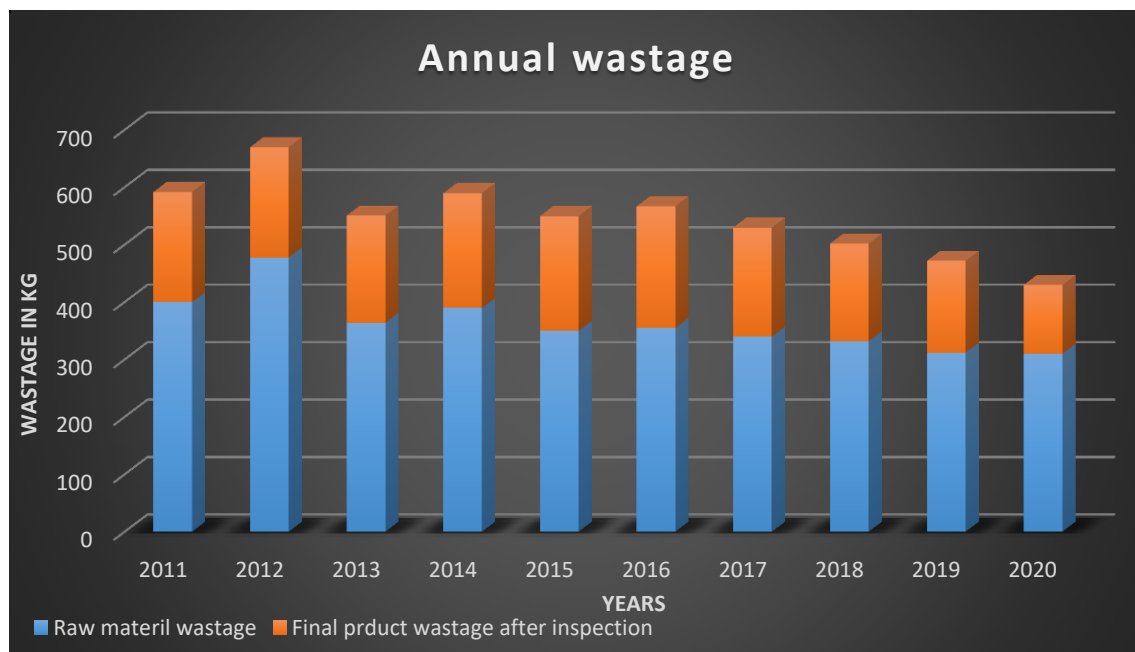


Chart no 1- Annual Wastage Bar Graph

So, based on the above graph, we can see that waste has been fluctuating in recent years, but if we look at the graph from 2016 onwards, we can see that total waste has been decreasing since that time. We discovered that the appropriate implementation of lean manufacturing is the reason for the decrease of wastage when we dug more into the waste investigation. So on an average we can see that the total wastage done in the past years is somewhat more than 400 to 500Kg of waste annually. Which is reducing slowly and hence improving the quality of the product.

In the second poll, we spoke about what happens to waste and if it can be recycled. Is it possible to repurpose it for production? Is it going to be as powerful as the basic materials? Is it as secure as the original? What's causing the increase in waste? What is the company's approach to lean manufacturing? What kind of lean manufacturing approach is being implemented?

So, before we get into the challenges and answers, we must first comprehend the company's production process. As a result, raw material coils are initially produced in the shape of a washer at this firm. Cold forming is used to complete this procedure.



Fig-1: Spring Washer

When the desired shape is given to the washer these washer all undergo heat treatment quenching process. Where the strength and the hardness properties of these washers are increased and there are less chances of cracking.

After the process of heat treatment the washers and then cooled and sent to electroplating where they have been electroplated and prevent them from rusting and decaying. After the electroplating process the washers have to go through inspection for any flaws or defects. When the inspection is done then they been dispatched to their respective orders.

1. Lean Manufacturing in the Company- So in this company the lean manufacturing is done by this method-

1.1 Without compromising on quality and process- Since this company is mass producing company the main factor for this company or any other company is that whatever maybe the material of a final product never comprise the quality of the material which may reduce the creditability of the company. Even if the company decides to compromise the quality the process may change cause of the quality of material changes.

1.2How can we reuse it- Since the wastage is so less in this company that the waste is recycled and sent to scrap places where it might be reused or the company may use the wastage material for displaying the components.

1.3 Identify the waste- The waste can be identified in the process by checking the parameters

1.4 Choosing the best lean manufacturing strategy – So, at this firm, the 8-D method is employed for lean manufacturing. The Eight Disciplines of Problem Solving is a problem-solving approach that focuses on determining the root cause of a problem, providing a quick cure, and implementing a long-term solution to avoid future issues. When a

company's product fails to meet customer expectations, or when your product is faulty or fails to meet your needs, your customers, an 8D is a perfect strategy to improve.²

This method was developed by Ford Motor Company for problem solving methodology, then known as Team Oriented Problem Solving (TOPS), in the 1980s. The early usage of 8D proved so effective that it was adopted by Ford as the primary method of documenting problem solving efforts, and the company still continues to use 8D today.

8D has become very popular among manufacturers because it is effective and easy to teach. Below we will find the techniques and benefits of 8D strategy, when it is appropriate to perform and how it is performed.

The 8D issue solving method is a team-oriented method to tackling major difficulties in the manufacturing process. It is a thorough and simple step-by-step method. The objectives of this technique are to identify the root cause of an issue, discuss decisions to safeguard customers, and take appropriate action to prevent future problems.

The 8D problem solving is a detailed and easy step to step strategy, it is a team oriented approach to solving main problems in the production process. The goals of this method is to find the main cause of a problem, discuss the decisions to protect customers and take correct action to prevent similar problems in the future.

The structure, discipline, and technique of the 8D process are its greatest assets. 8D employs a hybrid technique that incorporates best practices from a variety of existing techniques. It's a problem-solving technique that promotes systemic change by enhancing a complete process in order to prevent not only the current issue but also subsequent difficulties that may arise as a result of a systemic failure.³

The 8D process alternates inductive and deductive problem solving tools to relentlessly move forward toward a solution. The 8D are characterized as follows-

D0: Prepare and Plan for the 8D

Proper planning and decision making will always be a better start. Thus, before 8D analysis begins, it is always a good idea to ask an expert first for their ideas. After receiving feedback, the following criterion should be applied before forming a team:

1. Collect information where the root problem is.
2. Use a checklist to ask the correct questions.
3. Identify the need for an Emergency Response Action (ERA), which protects the customer from further exposure or does not meet the customer's demands.

D1: Form a team/group-

As the plan for the inspection is done then there is a team organized which the Cross Functional Team (CFT) is made up of members from many departments. In this department it tests the quality of a particular company takes this principle one step further and then the inspection is done by having two more sub teams:

1. A core team.
2. SME team.

Core Team employs data-driven strategies. People who are knowledgeable about the product, procedure, and data should be included in the Core Team Structure. To evaluate the data and look for mistakes, members of the SME Team brainstorm, research, and observe.

Additional Subjects to consider at various periods, experts are called in to help with brainstorming, data collecting, and analysis.

² <https://www.ease.io/how-to-use-the-8d-method-to-find-the-root-cause-of-nonconformances/>

³ <https://www.leansixsigmadefinition.com/glossary/8d/>

Teams need to be well-prepared. The importance of establishing ground rules cannot be overstated. Implementing disciplines such as checklists, forms, and procedures will guarantee that progress is made steadily. 8D requires two important members at all times: a Leader and a Champion/Sponsor:

The Leader is the person who knows the 8D process and can lead the team through it.

The Champion or Sponsor is the one person who can affect change by agreeing with the findings and can provide final approval on such changes

D2: Describe the Situation

The primary objective of the 8D approach is to accurately characterize the problem using known data and categories it for future comparisons. The "Is" data backs up the facts, but the "Is Not" data contradicts them. Many probable explanations for failure can be removed when the "Is Not" data is gathered

D3: Containment Action in the Short Term

A temporary remedial measure might be done to safeguard the consumer while the permanent corrective action is being considered. The Interim Containment Action (ICA) is only temporary, and it is usually withdrawn after the Permanent Correct Action (PCA) is implemented.

D4: Root Cause Analysis (RCA) and Escape Point

To take permanent action to eradicate the fundamental problem, it must be recognized. It must be able to be switched on and off at whim, according to the root cause definition. D4 includes the following activities:

Differences and changes between "Is" and "Is Not" are listed in a comparative analysis.

On the basis of the remaining elements, develop root cause theories.

Data collection and verification of the root cause

Examine the Process Flow Diagram.

Determine Escape Point, which is the closest point in the process where the root cause could have been found but was not

D5: Permanent Corrective Action (PCA)

The PCA focuses on the root cause and eliminates or modifies the circumstances of the product or process that caused the issue. The following are some of the things you can do with D5:

Establish the Acceptance Criteria, which should include both mandatory and optional requirements.

Conduct a risk assessment and a Failure Mode and Effects Analysis (FMEA) on the PCA options.

Make a balanced decision for PCA based on the risk assessment.

Select control-point improvement for the Escape Point

Verification of Effectiveness for both the PCA and the Escape Point are required

D6: Implement and Validate the Permanent Corrective Action

Proper planning is required to properly implement a long-term transformation. Communication, steps to completion, success assessment, and lessons gained should all be included in a project plan. The following are some of the things you can do with D6:

Create an implementation plan for the project.

All parties should be informed about the plan.

Improvements are validated by measurement.

D7: Prevent Recurrence

D7 enables the preservation and sharing of information, avoiding difficulties with comparable goods, methods, places, or families. At this stage, it is envisaged that documentation, processes, and work instructions would be updated to improve future usage. In D7, you can participate in the following activities:

Examine similar products and processes to avoid problems.

Procedures and Work Instructions should be developed and updated.

Instructions for Systems Prevention

Capture Standard Work / Practice and reuse

Assure FMEA updates have been completed

Assure Control Plans have been updated

D8: Closure and Team Celebration

To reach a good conclusion, teams needs input. The value of the 8D process is increased by recognizing both team and individual contributions and allowing the team to observe the prior and new states. The following are some of the D8 activities: - Archive the 8D Documents for future reference

Lessons in Documentation I learned how to improve my problem-solving skills.

In this business, the most common forms of waste are:

1. Production waste
2. Processed waste
3. Maintenance
 - A). Preventive maintenance
 - B). Reactive maintenance

Article analysis

So the solution for these above problem statement is as follows-

The oil utilized for heat treatment at this particular firm is quenching oil. The main purpose of quenching oils is to make steel easier to work with by limiting heat transfer during the quenching process. It improves steel wetting during quenching to prevent temperature and transformational gradients from forming, which can cause deformation or fracture. To achieve a particular product there are some characteristics for the quenching oil such as water content, flash point etc. the characteristics are given below in the table⁴ -

⁴ <https://www.machinerylubrication.com/Read/430/quench-oils>

Test	ASTM Standard	Application
Viscosity	ASTM D445	Oxidation of quench oils leads to increased viscosity and loss of heat transfer rate.
Water Content	ASTM D6304	Water contamination alters quench rate. A 2 percent increase is considered a red flag.
Flash Point	ASTM D92 or D93	The minimum flash point should be 90°C (160°F) above the quench oil temperature. A change in flash point of 10 percent or more is considered reportable.
Acid Number (AN)	ASTM D664, D974	AN provides an indication of oil oxidation and acid formation. An increase in AN of 1mg KOH/gm is considered reportable.
Precipitation Number	ASTM D91	Sludge or varnish tendency is characterized by the precipitation number. Typically a 10 percent increase is considered reportable.
Elemental Analysis	ASTM D4951 or D6595	For oils with organometallic additives, a drop in additive elements (e.g. calcium or sodium) by 10 percent is considered reportable.
GM Quenchometer	ASTM D3520	The procedure measures quenching speed and is not generally used for condition monitoring of in-service quench oils. It reports results in seconds, typically 12 to 30 seconds.

Table 1. ASTM References for Quench Oil Evaluation Methods

(Image taken from-<https://www.machinerylubrication.com/Read/430/quench-oils>)

Now for this company the oil used is quenching oil which is a type of quenching oil. It is an IS specification. The performance for this oil meets the demands for the company like here are some of the major features of this oil

1. Good thermal conductivity.
2. Oxidation stability is good
3. Excellent wetting characteristics.

So the problem which we discussed above can the oil be reused?

So for this particular oil the oil can be reused as the oil can filtered and it can be reused again. This is a very economical way to reuse the oil. Like for a company who is manufacturing 60 tons of washers annually by this method this is a very good way to be economical. The process for this oil can be reused is that we can use any filtration device to reuse it. The most common device used for BAPL centrifuge filtration which removes all the derbies and extends the life of the oil.

Now as we have discussed above the process of this particular company, after the completing of heat treatment lets discuss about the electroplating plant in this company. Electroplating as we know it prevents the material from being rust, gives the washers a good sparkle look. Now according to our analysis the chemical water used is very harmful for the nature. So this must be prevented. As of now from the Indian govt. there are some new laws regarding the environment and water pollution. **The water act 1974** is to provide for the prevention and control for the water pollution. The Water Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. At the Centre, the Water Act has set up the CPCB which lays down standards for the prevention and control of water pollution. At the State level, SPCBs function under the direction of the CPCB and the State Government⁵. This is a very major step to a clean environment.

⁵ <https://legislative.gov.in/actsofparliamentfromtheyear/water-prevention-and-control-pollution-act-1974>

As a result, the electroplating process in this firm contains hazardous chemicals that are extremely detrimental to the environment. As required by law, all manufacturing businesses must have a machine that transforms electroplating water to non-potable water, which is an excellent idea from the firm. Non-potable water is not used for drinking, but it is utilized for cleaning clothing and afterwards for irrigation. Then for watering the plant, toilet flushing etc. this is one of the best way to save water bodies and aquatic animals for purpose⁶.

As the plant is already installed in the company so there won't be any harmful wastage from the company which may lead to some serious actions. The electroplating water is now converted to non-potable water and used for the company purposes.

Conclusion-

- Lean manufacturing is highly endeavor. The company wastage should be as minimum as possible. The goal behind the "Lean manufacturing" is to minimize the number of wastage.
- The lean manufacturing method makes the production flow easier, reduces the product issues.
- In this company there were many changes in lean manufacturing as the production were in mass production
- In the electroplating plant was also the chemicals were also been converted to non-potable water where it can be used for industrial purposes.
- The total wastage came down to 4% of the total production in a year. Which reduces the wastage.
- The survey conducted in this paper helped a lot during this research paper as the data was perfect and the analysis helped a lot.
- Lean manufacturing is important in any company. As from the data collected from above we got to know the total wastage done by the company and what can be done to run the company more economical

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⁶ https://www.indiacode.nic.in/handle/123456789/1612?view_type=browse&sam_handle=123456789/1362