Improving the Performance By Lean Methodology

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***Abstract* - Productivity improvement techniques can be applied effectively in enterprises of any size, from one-person companies to corporations with thousands of staff. The majority of the techniques were first seen in mass-production operations but the benefits they can yield in SMEs is not to be underestimated. Many organizations are nowadays interested to adopt lean manufacturing strategy that would enable them to compete in this competitive globalization market. In this respect, it is necessary to assess the implementation of lean manufacturing in different organizations so that the important best practices can be identified. This paper describes the development of key areas which will be used to assess the adoption and implementation of lean manufacturing practices. Lean manufacturing is often seen as a set of tools that reduce the total cost and improve the quality of manufactured products. The lean management philosophy is one which targets waste reduction in every facet of the manufacturing business. This paper will review the current literature and describe how lean methodology can provide a framework mechanism for environmentally sustainable manufacturing sectors.**

Keywords— Lean manufacturing, Manufacturing, Performance improvement, Tools and techniques

I. INTRODUCTION

Lean manufacturing or lean production, often Simply "lean", is a systematic method for the Elimination of waste ("mudu") within a Manufacturing system. Lean also takes into Account waste created through overburden ("muri") and waste created through unevenness in Work loads ("mura").lean manufacturing is now One of the most powerful manufacturing systems in The world. Numerous plants around the world Have attempted to implement or adopt it to Enhance their efficiency.

II. VARIOUS LEAN TOOLS

Various Lean tools are available:

1. 5S
2. VSM
3. JIT
4. Pokayoke
5. SMED
6. Andon System
7. Kanban
8. Kaizen
9. Total Productive Maintenance (TPM)
10. One-Piece Flow
11. Work Flow Diagrametc.

All of the above methods focus on identifying and reducing the waste that occurs in a process.

2.1 5S:

5S is a systematic technique used by organizations comes from five Japanese words; Seiri (sort), Seiton (set in order), Seiso (shine), Seiketsu (standardize), and Shitsuke (sustain). This system helps to organize a workplace for efficiency and decrease wasting and optimize quality and productivity via monitoring an organized environment. It also provides useful visual evidences to obtain more firm results. There is a real need for empirical studies in field of new management systems and their impact on company's performance. As importance role of continuous improvement in today's organizations, and lack of sufficient evidence to show the positive impact of 5S on organizational performance, this paper aims to determine performance factors and characteristics in industrial organizations and identifying the effectiveness of 5S implementation on organizational performance as well. Surveying method is used and data collection is done by distributing questionnaire among five

target organizations which have implemented 5S techniques. The target organizations are chosen from different industries and diverse field of work. The results of this research obtained from a comparative measurement of organizational performance before and after 5S implementation. The results show that 5S is an effective tool for improvement of organizational performance, regardless of organization type, size, its production or its service. Consequently, 5S techniques would strongly support the objectives of organization to achieve continuous improvement and higher performance.

Transliterated into Roman script, they all start with the letter "S". The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The decision-making process usually comes from a dialogue about standardization, which builds understanding among employees of how they should do the work. The 5s are namely,

- Seiri
- Seiton
- Seiso
- Seiketsu
- Shitsuke

2.2 VSM:

The value stream mapping (VSM) is a visualization tool oriented to the Toyota version of lean manufacturing (Toyota Production System). It helps to understand and streamline work processes using the tools and techniques of lean manufacturing. The goal of VSM is to identify, demonstrate and decrease waste in the process. Waste being any activity that does not add value to the final product, often used to demonstrate and decrease the amount of waste in a manufacturing system. VSM can thus serve as a starting point to help management, engineers, production associates, schedulers, suppliers, and customers recognize waste and identify its causes. As a result, value stream mapping is a primarily a communication tool, but is also used as a strategic planning tool and a change management tool. Mapping out the activities in the manufacturing process with cycle times, down times, in process inventory, material moves, information flow paths, helps to visualize the current state of the process activities and guides towards the future desired state. In order to do this, the VSM visually maps the flow of materials and information from the time products come in the back door as a raw material, through all manufacturing process steps, and off the loading clock as finished products. The process usually includes the physically mapping of the current state while also focusing on where you get to, or the future state map, which can serve as the foundation for other lean improvement strategies.

Value steam mapping (VSM) is a lean manufacturing technique and it has emerged as the preferred way to support and implement the lean approach Grewal (International JournalManufTechnolManag 15:3–4, 2008); Singh and Sharma (Journal Measuring Business Excellence 13:58–68, 2009). VSM is different than conventional recording techniques, as it captures the information at individual stations about station cycle time, up time or utilization of resources, set-up time or change over time, work in process inventory, man power requirement and the information flow from raw material to finish goods. It covers both value adding as well as non-value-adding activities. This paper covers the review and classification of literature on VSM, as there is hardly any paper on literature review of VSM, so it will be very beneficiary for both academician and industry people. Applications of VSM are also presented by a case study of a small manufacturing Indian industry and reduction in lead time, processing time, work in process inventory and manpower requirement at individual stations are noticed.Value stream mapping is an enterprise improvement tool tohelp in visualizing the entire production process, representing both material and information flow. Defined value stream as collection of all activities value added as well as non-value added that are required to bring a product or a group of products that use the same resources through the main flows, from raw material to the end customers. Avery important part of the value stream mapping process is documenting the relationships between the manufacturing processes and the controls used to manage these processes, such as production scheduling and production information. Unlike most process mapping techniques that often, only document the basic product flow, value stream mapping also documents the flow of information within the system, where the materials are stored (raw materials and work in process, WIP) and what triggers the movement of material from one process to the next are key pieces of information.

2.3 JIT (Just In Time) :

Just in time is a term used to indicate that a process is capable of instant response to demand without the need for any over stocking, either in expectation of the demand being forth coming or as a result of inefficiencies in the process (Hutchins, 1999). Waste, any activity which add cost without increasing the product value, such as unnecessary movement of materials, accumulation of excess inventory, or the use of faulty production methods that create products requiring subsequent rework (J.Schonberger, 1984). JIT also known as lean production or stockless production improve profits and return on investment by reducing inventory levels, reducing variability, improving product quality, reducing production and delivery lead times, and reducing other costs. Dennis (2002), listed the key elements of Just In Time Flexible Work Force

The employees must be trained to operate the number of machines to perform machine maintenance task and quality inspections. In overall, JIT requires employees responsible for their own work. In Toyota production system, it tells about the concept of a “respect for people” maintains good relation between employees and management.

Reduce Lot Size :

In order to reduce the lot size in manufacturing and purchase sector, a close cooperation is necessary with suppliers in order to achieve reduction in order lot size for purchased items, since this will require frequent deliveries.

Reduce Lead Time :

In production department, the lead can be reduced by moving work stations closer together. This is done by applying group technology and cellular manufacturing concepts. In delivery department, the lead time can be reduced possibly by locating suppliers closer to the factory.

Preventive maintenance :

It should be carried out during worker and machine ideal time and prevent break downs.

Level out the workload (heijunka in Japanese):

Heijunka tells about level the production system. It is mainly responsible for the production control and production management people. Leveling the production schedule may require some front loading of shipments or postponing of shipments and may have to ask some customers to wait for the short period of time. Once the production level is more or less the same or constant for a month, pull system can be applied and balance the assembly line, but, if a production level varies from day to day, there is no meaning in applying to the system,because under such circumstance the work task cannot be standardized.

Reduce or eliminate setup time :
The main aim for single digit set up times (less than 10 min) or one- touch setup. It can be carried out by better planning, process re-designs and product re-designs. for example : improved setup time can be seen in auto racing, where a NASCAR pit crew can change all the four tires and put gas in the tank under 20 sec. the pit crews efficiency is achieved by the team members effort and also using specialized equipment and well coordinate , well – rehearsed process. In station quality (Jidoka in Japanese) .In this program, each and every worker is personally responsible for the quality of the work they perform and has an authority to stop production when something is wrong. The various techniques used in Jidoka are Andon lights, Podayoka, A3 reports and visual inspection. Single Lot (Single Unit) Conveyance

They use control system such as Kanban system or other signalling system to convey parts between work stations in small quantities ideally, one unit at a time. In its largest sense, just in time is not same thing as Kanban system and Kanban system is not required to implement just in time.

The benefits of JIT

1. Lower stock holding means a reduction in storage space which saves rent and insurances costs.

2. As stock is only obtained when it is needed, less working capital is tied up in stock.

3. Avoids the buildup of unsold finished products that can occur with sudden changes in demand.

4. Less time is spent on checking and reworking the product of others as the emphasis is on getting the work right first time.(Dennis, 2002)

2.4 KANBAN:

A Kanban System allows a company to use Just-In-Time (J.I.T) Production and Ordering Systems that allow them to minimize their inventories while still satisfying customer demands. It is a tool for material flow in the production process.

There are two kinds of Kanban (Dennis, 2002):

Production Kanban; which specifies the kind and quantity of product that the upstream process (supplier) must produce.
Withdrawal Kanban; which specifies the kind and quantity of product that the downstream process (customer) may withdraw.

Advantages of Kanban:

Reduce inventory and product obsolescence:
Since component parts are not delivered until just before they are needed, there is a reduced need for storage space. Should a product or component design be upgraded, that upgrade can be included in the final product ASAP (As Soon As Possible). There is no inventory of products or components that become obsolete. This fits well with the kaizen on continual improvement.

Reduces waste and scrap*:*
With Kanban, products and components are only manufactured when they are needed. This eliminates overproduction. Raw materials are not delivered until they are needed, reducing waste and cutting storage costs.

Provides flexibility in production*:*

If there is a sudden drop in demand for a product, Kanban ensures that are not stuck with excess inventory. This gives the flexibility to rapidly respond to a changing demand. Kanban also provides flexibility in how the production lines are used. Production areas are not locked in by their supply chain. They can quickly be switched to different products as demand for various products changes. Yes, there are still limits imposed by the types of machines and equipment, and employee skills; however the supply of raw materials and components is eliminated as a bottleneck.

Increases Output*:*

The flow of Kanban (cards, bins, pallets, etc.) will stop if there is a production problem. This makes problems visible quickly, allowing them to be corrected.

Kanban reduces wait times by making supplies more accessible and breaking down administrative barriers. This results in an increase in production using the same resources.

Reduces Total Cost*:*

The Kanban system reduces the total costs by,

- Preventing Over Production
- Developing Flexible Work Stations
- Reducing Waste and Scrap
- Minimizing Wait Times and Logistics Costs
- Reducing Stock Levels and Overhead Costs
- Saving Resources by Streamlining Production
- Reducing Inventory Costs

2.5 KAIZEN:

Kaizen is a Japanese name for continuous improvement, "Kai" means change or correct to, "Zen" means good. Kaizen is dedicated to continuous improvement, in small increments, at all levels, forever. It involves the commitment from top management to shop floor employees.(Imai,1986)

Kaizen is based on making little changes on a regular basis: always improving productivity, safety and effectiveness while reducing waste.

Features of Kaizen:
Highly effective and results oriented – Kaizen events will generate quick results, measurable results, establish the baseline, and measure the change.

Widely applicable – Used in both manufacturing and non-manufacturing firms.

2.6 TOTAL PRODUCTIVE MAINTENANCE (TPM) :

Total Productive Maintenance which is one of the key concepts of Lean manufacturing, changes the view that maintenance is no more than a function that operates in the background and only appear when needed. It engages all levels and functions in an organization to maximize the overall effectiveness of production equipment. Whereas maintenance departments are the traditional centre of preventive maintenance programs, TPM seeks to involve workers in all levels of department right from plant – floor to senior executive to ensure effective equipment operation. (EPA-United States Environmental Protection Agency, 1970)

TPM addresses the entire production system life cycle and build a solid plant – floor based system to prevent accidents. It mainly focuses on preventing breakdowns, mistake-proofing equipment, mainly to eliminate product defects in order to make maintenance easier (corrective maintenance), designing and installing equipment that needs little or no maintenance (no maintenance) and quickly repairing equipment after breakdowns occur (breakdown maintenance).

According to EPA-United States Environmental Protection Agency (1970), the goal is the total elimination of all losses, including breakdowns, equipment setup and adjustment losses, reduced speed, defects and rework, spills and process upset conditions, and startup and yield losses. The ultimate goal of TPM is zero equipment breakdowns and zero product defects, which lead to improved utilization of production assets and plant capacity.

2.7 Work Flow Diagram

According to Thornton (2009), a Work flow diagram consists of a sequence of connected steps. It is a virtual representation of actual work in an organization. The flow being described refers to a document or product that is being transferred from one step to another, shows the movement of material, identifying areas of waste. Aids teams to plan future improvements, such as one piece flow and work cells.

Visually representing the entire workflow allows the employees to better understand not only their job responsibilities but also other employees' role which increases accountability.

2.8 SMED:

As stated by Vorne Industries Inc., (1999) SMED (Single Minute Exchange Die) is a method for dramatically reducing changeover time at the constraint. As many steps as possible are converted to external (performed while the process is running) and remaining steps are streamlined (e.g. bolts and manual adjustments are eliminated).

- Increases usable production time at the constraint.

- Enables smaller lot sizes, resulting in improved responsiveness to customer demand.

- Enables smoother start-ups, since a simplified and standardized changeover process improves quality and consistency.

2.9 POKA YOKE:

Poka-Yoke (also referred to as "mistake proofing") designs defect detection and prevention into equipment with the goal of achieving zero defects .Vorne Industries Inc., (1999)

- Reduces the number of defects (which is also very important post-constraint).

III. 5S

5s In Manufacturing Company:

Basically, 5s is a management tool, which can improve housekeeping, environmental conditions, health and safety standards (Pasale and Bagi, 2013) that relevant to every people (Nasir, 2011). 5s implementation allows people to realize about the importance of good housekeeping, especially in manufacturing plan (Nasir, 2011) and to increase the safety climate (Srinivasan, 2012).

Hunglin (2011), on his research in Wang Chen Industry Manufacturing Factory, Taiwan, has done 5s implantation that focuses in organizing tools and improving the working environment. This research is using 5s methodology as the guidance to improving the factory. Pasale and Bagi (2013) also agree that 5s can improve the recent condition. They have done research in Sunmill Industries Pvt. Ltd. Shiroli M.I.D.C Kolhapur, India and used fixture setting time as the performance measurement. There are benefits of 5s (Walker, 2011) ; the pride is created in the workplace for who have input in decisions made, a clean and organized work place is safe, and increase product quality. 5s, an important tool of lean, concentrates on improving the layout of the workplace and reducing cost and waste. Moreover, 5s is simple, effective, easy to implement, and produces quick results. This makes 5s favourable over other lean tools, which may take longer to realize (Srinivasan, 2012).

5s In Workplace:

Recent Research:

This research has been done in Bengkel ABC, a motorcycle repair shop. This research focuses on implement 5s in order to simplify searching activities in Bengkel ABC. The performance evaluation of recent research are ; free area, payback period, service time comparison between before and after implement 5s, photograph comparison between before and after implement 5s, deep interviewing, and analyzing of employees and customers opinion through questionnaire

IV. VSM – ORIGIN

The use of waste removal to drive competitive advantage inside organisations was pioneered in the 1980's by Toyota's chief engineer, TaiichiOhno, and Shiego Shingo and is oriented fundamentally to productivity rather than quality. The reasons for this is thought to be that improved productivity leads to leaner operations which helps to expose further waste and quality problems in the system. Thus the systematically attack on waste is also a systematic assault on the factors underlying poor quality and fundamental management problems. The seven commonly accepted wastes in the Toyota production system were originally ,

- Overproduction (faster than necessary pace)
- Waiting
- Transport (conveyance)
- Inappropriate processing

Many manufacturing facilities have opted to follow the path towards a "5S" workplace organizational and housekeeping methodology as part of continuous improvement or lean manufacturing processes.

5S is a system to reduce waste and optimize productivity through maintaining an orderly workplace and using visual cues to achieve more consistent operational results (see chart below). The term refers to five steps – sort, set in order, shine, standardize, and sustain – that are also sometimes known as the 5 pillars of a visual workplace. 5S programs are usually implemented by small teams working together to get materials closer to operations, right at workers' fingertips and organized and labelled to facilitate operations with the smallest amount of wasted time and materials.

ListaInternational allow improved organization and maximum use of cubic space for the highest density storage. The result is an improved manufacturing process and the lowest overall cost for goods produced.

The first thing that we did after entering in the company is that we took the timing for each process that led to the manufacture of the final product. We noted the timing and it is as follows

Before Implementation:

STEP BY STEP PROCESS: (Before implementation)

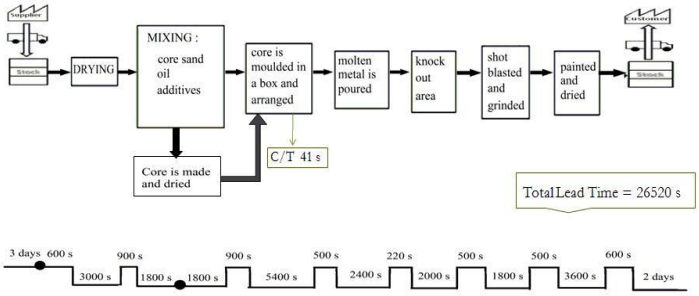
- Unnecessary inventory (excess stock)
- Unnecessary motion
- Defects (correction of mistakes)

V. IMPLEMENTATION

- 00.00.00 – wet core sand is taken for drying.
- 01.00.00 – wet core sand is dried. (1 Hr)
- 01.15.00 – dry core sand has reached core shop.(15 Min)
- 01.45.00 – core sand has been mixed with oil and additives in the mixer.(25-30 min)
- 02.15.00 – core was made and allowed to dry.(25 min)
- 02.30.00 – core reached machining area.(15 min)
- 03.45.00 – moulding box is set to be made and arranged.(90 min)
- 04.15.00 – started to pour molten metal
- 05.00.00 – molten metal is poured.(45 min)

- 05.40.00 – taken to the knock out area and the finished product is taken out.(35 min)
- 06.30.00 – kept in shot blast machine and grinded for accuracy.(45 min)
- 06.40.00 – goes to painting section.
- 07.50.00 – finished parts are painted.(1 hr)
- 08.15.00 – stored is dispatch area.

Before Implementation



After implementation:

STEP BY STEP PROCESS: (After implementation)

- 00.00.00 – wet core sand is taken for drying.
- 01.00.00 – wet core sand is dried. (1 Hr)
- 01.12.00 – dry core sand has reached core shop.(12 Min)
- 01.35.00 – core sand has been mixed with oil and additives in the mixer.(25-30 min)
- 02.00.00 – core was made and allowed to dry.(25 min) Fig 1.1
- 02.10.00 – core reached machining area.(10 min)
- 03.25.00 – moulding box is set to be made and arranged.(75-78 min)
- 04.00.00 – started to pour molten metal
- 04.45.00 – molten metal is poured.(45 min)
- 05.20.00 – taken to the knock out area and the finished pro duct is taken out.(35 min)
- 06.05.00 – kept in shot blast machine and grinded for accuracy.(45 min)
- 06.20.00 – goes to painting section.
- 07.30.00 – finished parts are painted.(1 hr)
- 07.50.00 – stored is dispatch area.

Process improvisation	Before (Time in sec)	After (Time in sec)	Time Save (in sec)
5s in core shop	900	700	200
5s in pattern shop	25	17	8
5s in machining zone	41	34	7/box
5s in core sand transportation	180	150	30

Table 1

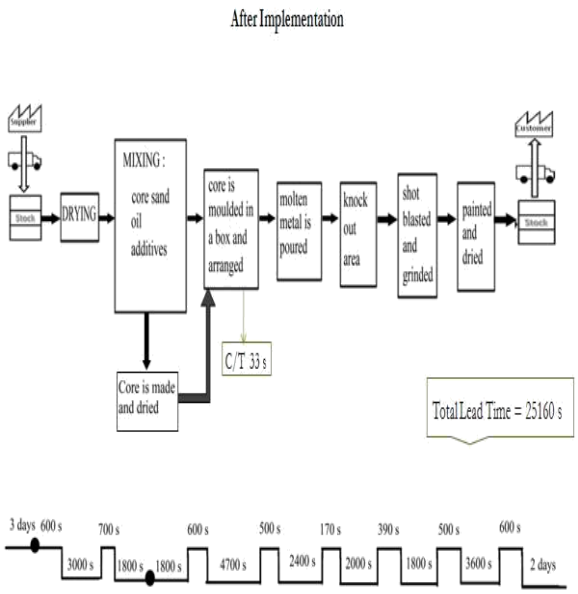


Fig 1.2

Results:

After implementing the two manufacturing tools, we could see a slight improvement in the manufacturing of a product i.e. in the productivity.

$$\text{Lead time Efficiency Increase} = \frac{\text{Lead time before Implementation - Lead time after Implementation}}{\text{Lead time before Implementation}} * 100\%$$

$$= \frac{26520 - 25160}{26520} * 100\ \%$$

Lead time Efficiency Increase / lot = 5.128%

VI. CONCLUSION

By implementing lean manufacturing tools (5s and VSM) ,

1. Found out bottlenecks.
2. Differentiate value and non value added activities.
3. Reduced the total lead time by 1360 seconds (approx..) .
4. Improved efficiency.

Only a few suggestions/Improvisation could be implemented owing to the non-feasibility/willingness by the firm. Many options were suggested for them in which they were uncomfortable with some of them. If all those suggestions were implemented the company would have seen a drastic improvement in the productivity, however it would have taken nearly 4-6 months for implementing and making it their routine. But however the company could now see nearly 4-6 % improvement in their productivity. The industry is likely to bring up the improvements in the near future

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