

# To Minimize the Waste in Production through Lean Manufacturing Process

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## Abstract

In production plants across the globe, lean manufacturing techniques are being used to meet increasing demands placed on manufacturers. Originally developed as a methodology to make production processes highly efficient, lean techniques have been adopted by more than 74 percent of machine shops across the country. For many of these, the techniques have helped them to dramatically increase their competitive edge, while continuing to remove wasteful practices and contribute to the bottom line. The core idea behind lean manufacturing is maximizing customer value while minimizing waste, thereby achieving manufacturing excellence through the creation of more value with fewer resources. Waste is defined as an activity that does not add value to the product. Through the elimination of waste along the entire manufacturing process, rather than at isolated points, companies are able to create processes that need less human effort, less space, less capital, and less time to produce high-quality, lower-cost products compared with traditional business systems. Given the shift toward a customer-centric environment while facing formidable competition, many manufacturers are implementing lean principles to help eliminate waste and increase efficiencies rather than relying on processes and procedures that have been used in the past. To help guide companies through a lean transformation, James Womack and Daniel Jones developed a five-step thought process detailed in their book, *Lean Thinking*. The five steps namely Specify value, Identify the value stream, Create flow, Establish pull, Seek perfection represent a continuous cycle of improvement, and act as the foundation for the successful implementation of lean in a facility.



**Keywords:** Production, Lean Manufacturing

## I. INTRODUCTION

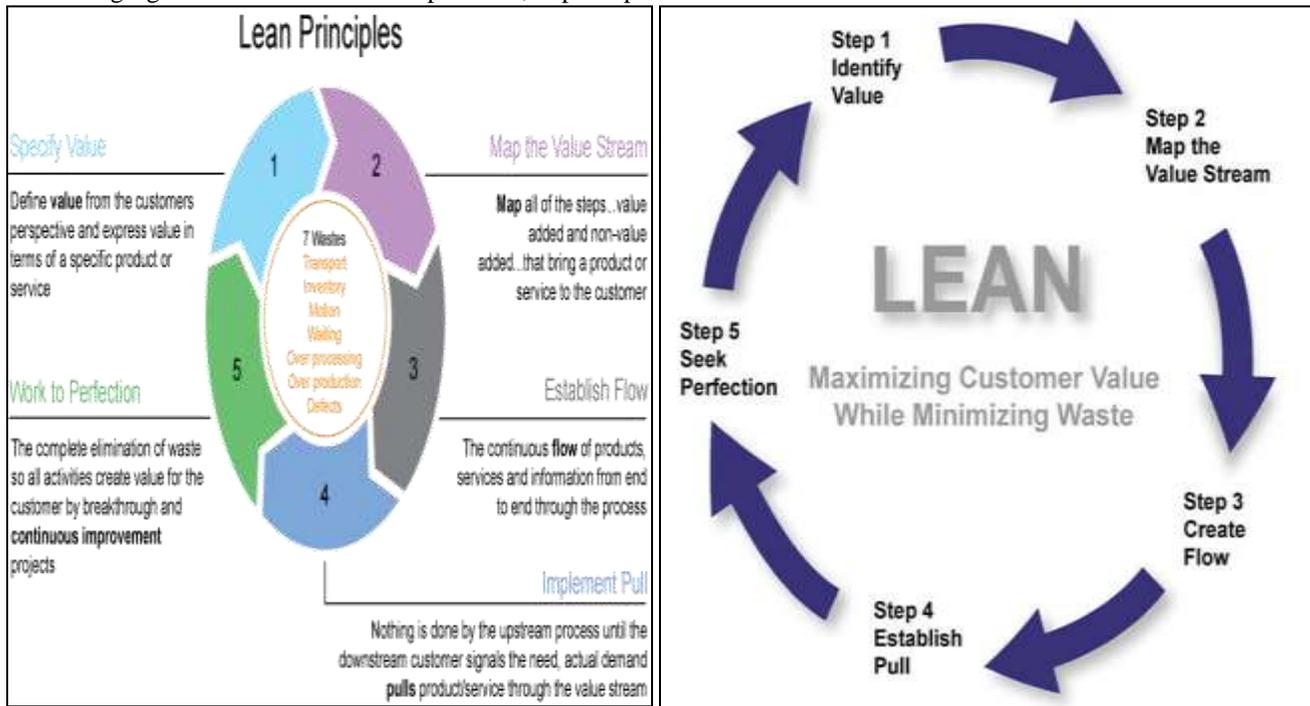
Definition-Lean manufacturing. ... Lean also takes into account waste created through overburden ("Muri") and waste created through unevenness in work loads ("Mura"). Working from the perspective of the client who consumes a product or service, "value" is any action or process that a customer would be willing to pay for. The primary goal of lean business processes is to reduce wasteful spending.

The five steps represent a continuous cycle of improvement, and act as the foundation for the successful implementation of lean in a facility:

- 1) Specify value. Identify the value of a specific product from the customer's perspective. Value can only be defined by the ultimate customer, although it must be created by the producer.

- 2) Identify the value stream. Identifying the entire value stream for each product will almost always reveal three types of actions along the value stream, including steps that create value, steps that create no value but are unavoidable with current technologies and production assets, and nonvalue-adding steps that can be eliminated.
- 3) Create flow. Once value has been precisely specified and the value stream for a specific product fully mapped, making work elements flow continuously with minimal queues and no rework or stoppages is the next step in a lean transformation.
- 4) Establish pull. After wasteful steps have been removed, and flow has been established, the ability to deliver only what is wanted by your customer, and only when they want it, is the fourth principle of lean thinking: pull. Allowing customers to pull a product through the process is indicative of the organization's ability to be responsive to a customer's needs.
- 5) Seek perfection. As organizations bring their processes through the initial four principles—accurately specifying value, identifying the value stream and removing wasteful steps, creating flow, and letting customers pull value from the enterprise—the fifth principle, perfection, becomes attainable.

The following figures show lean tools and practices, & principles



## II. LEAN MANUFACTURING IS A WAY TO STRATEGICALLY OPTIMIZE AND SIMPLIFY THE WORKING OF AN ENTERPRISE AND ITS ENVIRONMENT

### A. Understand the Value of Your End Product:

You want to reduce waste and be as efficient as possible, but in order to do this, you need to first place value on your end product. It comes down to a basic rule: know your customers and identify their greatest need. That way, you ensure you are creating quality products that your customers are willing to pay for, while minimizing the resources wasted during the process of producing it.

### B. Identify Waste:

Managers need to be trained in how to deal with problematic employees. Their training should tackle how to make better decisions, how to lead as well as follow instructions, and how to stay updated as well as improved on every level. Your managers should be willing to make changes, learn new programs, use new machines that are cost effective, and improve their understanding of the workplace and your products. Training, however, doesn't stop at the management level. It should then extend to all employees. For example, train your employees on how to improve their interactions with customers so they can bring in more quality to your company overall.

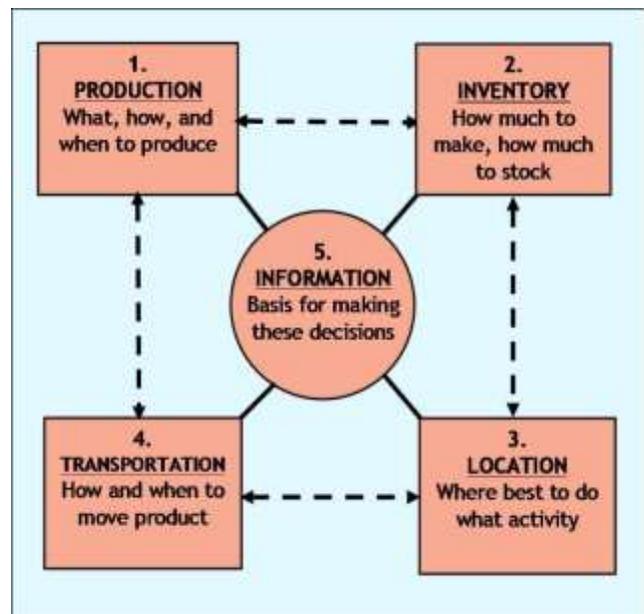
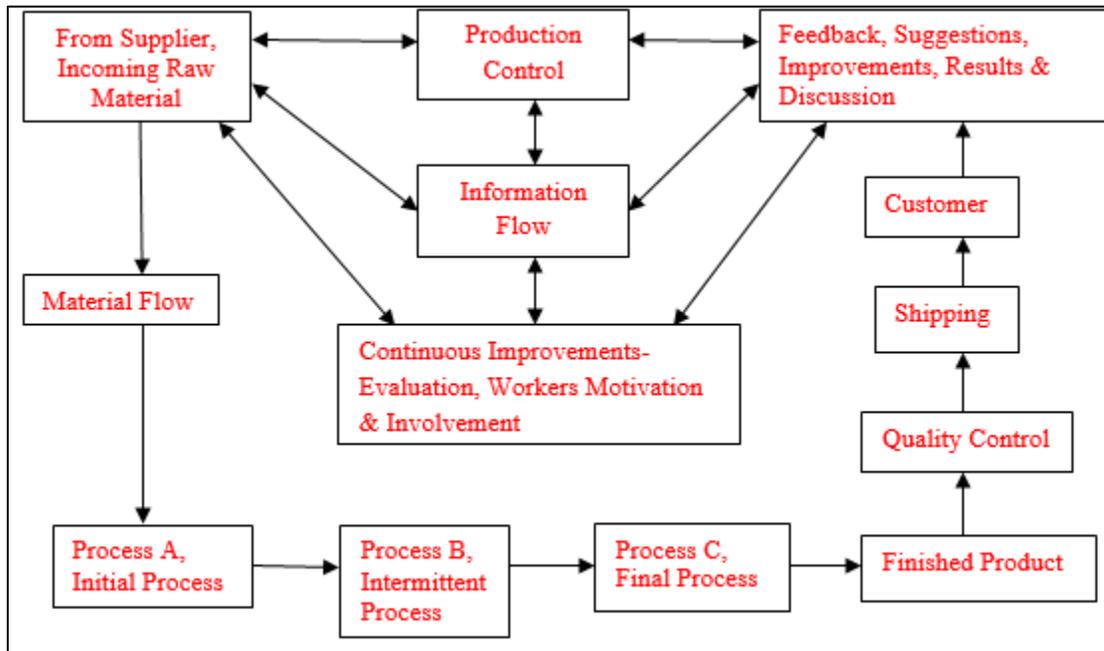
### C. Envision

Envision yourself and your company eliminating the need to make irregular changes every so often. Move ahead with a clear goal in mind: that of making sustainable change — no matter how small — and this will result in high-value end products. It's the only way to thrive, grow and function as a successful enterprise.

#### D. Training Sessions

Training sessions can also help boost employee satisfaction and value. In order to deal with workplace waste or wasteful employees, you must invest in training strategies that help educate your employees about the types of waste that everyone should watch out for.

### III. THE FOLLOWING CHART SHOWS CONVERSION OF RAW MATERIAL INTO FINISHED PRODUCT



### IV. CLASSIFY THE TYPES OF WASTE

If the big picture is too overwhelming, break down your waste into smaller categories:

- 1) Inventory Waste: List only what you need and make sure that overhead costs don't include items that are outdated or of no use to you any longer.
- 2) Overproduction Waste: It can be easy to overestimate production numbers. Identifying overproduction waste may be a process of trial and error, but you'll get to your goals in time.

- 3) **Waste of Time and Manpower:** When big mistakes are made, resources are wasted. To make sure your workers are reaching their full potential, invest in quality training programs that build efficiency within your teams and result in higher employee retention rates.
- 4) **In-House Machine Waste and Production Process Waste:** Part of the training mentioned above should encompass specialized programs to teach employees how to use the machines efficiently, saving cost and time, and adding value to the product.
  - **Defect Waste:** Learn to identify common mistakes and make everyone aware of them so that the mistakes do not occur consistently. This gets everyone on the same page and following a set standard of quality production and creation.
  - **Identify Workplace Waste:** Part of reducing waste during the manufacturing process is being able to better identify problems and solve them quickly, or before they have a chance to damage production on a larger scale.
  - **Perfect Tune-ups:** Small, consistent, and continuous checks, as well as minor improvements, will lead to a greater end product. Make sure all machines get regular tune-ups, big fixes, and upgrades if and when necessary. It is possible to achieve improvement by taking little steps at a time while making greater progress overall.
  - **Create Your Manufacturing Workflow:** Visualizing the step-by-step process of lean manufacturing can help to create an accessible workflow in your manufacturing environment. You will have to analyze all the waste points listed above, and create a working plan based on that analysis.
  - **One of the main principles of lean manufacturing** is to establish a continuous and synchronized production flow. Ask yourself and your employees: What is the root cause of such-and-such a problem? What practical steps are we taking to reduce, minimize, and eventually eliminate these waste factors?
  - **Train Your Employees:** By answering the questions above, you may realize that certain employees are responsible for the wasted time, money, and even an accelerated depreciation of equipment. So this next step must tackle workplace efficiency.
  - **Create Inventories:** One core value of lean manufacturing is proper inventory management. Professionals suggest just-in-time inventories, a process of only stocking resources and tools in the time you need them, rather than beforehand. In-depth analysis of inventory needs will reduce manufacturing waste at the very beginning.
  - **Ensure Lasting Workplace Efficiency Through Lean Management:** Are all these changes really necessary? It may seem daunting at first, but the end goal is to eliminate most of the hiccup phases. Your goal should be continuous improvement of your manufacturing process.

## V. THE KEY AREAS OF WASTE IN LEAN MANUFACTURING

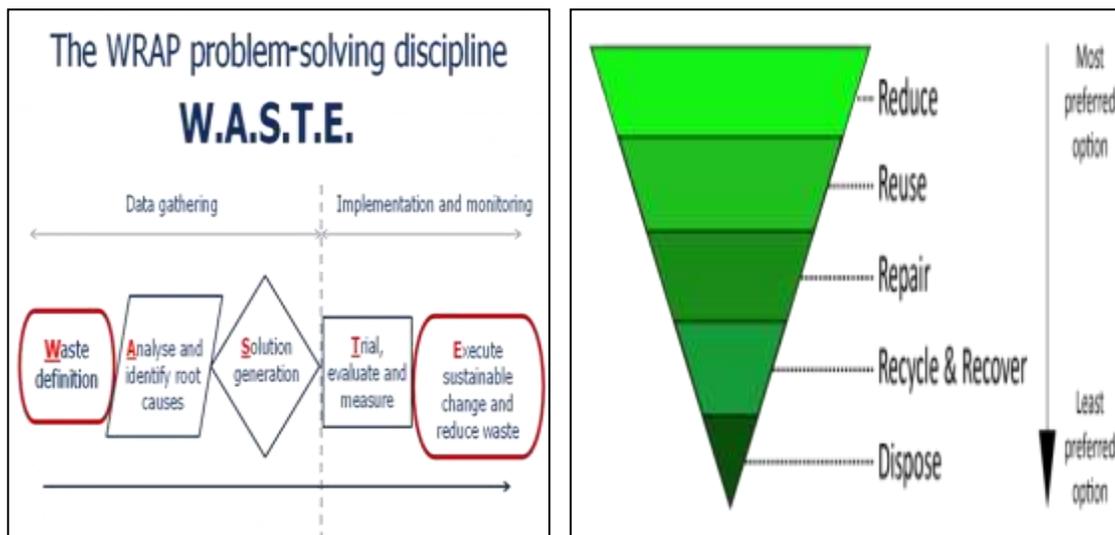
- 1) When you can transition your teams away from a “that’s just how we do it” mentality, you can start developing lean business processes by identifying and eliminating key areas of waste.

### A. Inventory

- 2) For product-based businesses, inventory can be a massive waste. Any inventory that isn’t directly required for meeting customer orders should be considered potential waste.
- 3) Examine your inventory against sales data to reduce inventory to the absolute minimum. Reset production processes so you’re only producing the inventory necessary to meet short-term sales. If you’re able to do so, transform your production process so that you’re producing based on customer demand rather than maintaining inventory overhead.
- 4) Inventory isn’t just applicable to your products. You have to consider your office supplies and what you regularly keep in stock for the administrative side of your business. If you spend money on office supplies, then you have wasted money sitting in unneeded files, supplies, extra copies, books and manuals, shipping supplies, and more.

### B. Overproduction

- 5) For manufacturing, this ties back to your inventory. Companies often want to keep employees busy so their labor is well-used, they’ll continue production, and move more stock into the warehouse.
- 6) In times like this you’re wasting on the product and the cost of maintaining that inventory as well as the labor involved in creating and maintaining that product.
- 7) Overproduction also occurs in the office and in service related businesses. For example, developers producing too many features beyond what is necessary (working out of scope), workers pulling reports before they’re needed, or over-analyzing data.
- 8) Multistep approval processes in production with lean batching, and cutting labor hours accordingly, can help reduce wasteful production that doesn’t produce an immediate return.



### C. Over-processing

- 9) It's staggering how many companies utilize an extensive system of checks and balances to catch errors, yet they still occur. Where we aim for improving quality on the output, we wind up wasting more without making a significant dent to justify the costs.
- 10) Over-processing often occurs when extra work is required to fix issues and defects, or to rework a problem that could have been done properly the first time if processes were carefully followed and/or improved upon.
- 11) Automated approval processes for document sorting and filing can streamline many of the problems that plague the office environment. Requiring an approval, and holding teams accountable for those approvals can get documents sorted quickly while keeping lead times down. It can also eliminate over processing in virtually any environment since each step requires an approval and review.
- 12) This improves accountability, reduces errors, reduces the number of people who need to be involved, and ensures that nothing is missed.

### D. Transportation

- 13) For manufacturing and physical goods, products are constantly moved from one facility to another despite the fact that they may sit for an extended period. In many cases, they're constantly routed around the same facility to make room for additional inventory being moved.
- 14) Products get routed further than necessary and transportation for filing, stocking, stacking and moving continues to eat up labor and fuel costs. Sometimes this transportation isn't authorized and employees move product randomly. There's an immediate cost to that, plus additional costs when other team members have to spend additional time locating the original products that should have never been moved.
- 15) For offices that utilize multiple systems without business process integration, a tremendous amount of waste occurs when the same data has to be entered multiple times across different platforms.
- 16) Integrated software applications, automated processes, and leaner operations can eliminate a great deal of this waste.

### E. Downtime

- 17) Downtime occurs regularly, often as a period of forced inactivity due to a downstream process that is halted or bottlenecked. Waiting for parts and subcomponents, change in orders, downed equipment, too-frequent inspections, product changes, a lack of orders and more can all bring manufacturing to a halt.
- 18) Marketing departments, accounting, and others may find themselves without work to do when they're stuck waiting for feedback, approvals or decisions from leadership.
- 19) Clearly defined, lean process can eliminate some downtime in production and manufacturing. For the office environment, approval processes with notifications can ensure that decisions and approvals are turned around quickly.

### F. Defects/Mistakes

- 20) This waste is related to the time and materials spent doing something of poor quality and later fixing it or scrapping it. Lean practitioners also count the cost of inspection as part of this waste
- 21) Here are a few examples from various industries:
  - Misdiagnoses in healthcare
  - The creation of parts that don't meet safety regulations
  - Software bugs

- Incorrect data entry
- Wrong food being delivered to your table in a restaurant

#### **G. Waiting**

- Waiting involves customers, patients, or parts sitting idle. Waiting happens when the person or item is ready for the next step, but the process is not ready to accommodate them.
- Patients in waiting rooms
- Software sitting in the QA queue
- System downtime
- Manufacturing processes waiting for component delivery
- Waiting for a flight that's been delayed due to maintenance being done wrong (a defect)

#### **H. Motion**

- The waste of motion involves unnecessary movement of people or items within a work center. It is often the result of neglecting the 5s'. Here are some examples:
- People searching for materials, tools or equipment
- Handoffs in software development
- Poorly structured or disorganized work spaces
- Having to make too many clicks in a website or software to accomplish a small task
- Writing down your name and address and personal information into your doctor's form for the umpteenth time

#### **I. Overproduction**

Producing more of a product than can be consumed at the time creates the waste of overproduction. Making too much of something (or making it too early) creates other types of waste. Overproduction is of particular concern because it tends to exacerbate the wastes of transportation, inventory and motion. Examples include;

- Production of components before the next stage in the process is ready to receive them
- Printing and filing of unnecessary documents

#### **J. Over processing**

Over processing simply means doing work that does not add value to the customer. Over processing is resolved with simplification. Sometimes, in Lean, we can stop doing some things instead of figuring out how to do them better.

- Entering the same data in more than one place on a form or in a software application
- Multiple approval levels for a small spending request
- Ordering unnecessary tests for patients

#### **K. Inventory**

The waste of inventory involves storing products or materials that are not needed at this time. Although it is a significant concern in manufacturing, it occurs in other sectors as well.

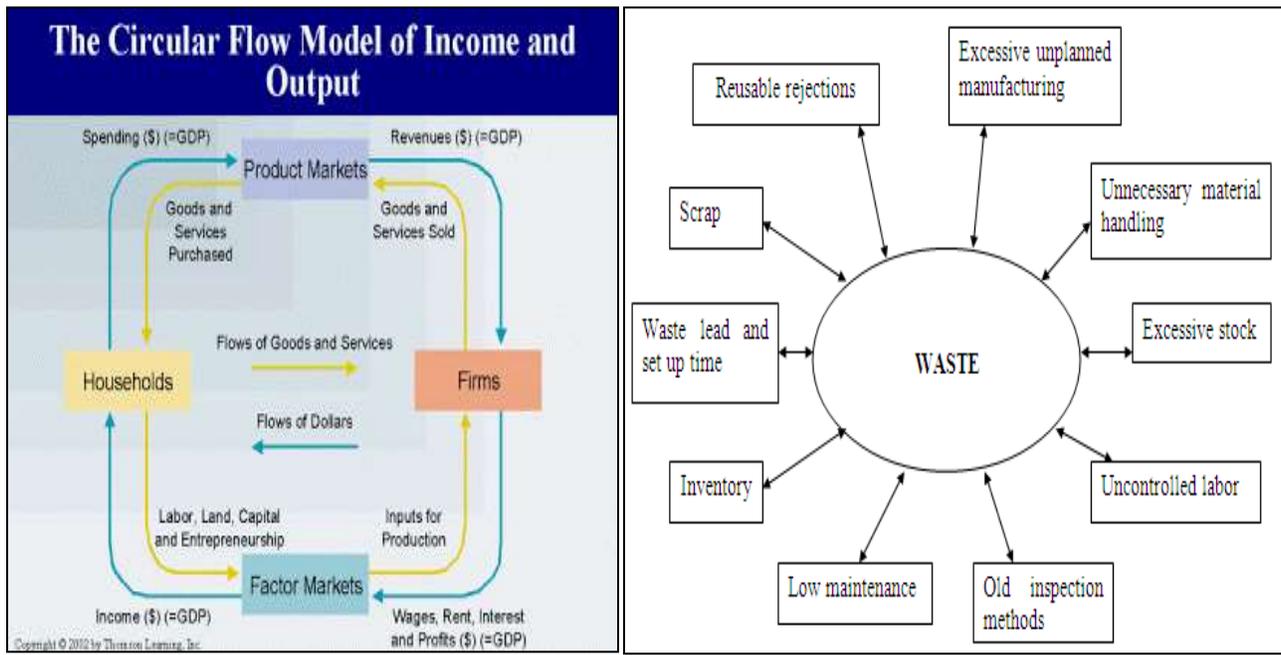
- Excess production of promotional materials or printed forms
- Cabinets full of office supplies
- Produce or food that goes to waste in our kitchen
- Kitchen gadgets that are accumulated and not used
- Unused or rarely used equipment

#### **L. Human Potential**

For a long time, discussion centered around only the prior seven wastes of Lean, but more recently, the waste of human potential has joined their ranks and with good reason. It is probably the most common and most damaging type of waste that organizations encounter. You see it when:

- Employees spend time on tasks that do not add value
- Career development and planning is absent
- People with advanced skills do routine work
- Employee ideas for improvement are ignored

When you identify waste, you also uncover opportunities for improvement and move closer to becoming a more efficient and cost effective organization.



## VI. ESSENTIAL LEAN MANUFACTURING TOOLS

5S: It eliminates waste that results from a poorly organized work area (e.g. wasting time looking for a tool), Organize the work area:

- Sort (eliminate that which is not needed)
- Set In Order (organize remaining items)
- Shine (clean and inspect work area)
- Standardize (write standards for above)
- Sustain (regularly apply the standards)

### A. Andon:

Visual feedback system for the plant floor that indicates production status, alerts when assistance is needed, and empowers operators to stop the production process.

Acts as a real-time communication tool for the plant floor that brings immediate attention to problems as they occur – so they can be instantly addressed.

### B. Bottleneck Analysis:

Identify which part of the manufacturing process limits the overall throughput and improve the performance of that part of the process. Improves throughput by strengthening the weakest link in the manufacturing process.

### C. Continuous Flow:

Manufacturing where work-in-process smoothly flows through production with minimal (or no) buffers between steps of the manufacturing process. Eliminates many forms of waste (e.g. inventory, waiting time, and transport).

### D. Gemba (The Real Place):

A philosophy that reminds us to get out of our offices and spend time on the plant floor – the place where real action occurs. Promotes a deep and thorough understanding of real-world manufacturing issues – by first-hand observation and by talking with plant floor employees.

### E. Heijunka (Level Scheduling):

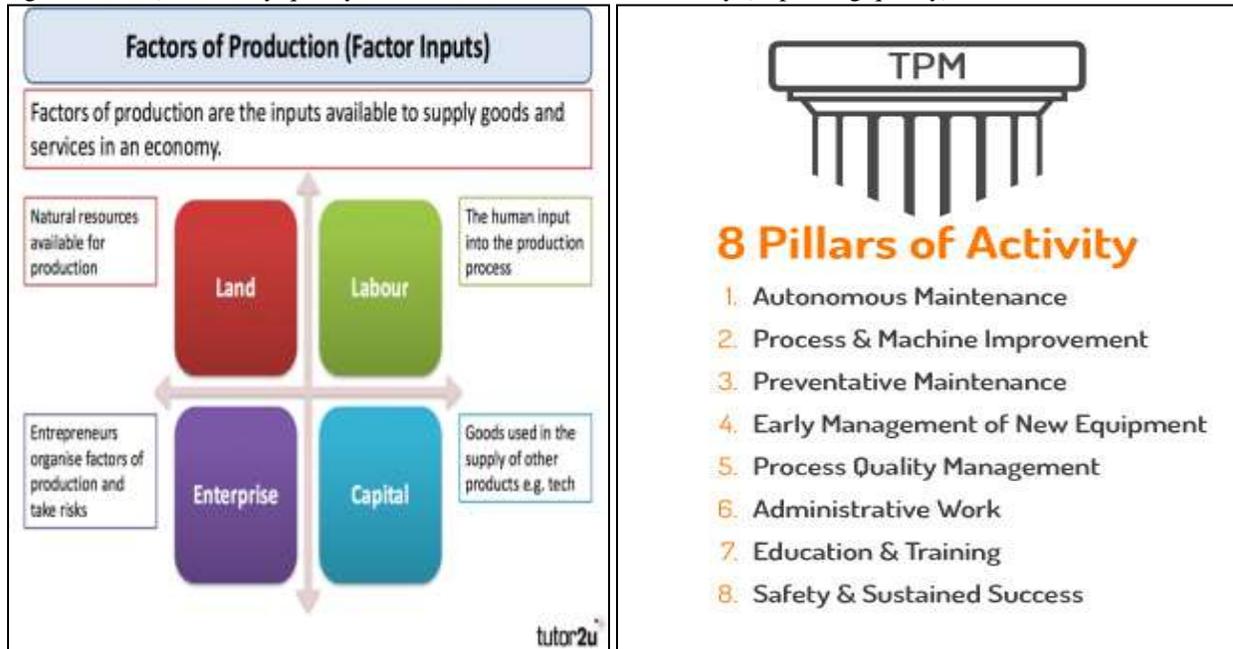
A form of production scheduling that purposely manufactures in much smaller batches by sequencing (mixing) product variants within the same process. Reduces lead times (since each product or variant is manufactured more frequently) and inventory (since batches are smaller).

#### **F. Hoshin Kanri (Policy Deployment):**

Align the goals of the company (Strategy), with the plans of middle management (Tactics) and the work performed on the plant floor (Action). Ensures that progress towards strategic goals is consistent and thorough – eliminating the waste that comes from poor communication and inconsistent direction.

#### **G. Jidoka (Autonomation):**

Design equipment to partially automate the manufacturing process (partial automation is typically much less expensive than full automation) and to automatically stop when defects are detected. After Jidoka, workers can frequently monitor multiple stations (reducing labor costs) and many quality issues can be detected immediately (improving quality).



#### **H. Just-In-Time (JIT):**

Pull parts through production based on customer demand instead of pushing parts through production based on projected demand. Relies on many lean tools, such as Continuous Flow, Heijunka, Kanban, Standardized Work and Takt Time. Highly effective in reducing inventory levels. Improves cash flow and reduces space requirements.

#### **I. Kaizen (Continuous Improvement):**

A strategy where employees work together proactively to achieve regular, incremental improvements in the manufacturing process. Combines the collective talents of a company to create an engine for continually eliminating waste from manufacturing processes.

#### **J. Kanban (Pull System):**

A method of regulating the flow of goods both within the factory and with outside suppliers and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed. Eliminates waste from inventory and overproduction. Can eliminate the need for physical inventories (instead relying on signal cards to indicate when more goods need to be ordered).

#### **K. KPIs (Key Performance Indicators):**

Metrics designed to track and encourage progress towards critical goals of the organization. Strongly promoted KPIs can be extremely powerful drivers of behavior – so it is important to carefully select KPIs that will drive desired behavior. The best manufacturing KPIs:

- Are aligned with top-level strategic goals (thus helping to achieve those goals)
- Are effective at exposing and quantifying waste (OEE is a good example)
- Are readily influenced by plant floor employees (so they can drive results)

#### **L. Muda (Waste):**

Anything in the manufacturing process that does not add value from the customer's perspective. It doesn't. Muda means 'waste'. The elimination of muda (waste) is the primary focus of lean manufacturing.

**M. Overall Equipment Effectiveness (OEE):**

Framework for measuring productivity loss for a given manufacturing process. Three categories of loss are tracked:

- Availability (e.g. downtime)
- Performance (e.g. slow cycles)
- Quality (e.g. rejects)

Provides a benchmark/baseline and a means to track progress in eliminating waste from a manufacturing process. 100% OEE means perfect production (manufacturing only good parts, as fast as possible, with no downtime).

**N. Poka-Yoke (Error Proofing):**

Design error detection and prevention into production processes with the goal of achieving zero. It is difficult (and expensive) to find all defects through inspection, and correcting defects typically gets significantly more expensive at each stage of production.

**O. Single-Minute Exchange of Dies (SMED):**

Reduce setup (changeover) time to less than 10 minutes. Techniques include:

- Convert setup steps to be external (performed while the process is running)
- Simplify internal setup (e.g. replace bolts with knobs and levers)
- Eliminate non-essential operations
- Create Standardized Work instructions

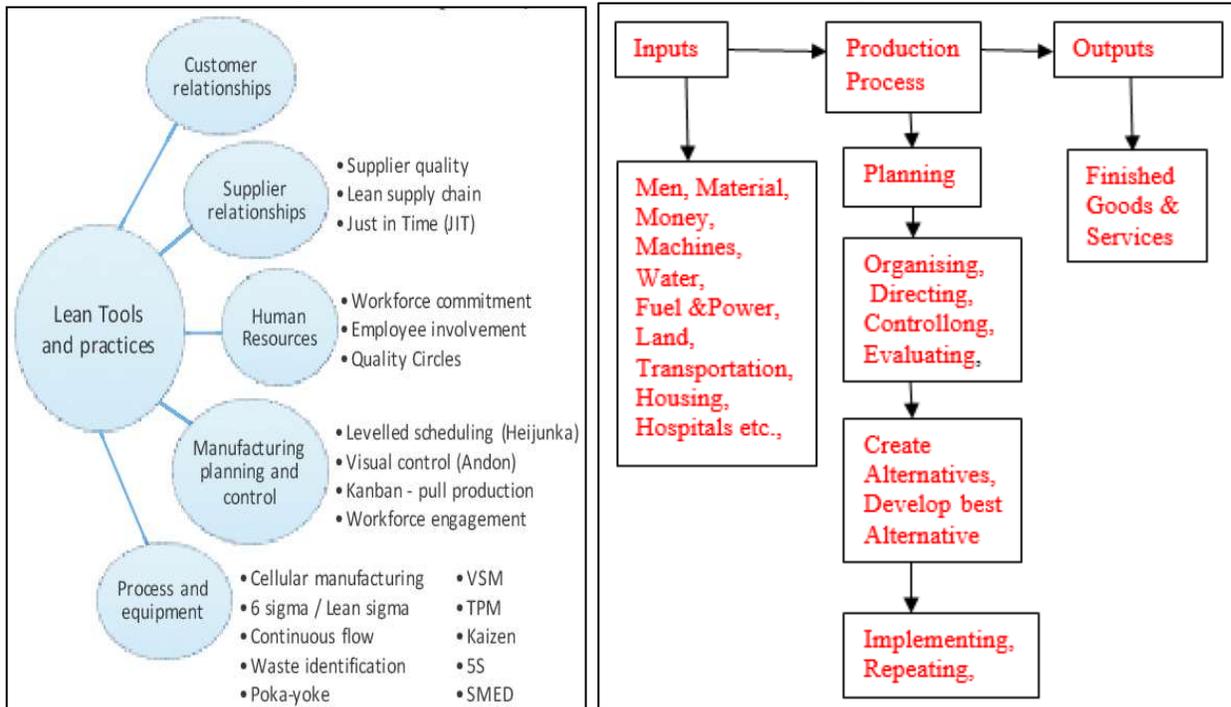
Enables manufacturing in smaller lots, reduces inventory, and improves customer responsiveness.

**P. Six Big Losses:**

Six categories of productivity loss that are almost universally experienced in manufacturing:

- Breakdowns
- Setup/Adjustments
- Small Stops
- Reduced Speed
- Startup Rejects
- Production Rejects

Provides a framework for attacking the most common causes of waste in manufacturing.



**Q. SMART Goals:**

Goals that are: Specific, Measurable, Attainable, Relevant, and Time-Specific. Helps to ensure that goals are effective.

**R. Standardized Work:**

Documented procedures for manufacturing that capture best practices (including the time to complete each task). Must be “living” documentation that is easy to change. Eliminates waste by consistently applying best practices. Forms a baseline for future improvement activities.

### S. What is Takt Time:

The pace of production (e.g. manufacturing one piece every 34 seconds) that aligns production with customer demand. Calculated as Planned Production Time / Customer Demand. Provides a simple, consistent and intuitive method of pacing production. Is easily extended to provide an efficiency goal for the plant floor (Actual Pieces / Target Pieces).

## VII. FOOD MANUFACTURING PROCESS

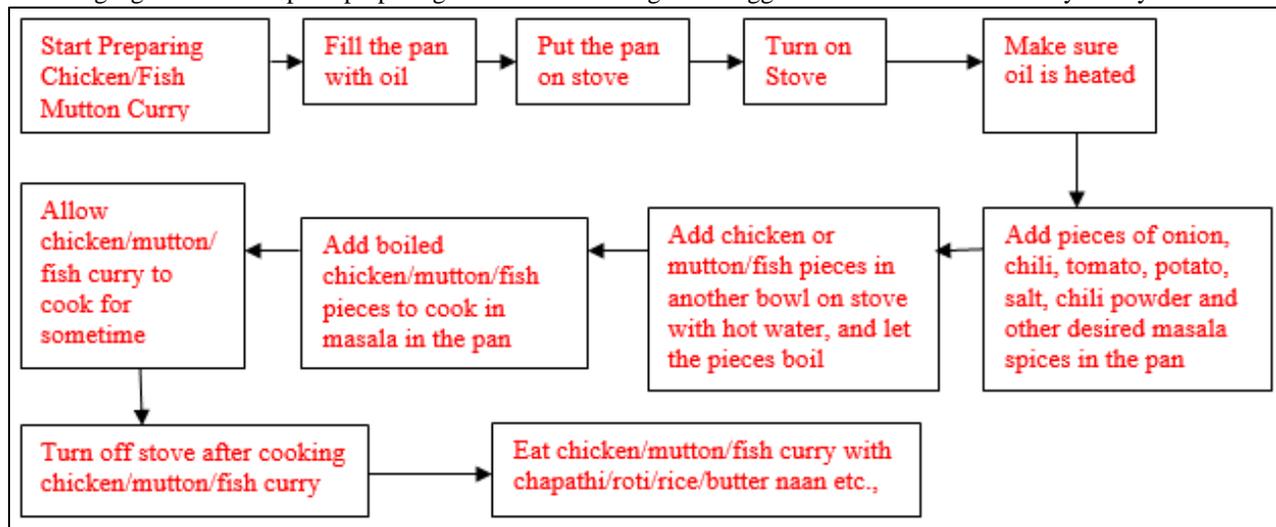
Flowcharts and process maps are used to:

- Increase understanding of a process
- Analyze how a process could be improved
- Show others how a process is done
- Improve communication between individuals engaged in the same process
- Provide process documentation
- Plan projects

Process maps can save time and simplify projects because they:

- Create and speed up the project design
- Provide effective visual communication of ideas, information and data
- Help with problem solving and decision making
- Identify problems and possible solutions
- Can be built quickly and economically
- Show processes broken down into steps and use symbols that are easy to follow
- Show detailed connections and sequences
- Show an entire process from the beginning to the end

The following figure shows steps in preparing the food called Vegetable/Egg/Chicken/Mutton/Fish Curry/Gravy



The following steps show how to prepare the food called Vegetable/Egg/Chicken/Mutton/Fish Fried Rice

- 1) In a saucepan, combine rice and water and boil rice. Reduce heat, cover, and simmer for 20 minutes.
- 2) In a small saucepan, boil carrots in water about 3 to 5 minutes. Drop peas into boiling water, and drain.
- 3) Heat, high heat. Pour in oil, then stir in carrots, onion, tomato, peas; cook about 10 minutes. Crack in eggs, stirring quickly to scramble eggs with vegetables. Add salt, chili, masala powder and Stir in cooked rice to the above. Shake in soy sauce, and rice to mix well. Drizzle with sesame oil, and stir again.
- 4) Fried Rice is ready
- 5) Please eat tasty/delicious mouthwatering fried rice

The following figure shows steps in preparing the food called Vegetable/Egg/Chicken/Mutton/Fish Biryani

Ingredients of Chicken/Mutton Biryani:

- |                                   |  |                                |
|-----------------------------------|--|--------------------------------|
| - 600 gm/1 kg basmati rice        | - 400 gm thinly sliced white onion       | - 2 pinches saffron            |
| - 4 tablespoon minced mint leaves | - 8 green cardamom                       | - 1 tablespoon ginger paste    |
| - salt as required                | - 1 tablespoon milk                      | - 4 sliced & slit green chilli |
| - 2 teaspoon coriander powder     | - 1 kilograms chicken/mutton/fish thighs | - 320 gm chopped tomato        |
| - 1 tablespoon garlic paste       | - 1 teaspoon garam masala powder         | - 2 teaspoon cumin seeds       |
| - 2 tablespoon tomato puree       |  | - 6 tablespoon refined oil     |

- 1) Step 1: First, in order to marinate the chicken, take a large bowl, put Greek yogurt, turmeric, chili powder along with salt as per your taste in a small bowl. Mix it well using a spoon and then, add the chicken thighs in the mixture and rub with this mixture. Keep aside for about 20-30 minutes, so that the yogurt mixture is properly absorbed by the chicken. Also, soak saffron in the milk to make saffron milk and keep aside.
- 2) Step 2: In the meanwhile, pour refined oil in a deep-bottomed pan, keeping it on medium flame. Add cumin seeds and green cardamom in it and saute for about 2 minutes. Once done, immediately add the sliced onion and fry for 2-3 minutes straight. Make sure you don't burn it, so when the onion starts to get brown in color, add tomatoes and tomato puree and fry for another 5 minutes.



- 3) Step 3: Next, add the slit green chilies to the mixture along with ginger-garlic paste, frying the mixture yet again for a minute. Then, add coriander powder and turn the flame to medium-low while stirring and cooking the masala. Quickly, add the marinated chicken and mix for a while so that the ingredients absorb the juices properly. Add required amount of rice in the large bowl and add necessary water to boil with masala in the bowl.
- 4) Step 4: Turn the flame to medium again and heat. Make sure to keep stirring during the entire process, else the chicken might stick to the bottom, eventually ending up burnt. You can add little water, if you find the consistency too thick.
- 5) Step 5: Once done, turn off the flame. Sprinkle milk soaked saffron along with garam masala, mint and coriander leaves. Put the remaining rice over this layer and garnish with the same mentioned four ingredients.
- 6) Step 6: Lastly, cover the lid, turn the flame to low medium and let the rice cook for about 25-30 minutes. Once done, put it off and let the biryani stay covered for about another 10 minutes. Serve hot biryani, along with raita or any chutney of your choice.

Note: We can also prepare idly, upma, wada, masala/onion/ravva dosa, puri, chapathi, pesarattu, uttappam and sweets like Gulabjamon, jalebi, jangri, laddu, gajar ka halwa, kalakandi, Rasgulla, Ariselu, peda and hots like murukulu, boondi, mixture, pappuchakkalu, chakli, janthikalu, chakralu, potato chips, potato/mirch bajji, onion pakoda, wada, samosa, omlet, cutlet, dal, sambar, chutney, pickles etc., with maximizing production, sales and profit and minimizing waste.

### VIII. ADVANTAGES OF LEAN MANUFACTURING PROCESS

- |  |  |  |
|--|--|--|
| 1) Reduced changeover time   | 9) Better and constant quality of products, services | 17) Establishes standards for operating equipment and conducting processes |
| 2) Decrease in flow distance   | 10) Reduced equipment breakdowns                     | Less spending on replacing lost or damaged items                           |
| 3) Increased floor space   | 11) Improves workplace safety                        | 18) Less stress and tiredness  |
| 4) Greater self-esteem   | 12) Fewer hazards                                    | 19) Improved morale and pride in the workplace                             |
| 5) Improvement of communication  | 13) Clean work place                                 | 20) Training time reduced for new employees                                |
| 6) Increase in productivity  | 14) Reduction in materials handling                  | 21) Greater efficiency in achieving goals                                  |
| 7) Fast work   | 15) Reduced lead time and cycle time                 | 22) Greater readiness for new tasks  |
| 8) Improved appearance of the facility and expectation for compliance to maintain that condition | 16) Reduced search time                              | 23) Better impression on clients   |

## IX. LIMITATIONS OF LEAN MANUFACTURING PROCESS

- Equipment Failure - Lean has very little room for error. Equipment or labor failure can lead to major inconsistencies within lean and can make the entire operation fall behind. In other mass production facilities, employees could just move over to another machine if one went out. In lean, there are not many other places for employees to move to, because everything within the operation is being utilized.
- Delivery Inconsistencies - In correlation with equipment failure, this drawback in production enables delivery inconsistencies. This disadvantage of lean can hinder customer relationships, push consumers toward competitors, and cost you revenue.
  - Insufficient supervisory skills to implement lean, Employee attitudes/resistance to change
  - Insufficient workforce skills to implement lean, Insufficient senior management skills to implement lean, Insufficient management time, Cultural issues, Cost of the investment
  - Insufficient understanding of the potential benefits, to convince shareholders/owners
  - High cost of implementation

## X. CONCLUSIONS & RECOMMENDATIONS

- 1) Manufacturing firms in India must advocate JIT philosophy which helps to minimize wastages and aims for continuous improvement.
- 2) Employee involvement is one of the pillar of world class manufacturing firms
- 3) TPM is key to lean implementation in Indian manufacturing firms which promotes self-discipline and aims to minimize equipment failures and improve reliability of the system.
- 4) Strict adherence to compliance and routine maintenance activities help to improve performance.
- 5) Recognize the importance of customers in product offerings, product development or product design.
- 6) Human resource focus is an important function to lean implementation.
- 7) Training & development, compensation, communication & reward are regarded to be most important dimensions of human resource focus in successful implementation of lean.
- 8) Manufacturing companies must invest on training & development activities & duly reward champions who produce excellence.
- 9) Total Quality Management-TQM is achieved through involvement of all stakeholders from sourcing to supplier's selection to delivery of raw materials to final conversion and distribution of finished goods to the customers or end users.
- 10) The findings suggest that firms who have implemented TQM have successfully implemented JIT. It is a philosophy which aims to reduce defects and improve product quality.

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