A BRIEF OVERVIEW OF LEAN MANAGEMENT PRACTICE IN MANUFACTURING INDUSTRIES

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ABSTRACT

A vibrant capital goods industry is a pre-requisite to propel the growth of the manufacturing activities in any country. For the manufacturers, streamlining the production processes and employing cost-reduction techniques are important to face the challenges. The fluctuation in customer demand increased variety, low volume of products and complex manufacturing environment. In the pace of competition, the rapidly changing environment forces the organization to transform their manufacturing paradigm to respond to customer's demands quickly. In pursing this goal, the manufacturers have adopted an advanced technique known as Lean Management Practices. In this context, a detailed literature review has been conducted to identify the Lean Manufacturing (LM) implementation in various manufacturing industry. This paper further will provide an overview of manufacturing industry, lean manufacturing, lean tools and types of waste before exploring feasibility of extending lean principles to manufacturing industry.

Keywords: Lean Manufacturing, Lean tools, Manufacturing Industry

1. Introduction

Today manufacturing industries in the world are restless, in the recent years challenges for the survival of any industry with emerging economics face situation with competitive power. Because of it, many manufacturers have started implementing lean manufacturing practices. The goal of lean manufacturing system is doing more with less of time, space, human effort while giving the customer what they want to be highly economical manner (Chen et al 2006). Today development of lean manufacturing system involve many changes in work culture and practices many of these changes are related to human factor with of lean behaviour for the most effective and efficient manufacturing and assembly practices.

Womack et al. (1990) defined the term "lean" as that system that utilizes less in term of all inputs, to create the same outputs as those created by traditional mass production system, which contribute increased varieties for end customer. Lean focuses on removing wastes and ads value from customer perspectives, it is necessary to identify the non-value added activity and value added activity in the manufacturing system, which creates wastes. Essentially a "waste" is anything for which customer is not ready to pay. The source of waste that involve the any of the undeterministic operation that in the production process, which is not supporting the customer, value about the product.

There are different tools and Panvnaskar et al. (1998) to improve the waste in industry classify technique in lean manufacturing. The different kinds of lean waste and attempts made for elimination found in literature surveys, which are found suitable lean tool and techniques of manufacturing practices. The various lean tools that are eliminating waste are value Stream mapping, kaizen, standardization of work, single minute exchange of dies, total productive maintenance, cellular manufacturing, kanban etc. Among the entire tool, VSM is the one of lean tool, which unveils all kind of waste, and it is the only tools, which link the information flow and material flow which are addressed by (Rother and Shook 1999).

The concept of lean manufacturing is increasingly adopted in many organizations as a potential solution in the early 1990's , particularly within the automotive and aerospace manufactruning sectors(Sanchez and Perez 2001) . The application of lean management concepts is found to be successful in various manufacturing industries and allied industries (Womack et al 1990 and Chase et al 2006). In this paper, the literature review findings such as existing level of lean practices, types of wastes and lean tools and techniques in various manufacturing industry.

2. Research objective and methodology

The main objective of this overview is

(i) To study the current trend of lean management practice in various manufacturing industries for past decades.

(ii) As evidence from the survey, the emphasis promotion of lean management concepts in manufacturing industries is found to be inadequate and toddler stage.

(iii) Hence, the awareness of lean management practice with specific reference to the manufacturing industry is presented.

3. Lean Management practices in manufacturing industry – An overview

A detailed review of research in current trend of lean management in various manufacturing industry like automotive industry, machine tool industry, semi-process industry, electronics manufacturing industry, steel industry, pump industry and furnishing industry has been discussed.

The lean management concept originally developed by Toyota in Japan, evolved as Toyota Production System (TPS) being a model for companies looking to eliminate or reduce wastes (Fujimoto 1999). The term lean Manufacturing was coined by the research team of Massachusetts Institute of Technology (MIT) that studied the Japanese automotive industries and compared them with other county’s automotive manufacturing performance in the late 1980’s and the early 1990’s. The results of the study revealed that the industries implementing LM concepts had superior productivity, quality and responsiveness over others and published as a book, “ The Machine that changed the world”(Womack et al 1990).

There were extensive literature available on lean manufacturing practices can be described based on the philosophical approach(Womack and Jones 1996) and practical perspective which consists of a set of managing principles and characteristics of the production system (Shah and Ward 2007) . A summary of important literature on lean evolved over a period of last decades are listed in Table 1.1

Table: 1.1 Important literature on Lean Management Journey (Kyle B. Stone 2011)

Years	**1970-1990**	**1991-1996**	**1997-2000**	**2001-2005**	**2006-2009**
Phase	Discovery	Dissemination	Implementation	Enterprise	Performance
Primary activities	1973 Oil Crisis spurs interest in Japanese methods. Results of MIT's and IMVP published	Lean Principles deployed within US manufacturing known as TQM , JIT , etc.	Lean Thinking elevated to strategic implementation.	Value Stream methods expand use beyond manufacturing to service sectors	Measuring leanness, Toyota Way articulates human resource and culture development aspects
Number of scholarly ' Lean Publications'	11	31	28	56	67
IMVP – International Motor Vehicle Project; TQM-Total Quality Management JIT- Just in Time; VSM – Value Stream Mapping					

Lander and Liker (2007) discussed the performance benefits of lean systems are often remarkable, greatly improving quality, cost, and delivery and studied the fundamental misunderstanding of TPS, viewing it as a specific tool kit technically implemented in a formulaic way to achieve pre-specified results. Petersen (2003) in his article made the analysis of the lean literature and concluded that among the authors dominates a view that lean is more than a set of tools, since it is a philosophical approach to lean. Therefore, lean production is also considered as a philosophy of continuous improvements and respect to people.

Liker (2003) illustrated the most common lean tools in the form of house as shown in Figure 1. The goal of lean production is set in the roof and consists of reaching for the best quality, lowest costs, shortest lead-time, highest safety and high morale. The left pillar encloses Just-in-Time principle that consists of production planning and leveling tools like takt time, continuous flow, pull system, quick changeover and integrated logistics. The right pillar deals with Jidoka, which prevents a defective part from proceeding into the next workstation as well as insists on separating people from machines. People are in the centre of the lean house concept since people see waste and solve problems that lead to continuously improvement of the processes. In addition, it is important to consider the characteristic of a lean work organization since the responsibilities are decentralized to multifunctional teams. The foundation of the house has to be stable for the pillars to stand steadily and consists of the tools like 5S, standardized work and leveled production.

According to David Magee (2007), different kinds of wastes in a process are categorized such as overproduction, waiting, unnecessary transport, over processing, excess inventory, unnecessary motion, defects and unused employee creative

In recent years, a plethora of literature has extensively documented the successful implementation of lean philosophy into various manufacturing sectors. Eswaramoorthi et al, (2011) discussed the current status of lean implementation in Indian machine tool industries as well as tinted some allied issues. The survey has attempted to formulate simple questionnaire based tool to identify the existing level of lean practices, reasons for inadequate priority to lean concepts, type of lean tools employed , perceived level of different wastes, and the common difficulties encountered by the Indian Machine tool Manufacturers . The survey results revealed that 31.6% of the companies have implemented different lean tools and techniques in selected areas. The remaining 68.4% of the companies have not yet taken up the lean initiatives.

Ajith kumar sahoo et al (2008) suggested a systematic approach for the implementation of lean principles and also describes an application of Value Stream Mapping (VSM). Consequently, the present and future states of value stream maps are constructed to improve the production process by identifying waste and its sources. Furthermore, Taguchi’s method of design of experiments is pursued here to minimize the forging defects produced due to imperfect operating conditions. A noticeable reduction in set-up time and Work-in-Process (WIP) inventory level is substantiated.

Nitin Upadhye et al, (2010) descried major actions taken by the company to implement lean philosophy to improve its efficiency and effectiveness. This study attempted to point out various wastages and issues to implement the lean manufacturing systems in MSME. It is observed that Lean Manufacturing Systems(LMS) helps to identify and minimize waste. Lean tools like kaizen, JIT, VSM, 5S, SQC, preventive maintenance, total employee involvement, and SMED were used to find and eliminate the wastages in a MSME. The implementation of lean tools and techniques will be successful only if these are used wisely. The MSMEs have to go a long way to achieve lean status with the use of proper lean tools and techniques, which are suitable to their work culture, conditions and available infrastructure. It is tedious job but not difficult. Lean tools and techniques will help MSMEs to overcome their weaknesses and utilize their strength. It is recommended that organization irrespective of its status should adopt lean philosophy as an improvement strategy. Lean management is the most suitable improvement strategy for all manufacturing industries like OEMs and component manufacturing industries.

Pool et al, (2011) al studied the principal of flow and pull production suggesting a regular demand driven product flow in semi-process industry by introducing cyclic schedules for improving production quality and supply-chain coordination. Demeter et al, (2011) found a significant relationship between lean management practices and inventory turnover and found the different types of inventories are sensitive to different contingency factors. WIPs affected strongly by the production system, while the type of order affects raw material and finished goods and further emphasis the important of the proper decoupling point placement in the supply chain. Behrouzi et al ,(2011) presents an innovative approach to measure the lean performance of manufacturing systems by using fuzzy membership function. Rubio et al 2008 has implemented a reverse logistics system for remanufacturing end-of-life products in a lean production environment.

Rachna Shah et al,(2007) mapped the operational space corresponding to the conceptual space surrounding lean production also identified the critical factor of lean production, how are the various factors of lean production related to each other and why they are related. Fawaz et al, (2007) described a case where lean principles were adapted for the process sector for application at a large integrated steel mill. They have used value steam mapping as a lean tools to identify the opportunities for various lean techniques and described a simulation model to contract before and after scenarios in detail to reduce production lead-time and to lower work in process inventory. Doolean et al, (2005) found that while electronic manufacturers have implemented a broad range of lean practices, the level of implementation thus vary and may be related to economic, operational or organizational factors.

Ramesh et al,(2009) discussed the lacuna in the existing flow line and has suggested a new one piece lean line design using the simulation software in pump manufacturing industry. Lluis et al ,(2011) identify the key performance metrics of the system and the effects of design parameters on system performance. Kuhlang et al,(2011) identified and exploited the productivity potentials is realized by the joint application of VSM and Method Time Measurement (MTM) to reduce lead time and increase productivity based an lean principles and standardized processes. John (2009) argues how return on investment can be achieved by implementing a new scheduling system that assisted implementation of lean manufacturing.

Marksberry et al ,(2011) looks a common approaches, theories and problems concerning the role of the executive an how it can affect companies in their efforts to adopt lean tool and principles. Deros et al ,(2011) aimed to reduce the setup time by exploring the efforts on assembly line improvements , and factors that can contribute to further reducing setup time in battery assembly by SMED lean techniques. Roberto et al, (2009) studied a case illustrate VSM use, as well as kanban and milkrun systems application on an assembly line. The results obtained showed that the path of improvement, measured through the Lean Rate (LR) and Dock-to-Dock time (DtD). Jennifer et al,(2009) studied 51 events in six manufacturing organization to identify the set of input and process factors that most strongly relate to the development of employee attitudinal outcomes and problem-solving capabilities in kaizen events of lean production. Jayaram et al,(2010)found a positive interaction effect between the TPS practice of preventive maintenance and the TPS rule of decentralized decision making on all performance measures i.e. manufacturing cycle time, quality, cost and delivery speed.

The numerous literature researches works shows the effectiveness of lean practices that have been published in various journals. This will further assist all manufacturing sector to drive their level of leanness, continuously improve their productivity, better customer satisfaction and will serve as a foundation for future research work.

4. Essential Lean Management Tools

The most important lean management tools, with a brief description of how each tool can improve the manufacturing activity as shown in Table 1.1 Vorne (2012).

Table 2 Types of Lean Tools Vorne, [Available at : http://www.leanproduction.com]

Lean Tool	What is it?	How does it help?
5S	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)	Eliminates waste that results from a poorly organized work area (e.g. wasting time looking for a tool).
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.
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.
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).
Gemba (TheReal 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.

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
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.
Jidoka (Automation)	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).
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.
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.
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. It eliminates the need for physical inventories (instead relying on signal cards to indicate when more goods need to be ordered).
KPI (Key Performance Indicator)	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	The best manufacturing KPIs: • Are aligned with top-level strategic goals (thus helping to achieve those goals)

	KPIs that will drive desired behavior.	• Are effective at exposing and quantifying waste (OEE is a good example) • Are readily influenced by plant floor employees (so they can drive results)
Overall Equipment Effectiveness (OEE)	Framework for measuring productivity loss for a given manufacturing process. Three categories of loss are tracked: • Availability (e.g. down time) • 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.
PDCA(Plan, Do, Check, Act)	Iterative methodology for implementing improvements: • Plan (establish plan and expected results) • Do (implement plan) • Check (verify expected results achieved) • Act (review and assess; do it again)	Applies a scientific approach to making improvements: • Plan (develop a hypothesis) • Do (run experiment) • Check (evaluate results) • Act (refine your experiment; try again)
Poka-Yoke (Error Proofing)	Design error detection and prevention into production processes with the goal of achieving zero defects.	It is difficult (and expensive) to find all defects through inspection, and correcting defects typically gets significantly more expensive at each stage of production.
Root Cause Analysis	A problem solving methodology that focuses on resolving the underlying problem instead of applying quick fixes that only treat immediate symptoms of the problem. A common approach is to ask why five times – each time moving a step closer to discovering the true underlying problem.	Helps to ensure that a problem is truly eliminated by applying corrective action to the "root cause" of the problem.
Single Minute Exchange of Die (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	Enables manufacturing in smaller lots, reduces inventory, and improves customer responsiveness.

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.
SMART Goals	Goals that are: Specific, Measurable, Attainable, Relevant, and Time-Specific.	Helps to ensure that goals are effective.
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.
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).
Total Productive Maintenance (TPM)	A holistic approach to maintenance that focuses on proactive and preventative maintenance to maximize the operational time of equipment. TPM blurs the distinction between maintenance and production by placing a strong emphasis on empowering operators to help maintain their equipment.	Creates a shared responsibility for quipment that encourages greater involvement by plant floor workers. In the right environment this can be very effective in improving productivity.

Value Stream Mapping	A tool used to visually map the flow of production. Shows the current and future state of processes in a way that highlights opportunities for improvement.	Exposes waste in the current processes and provides a roadmap for improvement through the future state.
Visual Factory	Visual indicators, displays and controls used throughout manufacturing plants to improve Communication of information.	Makes the state and condition of manufacturing processes easily accessible and very clear to everyone.

5. Results and Discussions

The results of survey highlight the status of lean management practices delivered on important message that most of the lean tools and techniques were rarely used in various manufacturing industries. The results further indicate that the fundamental building blocks of lean management like Andon (visual Control device), single minute exchange of dies, value stream mapping, Jidoka, Poka-Yoke are less frequently practiced in manufacturing industry.

6. Conclusions

The traditional manufacturing practices are indicated inadequate representation in lean management. This paper presented an important imminent into the status of lean manufacturing implementation in manufacturing industries. The progress in lean implementation is snail-paced and needs to be augmented. It has a further scope to develop focused lean concepts, which can be implemented in other kind of manufacturing environment and service sectors. The major reasons for the low level of lean management were anxiety in changing the attitude of workers, lack of awareness, and training about the lean management concepts involved in lean implementation. Therefore, it can be concluded that the manufacturing industry needs to give more attention to implement lean management in all the key areas like supply and logistics, stores, production process, assembly line, inspection and quality, packaging and Shipping .Therefore, suitable lean awareness, means of continuous improvement and research and development setup in association with manufacturing industries are to stimulate the lean management practices in their business process to competitive environment of current scenarios.

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