

# A Holistic Review of the Elements and the Tools of Lean Manufacturing

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**Abstract** - Lean manufacturing is an integrated manufacturing system envisioned to capitalize on capacity, re-utilization, and minimization of buffer inventories through minimization of system variability. Lean implies exterminating wasteful process steps and increasing the speed of operation with reduced capital. Lean manufacture has a comprehensive set of elements, rules and tools that emphasises on exclusion of waste and the creation of value-added output. Main focus of lean is to reduce wasteful process which would incur unnecessary time, and therefore manufacturing the product within the allotted time. Prime focus of lean manufacturing is to reduce the seven types of waste that could engender in the manufacturing industry like excessive inventory, low productivity, downtime etc. Scope of this paper is analyse and scrutinize the basic elements and tools of lean manufacturing along with that benefits and drawbacks of implementing lean manufacturing in a manufacturing industry.

**Keywords:** Waste, efficiency, value, productivity, value flow, TPM, 5S, JIT.

## 1. INTRODUCTION

The fundamental idea of lean manufacturing is actually pretty simple relentlessly work on eliminating waste from the manufacturing process. So, what is waste? Waste is defined as any activity that does not augment value from the customer's standpoint. It is an orderly approach of waste minimization without conceding on efficiency and throughput. This method of reducing waste was developed for two reasons; consumer satisfaction and cost-effectiveness. Finally, the consumers are the determining factor in what will be bought, therefore making a robust product that they choose out of all competitors makes sense. With lean, anything that is not providing value to the consumer is considered waste. There is no value in an item that is not being made money off of. Comprehending what consumers clearly value is a step in the right direction of reducing waste and moving more in the direction of lean manufacturing. Indubitably, this is easier said than done, but gathering a consensus on what consumers as a whole are asking for will allow an insight into what is being produced that is considered "wasteful". Lean manufacturing is becoming a top method for manufacturing industry leaders to further strengthen the operation through production efficiency.

## 2. ELEMENTS OF LEAN MANUFACTURING

### 2.1 Customer value

It is imperative to know that every activity in a process has a cost paid by the customer. If the activities that have cost are not controlled, then the product cost will go up. The main objective of customer is value for money. Anything which does not add value to the customer is waste and needs to be eliminated. The best price is not always the lowest price but rather the best combination of quantity, quality and delivery. A product/service adds value to the customer only when it meets the entire customer's known requirements and perceived requirements. Determining the value of a product, the order of the process from start to finish is crucial to be analysed.

### 2.2 Value stream

Value stream in a manufacturing environment can be well-defined as product production from order taking to delivery to the customer, and collecting money from him for the same. Sequence of all activities where cost is incurred is called value stream. There are 3 categories of

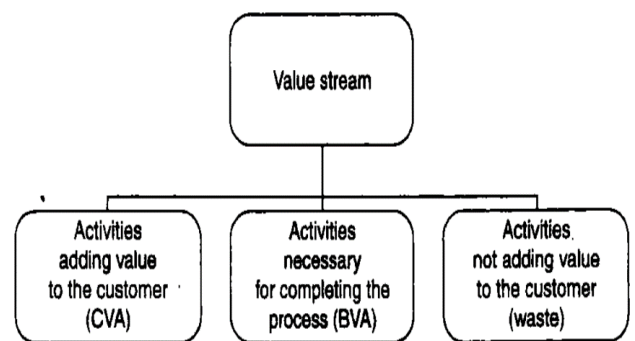


Fig 1. Subcategories of value stream

value stream as shown in fig 1

#### 2.2.1 Customer value added

- These are activities which add value to the customer and for which the customer is prepared to pay for.
- These activities are required to meet the customer requirements and add features as required by him/her.
- Without these activities it is not conceivable to achieve competitive advantage in relation to an organization's

competitor's.

### 2.2.2 Business Value Added

- There are activities that are compellingly included in the process, either because of government protocols or because without these processes, the business process cannot be completed.
- These processes may not add value to the customer directly but can be explicated as processes essential for the manufacturer to get the product.

### 2.2.3 Customer non value added

- When manufacturing a product, there are many activities that do not add value to the customer.
- Removing these activities will in no way affect the product features, performance and profitability for the customer.
- As these activities are shear waste, they must be removed from the value stream. Identification of the non-value-added activities and removing them are the central objective of lean manufacturing.

### 2.3 Value flow

On the basis of customer requirements, the product flows through all the processes at the proportion required by the customer. Every process activity in the production of the product is finished close to the rate demanded by the customer. The value flow is product produced using the value stream based on customer requirement. The management have to make sure that there are no tailbacks in the process and the flow of the value stream is smooth.

### 2.4 Customer Pull

In a push, the product is manufactured without knowing the specific customer need and sold to the customer by reaching him and entreating him to try the product. Pull on the contrary is producing any goods/service based purely on the customer. The word 'pull' is producing goods/services based on both internal/external customers.

### 2.5 Perfection by continuous improvement (KAIZEN)

It is compulsory to sustain the process, procedures, standards, efficiency and make sure that the organization does not swerve with what has been confirmed. Perfecting is by means of continuous improvement. The tactical management or management policy disposition is indispensable for executing lean enterprise systems.

### 3. Primary Lean tools

#### 3.1 5S

5S is a workplace organization technique. It is a system that is designed to guarantee workplace security, productivity, cleanliness and enhance quality. It is a way to involve associates in the ownership of their workspace. It aids to create and sustain the efficiency and effectiveness of a work area.

The 5S's components and their description given below in the table 1.0

Table 1.0

Japanese Term	Meaning	Description
3.1.1 Seiri	Sort Out	Separate out the things that are used and remove the things are not used from the working environment
3.1.2 Seiton	Set In Order	Arrange necessary items in proper order so that they can be easily picked up for use
3.1.3 Seiso	Shine	Clean your workplace / surroundings thoroughly so that there is no dust on the floors / machines & equipment
3.1.4 Seiketsu	Standardize	Establish procedures & standards to maintain 5S and perform regular patrol to all areas & continually audit the 5S progress
3.1.5 Shitsuke	Sustain	Cultivate spirits of self discipline and self awareness to maintain, encourage and continue 5S activities and sustaining it with timely motivation, training and sharing of working results

#### 3.2 Total productive maintenance (TPM)

Total

- all employees are involved
- it aims to eradicate all accidents, imperfections and breakdowns

Productive

- activities are performed while production goes on
- Complications during production are curtailed

Maintenance

- keep in good condition
- repair, clean, lubricate

TPM combines the conventionally American practice of preventive maintenance with Total Quality Control and Total Employee Involvement, to create a culture where operators develop ownership of their equipment, and become full partners with maintenance, engineering and management to assure equipment operates properly every day.

### 3.3 Workcell

A workcell is a logical and productive group of machinery, tooling and fully trained personnel producing similar products. Each cell has a leader who manages the workflow and is responsible for the work cell's success. The objective of the cell is the waste extermination by:

- Minimum movement of people
- Least movement of materials
- Reducing the setup time
- single piece flow
- Eliminating the downtime

### 3.4 Value Stream mapping (VSM)

VSM is a primary lean tool to visually indicate all actions needed to bring about a product or service in logical steps from start to finish. It shows all the actions required to complete a product or service through to the customer. The purpose of VSM is to understand the value flow. VSM helps in comprehending how the product flows from when the customer orders to the dispatch of the product to the customer. It facilitates to identify the steps that add value to the customer and do not add value to the customer.

VSM graphically depicts the following:

- Each process or activity
- Inventory or queues between the steps
- Set up times, cycle time
- Timeline for the whole value stream
- Information flow from customer through the production process
- Depiction of the complete process
- Changes needed to be executed

## 4. Secondary Tools

### 4.1 Cause and effect diagram

Recognizes the probable root causes of a problem. It categories out and relates some of the connections among the factors affecting a particular process or effect. The diagram scrutinizes the existing problems so that corrective action can be taken using organized approach. It encourages group participation and exploits group knowledge of the process. The cause and effect diagram use a systematic, easy-to-read format. It shows the possible causes of discrepancy in a process. The diagram increases knowledge of the process by helping everyone to learn more about factors at work and how they relate. It recognizes the areas where data should be collected for further study.

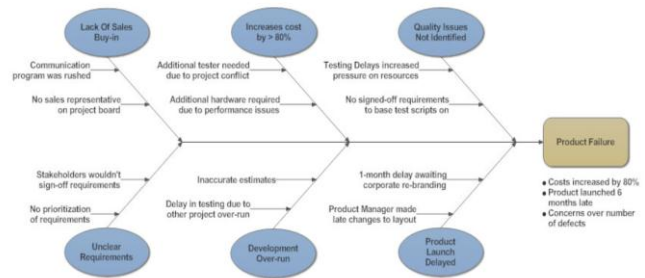


Fig 2. A sample cause and effect diagram

### 4.2 Pareto Chart

It graphically summarizes and demonstrates the relative importance of the differences between groups of data. The Pareto analysis is a way of organizing data to show what major factors significantly contributes to the effect being analysed. It helps in finding how much each cause contributes to the problem at hand. The chart helps teams to focus on the small number of really important problems or causes of problems.

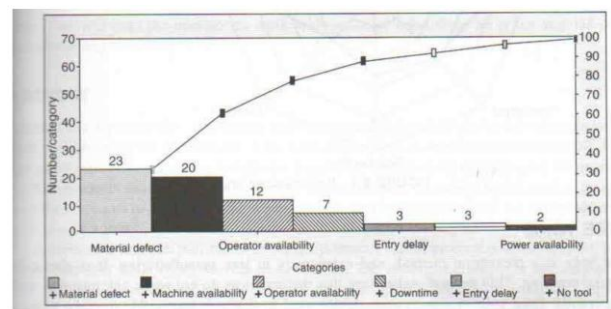


Fig 3. A sample pareto chart

### 4.3 Spider Chart

The spider chart is used to get a holistic view of several parameters at a single glance. It is used for weekly reviews and for recognizing the areas which require utmost attention. This chart is extensively used during implementation of lean manufacturing.

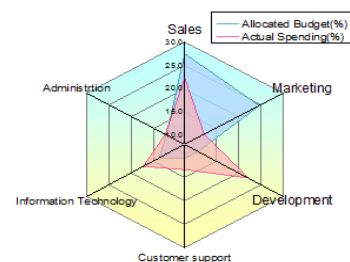


Fig 4. Spider chart

The advantages of spider chart are as follows:

- Condenses voluminous reporting.
- Can be automated so that anyone can watch the progress online.
- Depicts visually the area requiring immediate attention.
- Can be used for comparison purposes

#### 4.4 Poke Yoke (Mistake Proofing)

It is a prevention method used extensively in lean manufacturing, also called as mistake proofing. This method makes sure that the operators do not make any mistakes while in operation. It is a prevention device used so that it is impossible to make mistakes at all times. This is a strategy to strive towards making products with zero defects.

#### 4.5 Kanban (Instruction Card)

Kanban is a Japanese word meaning instruction card. It is a visual indication used to show/order the requirement of the parts/assemblies. It is a manual pull device that allows an efficient means to transfer parts from one shop to another and automatically reorders products using minimum inventory levels. It is usually preferred for pull manufacturing systems where the production is based on customer orders. Kanban delivers the right amount of material to the right place exactly when it is needed. A Kanban card is used when the move time and distance between producing and consuming departments are significant.

#### 4.6 Automation

It is an automatic signal that indicates the status of any machine, quality parameter or any other things that has to be measured. There is no manual intervention and everything is fully automatic. The signal can be in the form of light, sound or combination of both.

Signals used:

- Problem – Red light and Beep
- Normal operation – Green light
- Quality problem – Yellow light with I
- Quality problem due to Machine condition – Both red and yellow

#### 4.7 Single Minute Exchange of die (SMED)

Single Minute Exchange of Die (SMED) is a technique that focuses on simplifying machine setups. This allows stamping machines to go from four or more hours to few minutes in their set up or die exchange process. This technique is comparable to the process of removing and

placing a set of tyres in a racing car with just one bolt each, and in just five or six seconds. Lean manufacturing focuses on reduction of cycle time and lead time, SMED helps in achieving this by using appropriate jigs, fixtures, dies and moulds on the machinery to avoid longer changeovers.

#### 4.8 Design for manufacture and assembly (DFMA)

While designing any component, the designers mainly concentrate on the end use of the component/ assembly. As designers are not exposed to the intricacies of manufacturing, they purely think of the component from functional point of view. Design for manufacture is a concept that should be strictly followed to get the full benefit of lean manufacturing.

While designing any component there are many issues to be considered namely,

- Raw material
- Customer requirements are fully met
- Manufacturing process
- Quality parameters
- Ease of assembly
- safety

#### 4.9 Just in time (JIT)

This system can be described as a system that produces and delivers finished goods just in time to be sold, subassemblies just in time to be assembled into finished goods and purchased materials just in time to be fabricated in to parts.

Its fundamental principles are

Do not produce unless the customer has ordered it.

- Link all the processes to customer demand through simple visual tools.
- Maximize the flexibility of people and machinery.
- Improve quality and eliminate defects.
- Reduce raw material and finished goods inventory.

#### 4.10 Visual Workforce

Visual boards showing data required by project teams must be portrayed. Visual information aids the teams to understand project plan, accomplishment and targets. These can be online information on a computer, electronic boards or any other visual media which will facilitate the workforce to know what are the company's objectives, plans etc.



## 5. CONCLUSION

Lean Manufacturing is a manufacturing strategy that is used by every manufacturing industry to efficiently and productively manufacture products, so that products are manufactured on time whenever the customer initiates a purchase order. Scope of this topic has grown further to the next stage where different product customizations i.e. different product varieties are manufactured in a short time. The concept used is called Agile manufacturing which is the evolved strategy of Lean manufacturing. Scope of this concept has further evolved into another concept which is sustainable management which is an area which needs further research to fully explore the benefits and downfalls of this concept.

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## BIOGRAPHY



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