4.3 LEAN SYSTEMS

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1. INTRODUCTION

Lean production is an assembly-line manufacturing methodology developed originally for Toyota and the manufacture of automobiles. It is also known as the Toyota Production System. The goal of lean production is described as "to get the right things to the right place at the right time, the first time, while minimizing waste and being open to change". Engineer Ohno, who is credited with developing the principles of lean production, discovered that in addition to eliminating waste, his methodology led to improved product flow and better quality.

Instead of devoting resources to planning what would be required for future manufacturing, Toyota focused on reducing system response time so that the production system was capable of immediately changing and adapting to market demands. In effect, their automobiles became made-to-order. The principles of lean production enabled the company to deliver on demand, minimize inventory, maximize the use of multi-skilled employees, flatten the management structure, and focus resources where they were needed.

2. LEAN PRODUCTION SYSTEM (TOYOTA PRODUCTION SYSTEM)

It is a team-based approach of manufacturing focused on identifying and eliminating waste through continuous improvement by making the product flow as in accordance with the pull of the customer in pursuit of perfection. Lean manufacturing system is a systematic study of waste through in process inventory, excess lead-time, transportation, and internal movements, and unnecessary occupied space.

The basic purpose of lean manufacturing is to increase profits by reducing costs and to improve productivity. Costs include not only manufacturing cost but also administrative cost and capital-cost. To achieve reduction in cost, we must flexibly adapt to changes in market demand without having wasteful slacks.

3.BASIC ELEMENTS OF LEAN MANUFACTURING

The basic elements are pull systems, lead time reduction, continuous improvement. When these elements are focused in the areas of cost, quality and delivery, this forms the basis for a lean production system.

3.1 Pull Systems

A lean production system essentially needs a pull system, which authorizes the release of raw materials based on real customer demand, which is defined by the system status. A push system, in contrast, schedules releases based on forecasts. Reducing inventory is one of the key measures to implement lean manufacturing. The time between order release and product delivery (cycle time) must be short, to achieve this target.

In traditional push systems, suppliers are left with large amount of inventory and still may not be able to fulfill the customer's specific need. In a pull system, the parts move in small batches, by way of calculated buffers. Hence the products move fast out of the system and this means lower inventory levels and holding costs (Liker & Wu, 2000). In addition, the supplier can respond rapidly to customer demands, hence customer satisfaction is enhanced.

3.1 CONTINUE...

It is also relatively easy to identify defects in products and correct it in next batch. It requires fewer people to perform the same task than before, as non value-added activities are reduced in this system. In short, the overall productivity and efficiency of the plant increases by implementing a pull system.

It is a method of controlling the flow of resources by replacing only what the customer has consumed or demanded. Service organizations operate this way by their very nature. Manufacturers, on the other hand, have historically operated by a Push System, building products to stock, without firm customer orders.

There are several major benefits to pull systems. One benefit is the reduction of Work-In-Process (WIP); the second major benefit is it reduces scheduling complexities. Pull Systems consist of production based on actual consumption, small lot sizes, low inventories, management by sight, and better communications. Pull systems eliminate sources of waste in the production flow.

3.2 Lead Time Reduction

An objective of lean manufacturing is reducing production lead times. This can be achieved by reducing variability, leveling product flow, and enabling mix-model manufacturing by using flexible machines cross-trained workers (Liker & Wu). The set up times can be reduced by transforming internal setups to external setups by implementing Single Minute Exchange of Dies (SMED), using jigs, and fixtures and by reducing machine breakdowns by preventive maintenance. Cycle time reduction can be achieved by using cell manufacturing and by implementing a pull system.

3.3 Continuous Improvements (KAIZEN)

Every process can and should be continually evaluated and improved in terms of time required, resources used, resultant quality, and other aspects relevant to the process. When applied to the workplace, Kaizen means continuing improvement involving everyone - managers and workers alike.

Kaizen is not limited to manufacturing systems only. It also means continuing improvement in personal life, home life, social life, and working life.

4. OVERVIEW OF LEAN PRODUCTION SYSTEM

Wastes are referred to as non-valued-added activities and are known to Lean practitioners as the Seven wastes. Taiichi Ohno suggests that these account for up to 95% of all costs in non- Lean manufacturing environments.

These wastes are:

4.1 Over production

The waste of over production was the most serious of all the wastes because it was the root of so many problems. The aim should be to make exactly what is required, no more and no less, just-in-time and with perfect quality. The corresponding Lean principle is to manufacture based upon a pull system, or producing products just as customers order them. Anything produced beyond this ties up valuable labor and material resources that might otherwise be used to respond to customer demand. Overproduction discourages a smooth flow of goods or services.

It also leads directly to excessive lead time and storage times. As a result defects may not be detected early, products may deteriorate, and artificial pressures on work rate may be generated. All these increase the chances of defects. Overproduction leads to excessive work-in-process inventories which lead to the physical separation of operations and the discouragement of communication.

4.2 Waiting

The waste of waiting occurs whenever time is not being used effectively. Time is an important element for competitiveness and quality. Waiting involves a delay to non-value adding activities. When operators and employees are waiting for work or simply for something to do, it is waste.

4.3 Transportation

Customers do not have goods moved around. The number of transport and material handling operations is directly proportional to the likelihood of damage and deterioration. Double handling is a waste that affects productivity and quality.

Transporting is closely linked to communication. Where distances are long, communication is discouraged and quality may be the victim. There is increasingly the awareness that for improved quality in manufacturing or services, people from interacting groups need to be located physically closer together. For instance, the design office may be placed deliberately near the production area.

4.4 Processing

Inappropriate processing refers to the waste of using a hammer to crack a nut. Thinking in terms of one big machine instead of several smaller ones discourages operator ownership, leads to pressure to run then machine as often as possible rather than only when needed. It also leads to poor layout, extra transportation and poor communication. So the ideal is to use the smallest machine, capable of producing the required quality, distributed to the points of use. In general, a capable process requires having the correct methods, training and tools as well as having the required standards clearly known.

4.5 Inventory

Although having no inventory is a goal that can never be attained, inventory is the enemy of quality and productivity. This is because inventory tends to increase lead time, prevent rapid identification of problems, and increase space thereby discouraging communication. Related to Overproduction, inventory beyond that needed to meet customer demands negatively impacts cash flow and uses valuable floor space.

4.6 Motion

Unnecessary motions refer to the importance of ergonomics for quality and productivity. If operators have to stretch, bend, pick-up, move in order to see better, the victim is immediately the operator but ultimately quality and productivity.

4.7 Defects

Defects cost money. A defect should be regarded as a challenge, as an opportunity to improve, rather than something to be traded off against what is ultimately poor management.

4.8 Other Wastes

These include the waste of human potential or talent, the waste of excess energy or power used; the waste of pollution, the waste of space, and the waste of unnecessary complexity.

5.LEAN TECHNIQES

In order to reduce or eliminate wastes, Lean practitioners utilize many tools or techniques. There are a number of Lean techniques available such as, Value Stream Mapping, Visual Workplace, Setup Reduction, Cellular/Flow Manufacturing, Pull Systems, Just-in-Time (JIT) and Total Productive Maintenance.

5. 1 Just-In- Time Production

JIT is a collection of concepts and techniques for improving productivity. JIT is a process aimed at increasing value-added and eliminating waste by providing the environment to perfect and simplify the processes. Just-In-time manufacturing means producing the necessary items in necessary quantities at the necessary time. As the saying goes, time is money. If you focus on time, you're likely to find the hidden costs in an inefficient production system.

The power of JIT lies in what it can do for the bottom line. Having materials arrive at the factory in time to enter the production process allows a company to minimize the amount of inventory it must hold and store a costly activity. It also minimizes the cost of obsolescence, when parts sit on the shelf so long that they become obsolete.

By reducing the overall flow time of Boeing products, the company can reduce many of the associated costs of production, such as inventory holding costs. This strategy will also allow Boeing to meet customer demands quickly and efficiently.

Putting this concept into practice means a reversal of the traditional thinking process. In conventional production processes, units are transported to the next production stage as soon as they are ready. In JIT, each stage is required to go back to the previous stage to pick up the exact number of units needed.

5.1.1. Advantages of JIT

1.Shortened lead time

2.Reduced time spent on non-process work

3.Reduced inventory

4.Better balance between different processes

5.Problem clarification

5.2. Autonomation

In order to realise Just-in-time perfectly, 100 per cent good units must flow to the prior process, and this flow must be rhythmic without interruption. Therefore, quality control is so important that it must coexist with the Just-in-time operation throughout the Kanban system.

Autonomation means to build in a mechanism a means to prevent mass-production of defective work in machines or product lines. Autonomation is not automation, but the autonomous check of abnormality in the process. The autonomous machine is a machine to which an automatic stopping device is attached.

In Toyota factories, almost all the machines are autonomous, so that mass-production of defects can be prevented and machine breakdowns are automatically checked. The idea of Autonomation is also expanded to the product lines of manual work. If something abnormal happens in a product line, the worker pushes stop button, thereby stopping his whole line. For the purpose of detecting troubles in each process, an electric light board, called Andon, indicating a line stop, is hung so high in a factory that it can easily be seen by everyone. The Andon in the Toyota system has an important role in helping this autonomous check, and is a typical example of Toyota's "Visual Control System."

5.3 ANDON-Visual control

These are simple signals that provide an immediate and readily apparent understanding of a condition or situation. Visual controls enable someone to walk into the workplace and know within a short period of time (usually thirty seconds) what is happening with regards to production schedule, backlog, workflow, inventory levels, resource utilization, and quality. These controls should be efficient, self regulating and worker-managed, and include Kanban cards, lights, color-coded tools, lines delineating work areas and product flow, etc. If any reason the working line is stopped, a display lamp immediately appears on a board suspended above each line, showing at which process of line a problem has occurred.

Visual systems are used to transform a factory into a place where thousands of messages concerning product quality, productivity, scheduling, and safety are accurately and rapidly delivered every day. A "Visual Workplace" is self-explaining, self-ordering, self-regulating, and self-improving, where what is supposed to happen does happen, on time, every time, day or night - because of visual systems.

A visual system should answer the following six core questions, requiring visual answers; Where, What, When, Who, How Many, and How." There are four basic visual devices, Visual Indicators, Visual Signals, Visual Controls, and Visual Guarantee (also known as mistake-proofing and poka-yoke devices). One of the main impacts visual systems will have is in eliminating non- valued added motion.

5.4 POKA-YOKE (Fool proofing)

Poka-Yoke is designing the work process to eliminate human mistakes. Fool proofing system is a means to create devices that can discover defectives without the workers having to be attentive to minute details.

1. Steps

The steps for fool proofing are,

- If there is a miss step, the device does not allow goods to be mounted to jigs.
- If a disorder is found in the goods, the device does not allow the machine to start processing.
- If there is a miss step in work process or in motion, it is automatically adjusted, and the device will allow processing to proceed.
- The disorder that has occurred in preceding process is examined at the next process, and the device will stop defectives.
- If a certain operation is forgotten or stopped, the device does not allow the next operation to begin.

5.5 Workplace Organization (5 S)

This tool is a systematic method for organizing and standardizing the work place. It is one of the simplest Lean tools to implement, provides immediate return on investment, crosses all industry boundaries, and is applicable to every function with an organization. One of the most fundamental and widely applied tools of Lean Manufacturing is 5S.

The benefits of 5S are:

- It can be done today
- Everyone can participate
- Waste is made visible
- Has a wide area of impact
- Improves set up times
- Improves quality
- Improves safety
- Improves morale
- Improves productivity

There is an order and logic to how 5S is carried out. It doesnt make sense to start by arranging things neatly, if most of those things are not needed.

The five S words below are the steps of 5S.

5.5.1 Sort

It is about removing all items that are not required or are unnecessary within a period ahead. Such items are waste, or lead to waste. They take up space, lead to extra walking around, and lead to waste of time whilst searching for needed items buried under piles of less important material.

5.5.2 Straighten

It is about having things easy to hand, labeled, classified and easily visible. Shadow boards may be used for tools, books arranged by topic, shelves not too high, wheels on carts, heavy low and light high, colour coded connections and pipes.

It has a direct impact on productivity-Searching for lost papers and tools should be eliminated. And time wasted should be cut by careful location of tools and materials.

5.5.3 Scrub (Sweep)

Clean and check regularly is about keeping things clean and ready to go. This step follows clean and orderliness. It needs to be done daily. Routine maintenance may be in cooperated oil every day, replace after 5000 sheets, and air craft style checks where items are checked at the start of every shift. One important activity is identifying which maintenance activities are the responsibility of the ordinary staff, and which are the responsibility of the specialist maintenance staff.

5.5.4. Standardize

It refers to engendering the habits of workplace procedures. It is about the establishment and maintenance of standards. The first standard is to ensure that the previous 3Ss are in place and maintained. Standards should be kept line side and be diagrammatic or written, but never verbal. Standard procedures can be color coded to match the product, which carries a label of matching colour.

When an engineering change occurs, a number on the product should match the number on the standard sheet. Any standard should cover not only what to do when things are normal, but also what to do if things go wrong.

5.5.5 Self Discipline

It is to make sure that the activities are kept going. This amounts to identifying responsible people, setting the frequency of review, and maintaining a visual record for important equipment. Prevention is the watchword. But even better than prevention is failsafing, whereby inspection is automatic and a warning occurs. Examples are automatic counts on cutting, showing a light when tool change is required, or automatic backup of hard disk.

Management participation and interest is vital to keep a 5S programs going. Expectation and example are important. Management must be seen to practice 5S themselves, and to maintain commitment.

5.6. Total Productive Maintenance (TPM)

It is a concept of productive maintenance aimed at achieving overall effectiveness of the production system through the involvement of all the people in the organization. It consists of a company wide equipment maintenance program covering the entire equipment life cycle. The goal of TPM is to minimize downtime due to maintenance, and maximize machine uptime. One of the key elements of TPM is autonomous maintenance where the operators are responsible for maintaining their own equipment.

TPM stages are break down maintenance, preventive maintenance, productive maintenance, and total productive maintenance.

TPM capitalizes on proactive and progressive maintenance methodologies and calls upon the knowledge and cooperation of operators, equipment vendors, engineering, and support personnel to optimize machine performance. Results of this optimized performance include; elimination of breakdowns, reduction of unscheduled and scheduled downtime, improved

utilization, higher throughput, and better product quality. Bottom-line results include; lower operating costs, longer equipment life, and lower overall maintenance costs.

5.7 Heijunka

It is a production scheduling / load leveling tool, essentially to distribute Kanban cards in an efficient manner.

5.8 Value Stream Mapping

Value stream mapping is usually the first step in the evaluation of an existing manufacturing process. A Value Stream Map is a visual documentation of the process flow, both material and information flows are depicted. It is used to provide a snapshot of the "Present State" of your manufacturing process.

Producing this present state flow diagram will help identify all of the value adding and non-value adding steps within your process. Once this present state map is completed, a company will clearly see where the opportunities are for eliminating the non-value adding steps. The "Future State" Map of a process is then created showing the improved, streamlined flow. Using this method will allow a company to look at the "Big Picture" of a manufacturing process. Value Stream Mapping doesn't require any special software tools; everything should be drawn by hand and in pencil.

5.9 The 5 Whys

The 5 whys is a technique to ensure that the root causes of problems are sought out. It simply requires that the user asks why several times over. This simple but very effective technique really amounts to a questioning attitude.
Never accept the first reason given; always probe behind the answer. It goes along with the philosophy that a defect or problems something precious; not to be wasted by merely solving it, but taking full benefit by exposing the underlying causes that have lead to it in the first place.

The 5 why analysis gives guidance to the role of an effective quality department. With total quality established, much responsibility for quality will be placed at source, that is with the person that makes it. The quality professionals need to be spending more time on the detective work of tracing problems to their root cause. This is real continuous improvement and prevention.

5.10 Setup Reduction

It is the technique of time to change a process from running one specific type of product to another. The purpose for reducing changeover time is not for increasing production capacity, but to allow for more frequent changeovers in order to increase production flexibility. Setup reduction is driven by the need of being able to change over a given process to produce a different product in the most efficient manner.
Reducing Setup (or Change Over) is the lean manufacturing technique allowing the mixing of production/products without slowing output or creating higher costs associated with non-value adding activity. Changeovers add no value and therefore should be minimized. The goal is to reduce and/or eliminate downtime due to setups and changeovers.

The setup process should be viewed from two different perspectives, one is Internal, steps required to be completed when the machine is stopped versus external steps accomplished offline while the machine is in operation.
Quick Changeover will increase productivity, reduce lead-time, lower total costs, and increase flexibility to adapt to a changing market and/or product mix.

5.11 Cellular/Flow Manufacturing

It is an approach in which manufacturing work centers [cells] have the total capabilities needed to produce an item or group of similar items; contrasts to setting up work centers on the basis of similar equipment or capabilities, in which case items must move among multiple work centers before they are completed; the term group technology is sometimes used to distinguish cells that produce a relatively large family [group] of similar items.

It is the linking of manual and machine operations into the most efficient combination to maximize value added content while minimizing waste of motion and valuable resources. It is the technique of arranging operations and/ or people in a cell rather than in a traditional straight assembly line. Cell construction will help achieve simplified flows by integrating process operations in a one way material flow. Cellular Manufacturing is one of the primary techniques used to obtain the Lean benefits of shorter lead-times, improved quality, reduced inventories, simplified scheduling, and minimized material handling.

5.12 Batch Size Reduction

Historically, manufacturing companies have operated with large batch sizes in order to maximize machine utilization, assuming that changeover times were fixed and could not be reduced. Because Lean calls for the production of parts to customer demand, the ideal batch size is ONE. However, a batch size of one is not always practical, so the goal is to practice continuous improvement to reduce the batch size as low as possible.

Reducing batch sizes reduces the amount of work-in-process inventory (WIP). Not only does this reduce inventory-carrying costs, but also production lead-time or cycle time is approximately directly proportional to the amount of WIP. Therefore, smaller batch sizes shorten the overall production cycle, enabling companies to deliver more quickly and to invoice sooner (for improved ash flow). Shorter production cycles increases inventory turns and allows the company to operate profitably at lower margins, which enables price reductions, which increases sales and market share.

5.13. Total Quality Management

Total quality management is a management system used to continuously imrove areas of a companys operation. TQM is applicable to every operation in the company and recognizes the strength of employee involvement.

6.Characteristics of Lean

Characteristics of Lean are discussed below

6.1 Multy skilled workforce

In order to have smoothed production, it is necessary that the worker be skilled in a number of functions. The use of mono skilled and mono-function worker in industry, leads to much underutilization of labor/machinery. Small fluctuations in the demand can be taken care of by lean production, through use of an elongated shift working and deployment of skilled workers. If the demand is slightly lower, the work is finished early and the rest of the period is used for either workers rest, or activity such as practicing set-ups, preventive maintenance etc.

6.2 Short set up time

The characteristics of smoothed production is to have a short set up time, because it assumes that there is very little time loss between different changeovers. The aim is to please the customer by producing only those products which he has ordered. We cannot complain about the frequency of die- exchange. So the alternative left is to shorten the time spent for exchange of die. Through constant efforts by use of quality circles, set up times have been reduced to single-digit or even less than one minute. Known as single set-ups and one-touch-set-ups respectively.

6.3 Employee involvements and empowerment

It involves organizing workers by forming teams and giving them training and responsibility to do many specialized tasks, for house keeping, quality inspection, minor equipment repair and rework. And also allowing them to meet to discuss problems and find ways to improve the process.

6.4 Supplier involvement

The manufacturer treats its suppliers as a long term partners. They often ust be trained in ways to reduce set up times, inventories, defects, machine breakdowns, etc. in order to enable them to take responsibility for delivering the best.

6.5. Improved quality through immediate feedback

Before lean manufacturing there was batch method of production. So an error in one of the machining operation or material defect was identified only after completing of particular process. Also the same defective component was machine to final stage and after that error was identified. This caused rejection of total batch quantity and wastage of resources.

Because of lean manufacturing smooth flow of material/production resulted. The error or defect in previous manufacturing operation is immediately identified by operator and he gives feed back. In this way continuous and batch rejection is avoided. Effects in materials like cracks, blow holes, excess are pointed out quickly. Thus there is continuous quality improvement due to lean manufacturing. The overall effect is less rejection.

7. BENEFITS OF IMPLEMENTING LEAN

The benefits of implementing Lean can be broken down into three broad categories; Operational, Administrative, and Strategic Improvements. Even to this day, most organizations that implement Lean do so the operational improvements, primarily because of the perception that Lean only applies to the operations side of the business. However, from our experiences, Lean administrative and strategic benefits are equally impressive.

Some of Lean benefits are summarized below.

7.1 Operational Improvement

The NIST Manufacturing Extension Partnership recently surveyed forty of their clients who implemented Lean Manufacturing. Typical improvements were reported as follows:

- Lead Time (Cycle Time) reduced by 90%
- Productivity increased by 50%
- Work-In-Process Inventory reduced by 80%
- Quality improved by 80%
- Space Utilization reduced by 75%

7.2 Administrative Improvements

A small sample of specific improvements in administrative functions is

- Reduction in order processing errors
- Streamlining of customer service functions so that customers are no longer placed on hold
- Reduction of paperwork in office areas
- Reduced staffing demands, allowing the same number of office staff to handle larger numbers of orders
- Documentation and streamlining of processing steps enables the out- sourcing of non-critical functions, allowing the company to focus their efforts on customers needs
- Reduction of turnover and the resulting attrition costs.

7.3. Strategic Improvements

Many companies who implement Lean do not adequately take advantage of the improvements. Highly successful companies will learn how to market these new benefits and turn them into increased market share.

One specific example involves a mid western manufacturer of a common health care product. Of approximately forty U.S. competitors, the third largest company in the industry decided to implement Lean manufacturing principles. The industry average lead-time was fifteen days, and this company was no different. At the end of the project, Company #3 average lead-time was four days, with no products shipped in less than seven days. In order to capitalize upon these improvements, the company began a marketing campaign, advertising that customers would receive the product in ten days, or the order would be FREE. Sales volume increased by 20% almost immediately. After making the appropriate improvements to handle the new demand, they company initiated another marketing campaign; for only a 10% premium, they would ship within seven days. Again, sales volume increased (by only 5%) because new customers wanted the product within seven days, but more than 30% of existing customers also paid the premium, even they were already receiving the product in less than seven days. The end result was that the company increased revenues by almost 40% with no increase in labor or overhead costs. Another key benefit was that the company was able to invoice customers eleven days sooner than before, greatly improving cash flow.

8. CONCLUSION

Lean techniques are applicable not only in manufacturing, but also in service-oriented industry and service environment. In the era of globalization, all organizations try to improve productivity and quality using all industrial engineering techniques. Lean manufacturing is a dominant tool which is proven globally as one of the best tool available to improve overall operating efficiency.

Assignment 8

Q 1. What is Lean Production system ? Explain.
Q 2. What are the basic elements of lean manufacturing ?
Q 3. Give the overview of lean production system.
Q 4 Explain Lean Techniques in detail.
Q 5. Explain the benefits of implementing lean.