A Review of Lean Tools & Techniques for Cycle Time Reduction

Mayank Pandya¹, Vivek Patel², Nilesh Pandya³

¹,²G H Patel College of Engineering & Technology, V.V.Nagar-388120, Gujarat, India
³Foundry manager at Priti Marine PVT. LTD., Sihor, Dist. Bhavnagar, Gujarat, India

Abstract

In today’s enormous competitive world, in order to survive in the market, any company has to satisfy their customers by providing right quantity with right quality and right price within stipulated time. All small scale industries facing problems in fulfilling customers demand within stipulated time period. In this paper the prime focus is various lean tools & techniques with their principles of application. There are many ideas and tools to explore in lean, so the one way is to do survey of some most important lean tools and its principles. This paper contains review of various lean tools and techniques such as 5S, Heijunka, SMED, Kaizen, PDCA, Takt time, TPM, and also about which tool can give better results for cycle time reduction also described with the help of literature review.

Key words: lean tools & techniques, 5S, Heijunka, SMED, Kaizen, PDCA, Takt Time, TPM

I. Introduction

In Today’s Competitive era of globalization, in order to strive in this competitive market situation, companies now must look forward to please their customers in every possible manners and must complete customer’s ordered requirements within the stipulated time period which is given by customers. Improving customer service, making processes faster, more operations and reduction in costs are challenges faced by many manufacturers today. To meet these challenges many companies now searching to improve their skill to compete globally (Rajesh Gautam, et al., 2012). Today many industries are adopting various new tools and techniques to produce goods to compete and survive in the market. The most unfavorable issue faced by manufacturers today is how to deliver their products or materials speedily at low cost and good quality. One encouraging method for addressing this issues is the application of lean management principles and techniques (Mihir R. Prajapati, et al., 2015). Cycle time reduction is now a day one of the most vital elements of successful manufacturing today because more and more customers are demanding that manufacturers quickly respond to their wants and needs and deliver perfect quality products on time. This trend, which will continue, has led companies to focus more attention on their order-to-delivery cycle time (Mushtaq Patel, et al., 2014). The Toyota Production System (TPS) was developed in Japan by Taichi Ohno and Shijio Shingo and forms the basis of lean manufacturing. Toyota could not afford the capital intensive mass production systems used in the USA so instead focused upon minimizing waste in all aspects of its operations. Toyota used many lean techniques and tools to reduce waste including Kaizen, cellular manufacturing, synchronous manufacturing, PoKa-Yoke, standardized working and work place organization (Herron C, et al., 2007). There are many different techniques of waste reduction and thereby cycle time reduction like 5S methodology, Production leveling by Heijunka, SMED, PDCA cycle, Takt time, Total Productive Maintenance (TPM), Kaizen etc. The 5S is one very important lean tool improves environmental performance and thus relate primarily in reduction of wastes in manufacturing. It promotes neatness in storage of raw material and finished products (Vipul Kumar Patel, et al., 2014). Production Leveling aims to achieve a much more stable schedule for mixed model production, by combining two well-known concepts of Lean Manufacturing: Kanban System and Heijunka. The latter means a smoother pattern for daily production sequencing at assembling lines (Luciano Fonseca Araujo, et al., 2014). SMED is one of the Lean production method for reducing waste in manufacturing process. It provides rapid and efficient way of converting a manufacturing process from running the next product (Mihir R. Prajapati, et al., 2015). The plan-do-check-act (PDCA) cycle underpins many lean principles and offers a paradigm for continuous improvement of design, construction, and operations processes (Kristen Parrish, et al., 2013).

II. Lean Manufacturing Concept

Lean manufacturing is all about systematic identification and thereby elimination of all types of wastes (MUDA) within a manufacturing system and it also takes into account waste created through overburden (MURI) and waste created through unevenness in workloads (MURA). Lean manufacturing is a continuously developing philosophy around the world because its application is altered for each and every company. Lean has had a number of names over the years, developed primarily from the Toyota Production System (TPS) it has been called World Class Manufacturing (WCM), Continuous Flow Manufacturing, and Stock-less production system to name a few (Mr. R. Vinayagasundaram, et al., 2015). Basically, Lean is the set of many “tools” that helps in the identification and there by elimination of all types of wastes and as this happens,
ultimately quality improves and production cycle time and costs are reduced. Here are seven types of wastes (MUDA) that can arise in any industries are as below:

1. Transport: Transportation means just to move any material from one place to another place. The imperfect layout of industry always results in unnecessary transportation of any product which adds almost no value to the product. The excessive movement of the products increases material handling to the extreme level and which cause damage and deteriorate the quality of the product. The transportation can be minimized through preparing easy planning product flows which can make this easier to envision.

2. Inventory: Unnecessary inventory is entitled storing excess products with no orders in the warehouse and having additional WIP. This will block and tie up the flow of products.

3. Producing Defective Items: Higher production always causes high chance of producing defective items due to accidental human errors. Quality defects resulting in rework or scrap are terrific cost to organizations. Associated costs include isolating inventory, re-inspecting, rescheduling, and capacity cost. This can be reduce through proper employee involvement and Continuous Improvement in process which results in huge opportunity to amended defects at many facilities.

4. Waiting Time: Waiting time or we can say idle time means when any delay occurs in getting order, getting item, getting tools & instruments or any individual delay due to human personal intervene (go to bathroom, washroom etc.). It can simply understand when goods are not moving or being processed, the waste of waiting occurs. It happens due to poor material flow or production runs are too extended and large distances between work centers. The Idle time can be minimize by networking processes together so that one feeds directly into the following can dramatically reduce waiting Time.

5. Over-Processing: Sometime it happens that product fall in extreme dimension during inspection of any product which can be transformed within the tolerance by rework by any process. This is done due to fine tolerance of the manufactured goods. Many organizations use costly high precision equipment where simpler tools would be enough. The redundant process causes due to poor layout of plant. This can be minimize by linking steps will greatly reduce the waste of over-Processing.

6. Over-Production: The Overproduction means manufacture an item more than its actually wanted. This can be realize by producing too much items on any stage of production which rises lead times, results in high storage costs, and makes it tough to spot defects. The unnecessary production eats extra time of production, produces defective items in that time, exploits man power, machine etc. which fallouts in delay in bringing urgent items. The concept is to plan and produce only what can be instantly sold / shipped and improve machine changeover /set-up capability.

7. Defects: Defects will add extra rework.

III. Different Lean Tools & Techniques

Here are various Lean Tools and techniques with its brief application described in following table.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Lean Tools &amp; Techniques</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5S Methodology</td>
<td>Eliminates Waste that occurs because of poorly designed work area.</td>
</tr>
<tr>
<td>2</td>
<td>Heijunka (Production Leveling)</td>
<td>Reduces lead times &amp; Inventory</td>
</tr>
<tr>
<td>3</td>
<td>SMED (Single Minute Exchange of Dies)</td>
<td>Reduces Set up time to less than 10 minutes.</td>
</tr>
<tr>
<td>4</td>
<td>Kaizen</td>
<td>Continuously improves the working environment by eliminating production losses</td>
</tr>
<tr>
<td>5</td>
<td>PDCA</td>
<td>Making improvements in whole cycle</td>
</tr>
<tr>
<td>6</td>
<td>Takt Time Analysis</td>
<td>Provides a simple as well as consistent and intuitive method of pacing production and efficiency goal.</td>
</tr>
<tr>
<td>7</td>
<td>TPM</td>
<td>Increase Productivity and Overall Equipment Effectiveness of Machineries</td>
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</tbody>
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5S Methodology:

Many manufacturing facilities now a days have opted to follow the path in the direction of a “5S” workplace organizational and housekeeping methodology as part of continuous improvement or lean manufacturing processes. 5S is a system to reduce waste and improve productivity through maintaining a neat workplace and using visual signs to achieve more consistent operational results. The term 5S refers to five steps – sort, set in order, shine, standardize, and sustain – that are also sometimes known as the 5 pillars of a visual workstation. 5S programs are regularly implemented by small teams working together to get materials closer to operations, right at workers’ fingertips and structured and labeled to facilitate operations with the smallest amount of wasted time and materials. The 5S system is a good starting point for all improvement efforts aiming to drive out waste from the manufacturing process, and ultimately improve a company’s bottom line by improving products and services, and lowering costs. Many companies are seeking to make operations more efficient, and the concept is especially attractive to older manufacturing facilities looking to improve the bottom line by reducing their costs.

Heijunka (Production Leveling):
Heijunka can be well-defined as “The dispersal of production volume and blend evenly over time”. Heijunka is principle that is used for distributing production volume evenly over entire time period. It converts uneven Customer Pull into flat and predictable manufacturing process and it is generally used in combination with other key lean tools & techniques to stabilize value flow.

SMED:
Single Minute Exchange of Die (SMED) is one of the various lean thinking methods for reducing wastes in a manufacturing method. It provides a quick and efficient way of converting a manufacturing process from running the current product to running the following product. This rapid conversion is key to reducing production lot sizes and thereby improving flow. The catchphrase “single minute” does not mean that all conversions and startups have to take only one minute, but that they would take less than 10 minutes (in other words, “single digit minute”) (Yash Dave, et al, 2012). SMED is the term used to represent the Single Minute Exchange of Die or setup time that can be calculated in a single digit of minutes. SMED is frequently used interchangeably with “quick changeover”. SMED and quick changeover are the rehearsal of reducing the time it takes to change a line or device from running one product to the next. The need for SMED and quick changeover programs is more widespread now than ever due to amplified demand for product variability, reduced product life cycles and the need to ominously reduce inventories (Yash Dave, et al, 2012).

Kaizen
Kaizen is a Japanese word for the thinking that defines management’s role in constantly inspiring and applying small improvements involving every person. It is the process of continuous progresses with little increments that make the process more efficient, effective, under control and easygoing. Improvements are usually accomplished at little or no costs, without sophisticated techniques or expensive equipment. It focuses on the simplification by breaking down composite processes into their sub-processes and then refining them.

PDCA
PDCA is a continuous endlessly improvement cycle and it is totally different way of thinking process. The concept of PDCA was originated by Walter A. Shewhart and then W.E.Deming modified PDCA cycle in Plan-Do-Study-Act Cycle. The PDCA cycle can be an effective and quick method for applying continuous progress. Each step: Plan, Do, Check, and Act are critical for reliable application of successful process improvements. Now a day different industries using the cycle uniquely, but companies that use it well develop tools around PDCA to use it effectively.

Takt Time Analysis
Takt Time is the pace of production (e.g. manufacturing one piece every 34 seconds) that aligns production with customer demand. In other words, it is how fast you need to manufacture product in order to fill your customer orders. Takt Time is calculated as:

\[ \text{Takt Time} = \frac{\text{Planed Production Time}}{\text{Customer Demand}} \]

So Takt Time is how often a piece must be produced to meet customer demand. It is often used to pace a production line, and it is a calculated number. Takt Time is a vital concept in lean manufacturing. It is the heartbeat of a lean business – matching actual production to customer request. It is not a goal to be surpassed, but rather a goal for which to aim:
- Producing faster than Takt Time results in overproduction – the most essential form of waste.
- Producing slower than Takt Time results in logjams – and customer orders that may not be filled on time.

Total Productive Maintenance (TPM)
Total Productive Maintenance (TPM) is a maintenance program which involves a newly defined concept for upholding plants and equipment. TPM is an innovative Japanese concept invented in 1951 when preventive maintenance was introduced in Japan. The goal of the TPM program is to noticeably increase production while, at the same time, increasing employee morale and job gratification. It can be considered as the medical science of equipment. TPM brings maintenance into focus as an essential and vitally important part of the business. It is no longer stared as a non-profit activity. Down time for maintenance is arranged as a part of the manufacturing day and, in some cases, as primary part of the manufacturing process. The goal is to hold crisis and impulsive maintenance to a minimum.

IV. Reviews of Different Researchers about Various Lean Tools & Techniques

<table>
<thead>
<tr>
<th>Title</th>
<th>Journal</th>
<th>Author/ Year</th>
<th>Tools &amp;Techniques</th>
<th>Summary of conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review on Lean Tools &amp; Techniques. Continuous Improvement in Industry</td>
<td>IJAIE</td>
<td>Mihir K. Shah 2015</td>
<td>Timestudy, 5S-Kaizen, SMED, TPM, Plant Layout</td>
<td>All mentioned tools briefly described. After literature review it is analyzed that TPM and SMED are most widely used.</td>
</tr>
</tbody>
</table>

A Study of Lean Manufacturing Tools & Techniques Implemented in the Andhra Pradesh Silk Production Industry | IJMER | Y. Sujatha | 2013 | 5S, TPM, Kaizen, TPS, PDCA, JIT, VSM | Adopted mentioned Lean Tools in Silk Production Industry and Questionnaire Survey analysis has done.


Kaizen: A Case Study in Small Scale Industry | IJSRET | Promod Kumar | 2013 | Kaizen | Excessive Cycle Time and Poor Quality was there in Irrax Tube Cutting & Slitting Operations, Kaizen is applied and new Jig Provided.

Lean Manufacturing Implementation of concept to Reduce Defects in Small Scale Industry: A Case Study | IJERS | Anilkumar | 2015 | Kaizen, Six Sigma, JIT, TQM | Rejection Rate of Drilling Process Reduced from 27% to 7% by applying Kaizen Systematically.


Implementation of Lean Manufacturing Practices and its Impact on Production in Coimbatore Foundries | IJMER | Mr. R. Vinayasundaram | 2015 | Lean Manufacturing | Data Gathered by Survey Questionnaire and tested by forming Hypothesis and reported benefits of implementing Lean Manufacturing in 60 Foundries of Coimbatore.

Productivity Improvement in Small Scale Industry | IJMPE | N.B. Venugopal | 2015 | TPM, Kaizen | Study the Role of OEE in SSI, TPM is applied in SSI and that improves its OEE from 50% to 72.8%, Kaizen activity was main part of case study.

V. Conclusion

In this immense competitive world, Industries are facing many problems regarding waste elimination, cost reduction and cycle time reduction. In order to survive and thrive in this continuously changing business environment, industries are looking for newer and better methodologies and that’s where concept of “Lean Thinking” strikes. There are many researchers who have studied in this area and have found the positive effect of the concept on the organizational performance. The adoption of the tools and techniques also makes manufacturing to be very cost-effective, as a result of fast production of goods and products; also the substantial reduction in cycle times and manufacturing lead times as well as production costs enable organizations to immediately sell their products, tired out their competitors and also increase the rate of income, thereby maximizing profit. Based on this much literature review, Kaizen looks more promising methodology to apply in order to gain substantial saving of cycle time. Kaizen is a proven methodology to gain success and there is no doubt about that. However, Kaizen methodology will not achieve the desired results if not properly applied; this is because Kaizen is not just the application of its bunch of tools & techniques but rather a completely different approach to manufacturing.

References