
**LEAN MANUFACTURING 'A RADICAL CHANGE' AND 'PARADIGM SHIFT IN
MANUFACTURING'**

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ABSTRACT

Lean Manufacturing process is bringing a radical change not only in global manufacturing but also in almost all service sectors - such as retail, hospitals or offices. The approach, the enterprises can use to improve creating more value for customers with fewer resources. Many companies are struggling to survive in today's highly competitive global economy. Lean manufacturing offers them a proven method to reduce costs, eliminate waste, increase productivity, maintain high levels of quality and still make a profit. An implementation of this, 'paradigm shift' (a radical change), is taking place across numerous industrial and service sectors. This paper reveals Lean Manufacturing as a paradigm shift in manufacturing. It reveals challenges and benefits of Lean process. The paper is purely based on secondary research. Case studies already done are sought as an example in understanding the benefits of Lean Manufacturing and their challenges. In the process of writing this paper, we have ascertained that the Lean Manufacturing environment has ability to bring in overall efficiencies in manufacturing, while removing wasteful activities that don't add any value to the end product. Thus creating more value to the customers – leading to enhancement in good-will of a company and a win-win situation for both customers and manufacturers.

Lean Manufacturing, Batch Production, Muda, Muri, Mura, JIT - Just in time, VSM - Value Stream Mapping

INTRODUCTION

At the end of Second World War Japan was completely devastated. The problems were severe—the domestic market was tiny and demanded a wide range of vehicles. The native Japanese worker was no longer willing to be treated as variable cost. The new labor laws introduced favored, favorable working conditions for workers and employment. The war ravaged Japanese economy faced severe financial crunch in capital and foreign exchange. Toyota motors faced daunting challenge the question was how to succeed against western mass production auto giants who were on the brink to enter Japanese market. The credit goes to Mr. Taichi Ohno, the pioneer of Toyota production systems, who conceptualized 'Lean' a technique/method while dealing with fruit seller in supermarket. The lean manufacturing idea struck his mind when he saw the fruit seller replacing a new fruit of raw apples after selling the old one, '*in production it conveys, produce only when it is demanded*' and save undue cost of storage. Thus the concept of Lean emerged by Taichi Ohno. Mr. Ohno first identified the seven types of MUDA in Japan it is (waste). In the 1950s, Ohno, developed Toyota "Just-in-time" Production System, created the modern intellectual and cultural framework for Lean Manufacturing and waste elimination. Ohno defined waste as '*any human activity which absorbs resources but creates no value.*' In its most basic form, Lean Manufacturing is the systematic elimination of waste by focusing on production costs, product quality and delivery, and worker involvement as defined by Shigeo Shingo and Taichi Ohno. While 'waste' is been thought of as an undesirable by-product of most factory production systems, many have considered it as an inevitable which reflects on the corporate balance sheet. Henry Ford was one who first realized that waste also represents inefficient (and more costly) production processes. In the early 80's, several Japanese manufacturers built plants in the U.S. and operated them with Lean principles. The success of these plants proved that Lean was not just a Japanese cultural phenomenon, but could be successful even outside of Japan. In its most basic form, Lean Manufacturing is the systematic elimination of waste by focusing on production costs, product quality and delivery, and worker involvement.

Largely, Lean Manufacturing represents a *fundamental paradigm shift* from traditional "*batch and queue*" mass production to the production systems based on product aligned "*single-piece flow, pull production.*" "*Batch and queue*" involves mass-production of large inventories of products in advance based on potential or predicted customer demands while a "*single-piece flow*" system rearranges production activities in a way that processing steps of different types are conducted immediately adjacent to each other in a continuous and single piece flow. If implemented properly, a shift in demand can be accommodated immediately, without the loss of inventory stockpiles associated with traditional batch-and-queue manufacturing.

Companies embrace Lean Manufacturing for *three fundamental reasons*. First, the highly competitive, globalized market of the late 20th and early 21st century require that companies to lower costs so that they could increase margins and/or decrease prices through the '*elimination of all non-value added aspects of the enterprise.*' Second, customer responsiveness is a key. That is rapidly changing customers' preferences that demands variety of rapid product mix. Finally, producing desired goods quickly and of quality. Thus, efficiency, responsiveness, and quality are three key goals of Lean Manufacturing. This leads to an understanding that Lean production mainly focuses on identifying and removal of waste and further utilizing those activities to add value to the final product. VSM or Value Stream Mapping is one of those concepts of lean which identifies the non-value added activities in the value stream. Value stream is all the activities in a supply chain required to provide a

specific product. From the customer point of view—value is something which a customer is willing to pay for the product or service. Formally value adding activities are those activities that transform or improve the product for the customers. On the other hand non-value added activities can be defined as those activities that consume resources yet do not directly contribute to the product or service. This non-value added activities are the waste in lean manufacturing.

The Objectives of the study are:

- To determine whether Lean manufacturing is really having a profound effect on global business practice.
- To identify the challenges the companies facing in implementing lean manufacturing system.

LITERATURE REVIEW

Substantial research and literature exists indicating that many industries are actively implementing Lean Manufacturing as a key strategy for remaining competitive in today's manufacturing environment, an implementation of this '*manufacturing paradigm shift*' (*a radical change*) is taking place across numerous industrial and source sectors. The global industry in 21st century has forced most of the leaders in several sectors to implement more competitive manufacturing system. The best answer as founding the journals is lean manufacturing. Initially it's started at Toyota plant, Japan, which is known Toyota Production System (TPS).

According to (Rineheart et.al 1997) lean manufacturing will be the standard manufacturing mode of the 21st century. There is no alternative to lean manufacturing (Dankbaar 1997). Researchers agreed that lean manufacturing could be a cost reduction mechanism and if well implemented it will be a guideline to be world class organization (Papadopoulou & Ozbayrak 2005). Theoretically, Lean Manufacturing can be applied to all industries (Billesbach 1991, Womack et al 1990). Meier & Forrester (2001) found lean manufacturing was successfully implemented even in the tableware industry.

Lean is considered as a concept which integrates manufacturing system, comprise of principles, practices and techniques (Karlsson & Ahlstrom 1997). The objective of lean is to identify and eliminate waste throughout the organization from ordering raw materials to delivering goods to customer. Better, cheaper, faster... These are more than buzzwords in successful manufacturing organizations worldwide. To compete and to win in today's marketplace requires manufacturers to improve productivity while lowering costs and bringing quality products to market quicker than ever before.

Many people think that Lean Manufacturing means coordinating schedules so that parts and materials arrive at their point of use "just in time" to avoid inventory and the space it consumes. Indeed, that is part of Lean Manufacturing – an important part. But there is considerably more than that to Lean Manufacturing. That's because Lean Manufacturing is a strategy for achieving significant, continuous improvement in performance through elimination of all waste of time and resources in the total business process.

For most companies, improving performance means change – dramatic change – in the way they do business. Change can be unsettling as people face new roles, new risks, and new standards of achievement. Lee (1997) and Bonavia (2006) found that large and small companies have the right opportunity to implement lean manufacturing. But to SMEs, to implementing all elements at one time

is impossible since the factors of financial constraint and lack of management commitment (Achanga 2006).

In *'The Machine that Changed the World'*, authors Womack and Jones articulates how to utilize Toyota's Lean production systems to improve factory performance. In their work, Womack and Jones revised on Ohno's definition of waste by defining it as mistakes which require rectification and no one needs any excess inventories by producing more so that stock could pile up – this process of inventory is not needed therefore whenever need arises or when customer pulls the product then only the production process for that item is triggered. Further, movement of employees and transport of goods from one place to another without any purpose is also waste. People waiting in a downstream activity because upstream activity has not delivered on time for its goods and services and customers waiting to be served is also considered as waste of time.

According to Badurdeen Aza (2008), the concepts of Lean manufacturing were developed over past five to six decades, in Japan, at Toyota production system. These concepts were tested and time and again proven to be successful for several years and now it is a powerful technique in both manufacturing as well as in service sectors. It is not a fine tuning of the existing manufacturing processes but a conceptually different technique from the traditional process. For example, traditional manufacturing is based on safety inventory to anticipate future demand. But lean manufacturing poses question to the role of inventory and it defines it as a wasteful effort in producing excess when there is no demand–this itself is the reflection of the imperfection a traditional system has. To successfully implement lean manufacturing, it is paramount to understand the differences between the lean manufacturing concepts to that of the conventional manufacturing. Failing, will eventually kill your success.

Muda: Muda is any activity that does not add value to the product or service. It increases the time spent on product or service but adds no value for the customer. The following wastes are examples of Muda. The first seven wastes are defined by 'The Toyota Production System' and accepted as main waste in a manufacturing environment. Later an eighth waste '*unused human talent*' was defined by Womack and Jones (2003).

1. Overproduction
2. Waiting
3. Transport
4. Inappropriate processing
5. Unnecessary inventory
6. Unnecessary motion
7. Defects
8. Unused human creativity

Muri: Second type of waste is muri. Muri means overburdening of equipment, facilities and people facilities and people beyond its natural limits. According to Liker (2004), '*Muri is pushing a machine or person beyond natural limits.*' This over burdening may result in fatigue to the people working resulting in safety and quality problems. Also overburdening of the equipments may cause breakdowns and defects in the process.

Mura: The third type of waste is called Mura. Mura exists when the workflow is imbalanced and work load is inconsistent. Muda and Muri will be a result of Mura, Liker (2004).

Kaizen: is another idea developed in Japan. It supports lean production by introducing the idea of continuous improvement. Kaizen is a concept that makes improvement the responsibility of everyone involved in production. Improving efficiency becomes a continuous process, not a one-off activity. Kaizen implies that even the smallest improvement should be made, as many small improvements can lead to big savings.

Our objectives

- To find whether Lean manufacturing is having a profound effect on businesses.
- To identify the challenges the companies facing in implementing lean manufacturing system.

Have met through the discussion of the Case Studies already done. Following are the case-studies discussed and analyzed

- i. Case study of **BOEING** by Ross & Associates
- ii. Case Study of **JAGUAR** Business Case Studies LLP – Registered in England
- iii. Case Study of **PORTAKABIN** Business Case Studies LLP – Registered in England

THE BOEING CASE STUDY

The Boeing case study provides a dramatic shift in manufacturing paradigms in accepting Lean strategies to eliminate non-value added aspects of the enterprise and ensuring optimal competitiveness. Lean strategies utilized at Boeing have reduced the amount of energy utilized, raw materials, and any non-product activities associated with its manufacturing processes, in turn translating the reductions into enhancing value to the customers and also environmental improvements.

Initially Lean Manufacturing principles was implemented on five “assembly” and two “metal fabrication” later it was adopted throughout its Commercial Airplanes division in February 1996. Lean efforts have since been expanded to the entire Boeing Company.

Boeing Case Study Findings

Importantly, the waste elimination culture at Boeing is largely grounded in powerful financial incentives. The focus of Boeing’s Lean effort was continuous elimination of waste in the Company’s manufacturing processes, including reducing costs, cycle time, and defects.

It adopted Lean Manufacturing principles and strategies to improve and streamline its overall production systems and maximizing its production efficiency, and helping to achieve its goal of standard operations, ensuring that employees are doing the right work, the right way, at the right time.

Boeing has based its Lean activities on the *principles demonstrated in the Toyota production system* and identified in ‘Womack & Jones’. *Among the Lean principles embraced by the Boeing Company are the following.*

Identify the value stream: Identifying the actions required in producing raw materials into a finished product.

Make value flow: Ensure that products and processes flow continuously by removing the unnecessary steps in the manufacturing process,

Pull value through from the customer: Work begins only when a customer has requested (“pulls”) the product,

Remove waste: Eliminate all “non-value added” aspects of the production process.

Pursue perfection: Improve products and processes continuously.

Complexity: Reduce or eliminate complex solutions because they tend to produce more waste and are more difficult to manage,

Labor: Eliminate all unnecessary “movement” and steps of people,

Overproduction: Produce only the exact amount of goods the customer wants when the customer wants them.

Space: Conserve space by improving arrangement of machines, people, conveyors, or work stations, and storage of excess raw materials, parts, work-in-process, and finished goods inventories.

Energy: Operate equipment and use person-power only for productive purposes.

Defects: Strive to achieve the goal of no rework.

Materials: Convert all materials into products. Avoid scrap, trim, excess, or bad raw materials.

Idle materials: Make sure that nothing sits idle so there is a steady flow to the customer.

Time: Eliminate delays, long setups, and unplanned down time of machines, processes, or people.

Transportation: Eliminate the movement of materials or information that does not add value to the product.

Unsafe acts: Eliminate dirty, dumb and dangerous acts.

As a result of the above initiatives, Boeing was able to bring down its inventory levels by \$1 billion since January 1999, and further it was also successful in bringing down the manufacturing time by 60% and saving in manufacturing floor space by more than 50%. This helped the company to lower the cost in production activities and also freed its manufacturing capacity by not over-burdening machines.

A JAGUAR CASE STUDY (IMPLEMENTATION OF LEAN PROCESS)

This case study focuses on the way in which Jaguar, one of the world’s most prestigious car manufacturers, has employed lean manufacturing processes for its new Jaguar S-Type production line at its Castle Bromwich factory in Birmingham. Jaguar was a part of the Ford Group when this case-study was done but now it is TATA Motors.

The change process

Jaguars had its own culture and its own style of working but it was necessary to develop new ways of working style in order to improve efficiency and reduction in costs. One of the most significant changes was that of creating continuous flow system of production based on a ‘just-in-time’ approach. Previously, the set of production processes in the of Jaguar cars were using batches of components but with the implementation of Lean and JIT approach it cut down stocks of components and kept the numbers required at workspace to keep production flowing smoothly.

One of the greatest measures of improved working systems at Jaguar after the implementation of Lean manufacturing was it would match the supply of new cars coming off the line at Castle Bromwich to the demand from Jaguar customers which itself is a "PULL SYSTEM". The key manufacturing principle it introduced as a Japanese Lean Manufacturing philosophy is that producing a product right-first-time and every time. Right-first-time specifies that there should be zero defective items. Furthermore, the quality of components supplied by the supplier whether supplier is internal or external should be of quality and is the sole responsibility of whoever supplies them. Under the new working arrangements at Jaguar, workers were encouraged to take responsibility for their own work. Working procedure were standardized so that everyone knows their accountability and responsibility of work in order to maintain quality standards.

Jaguar continues to progress in improving its manufacturing methods performance. It is a key player in a major industrial renewal project. In this way, Jaguar's winning formula continues.

A PORTAKABIN CASE STUDY: LEAN PRODUCTION AT PORTAKABIN

Portakabin is an international company which produces advanced building systems. The company is part Shepherd Group. *Portakabin* buildings can be raised anywhere in the globe with the same high quality because it closely monitors its process and maintains standardization during its production at its site.

This case study focuses on how *Portakabin* is using lean production methods to ensure that it produces a quality product that adds value to the customer. *Portakabin* is working in the direction of eliminating waste. Lean production as a strategy strives to eliminate waste by reducing defects so that products coming out or built are 'right first time' and are of a high quality that meets customer requirements and specification.

Quality is a prime objective for *Portakabin* therefore it uses a Quality Management System. The purpose of this is to designed and give customers what they want, for example, '*a safer learning environment or a more inspiring office*'. Thus High quality is ensured through a process known as Kaizen. With just-in-time procedure, '*the demand for new buildings pulls supplies through the system. This is a very important business principle*'. When demand increases new component supplies are ordered, rather than having them in stock. It only holds those stock items which it needs for the orders in process. This reduces costs and ensures that stock carried in process specifically meet the requirements of the individual businesses. This is achieved through the usage of detailed information technology systems to manage the flow of production. Thus the records of supplies at every stage of production are available exactly when required. To ensure smooth flow of process *Portakabin* ensures Good relationships with suppliers as any delay in delivery of raw materials can hold up the entire production process.

CHALLENGES FOR INDUSTRIES TO OVERCOME

Large organizations have blend of resources like (finance, manpower, and equipment), they might not face difficulties on lean implementation. But for small organization, any new implementation of management system may face lot of obstacles especially on financial needs. Small organization perceives that the implementations of lean practices are beyond their reach (Finch 1986). Further, any cost implications in the implementation of new management system for educating and

training component, is much harder for small organizations (Antony & Kumar 2005). But there was no difference found between small and large organizations related to workforce management practices (Doolen & Hacker 2005) which is Supported by (Shah & Ward 2003), that both the small organization and large organization show similar implementation on cross functional workforce and quality management programs. Hence, the employees are flexible enough for job-rotation as and when need arises.

Furthermore, Lee (1997) and Bonavia (2006) found that large and small companies have the opportunity to implement lean manufacturing. But to Small and medium-sized enterprises (SMEs), implementing all elements of Lean Manufacturing at one time is impossible because of financial constraint and lack of management commitment (Achanga 2006).

CONCLUSION

This paper has attempted to determine how manufacturing arena is changing radically and shifting to practices like Lean process, 'a paradigm shift in manufacturing'. This aim together with more specific objectives defined earlier have been met through the literature review. The overall conclusion of this study is summarized as follows:

Lean is proven and tested system. It provides very simple solution to the complex problems. Lean manufacturing system as it stands today is a prime need for many organizations in order to cut down costs and add value to customer – so that companies can survive in this turbulence business climate. Furthermore, lots of benefits can be achieved through Lean manufacturing, its ability to provide accurate estimates for processing times, cycle times and just in time delivery, with 100% quality check and no wastivity of any efforts, a pure efficient and zero waste management. Nevertheless, we need to understand critically that there are still some drawbacks to overcome for a complete integration of Lean manufacturing techniques, the worker participation, training, system integration and many more alike. Moreover only large manufacturing enterprises have developed and applied successfully, like the aerospace and automotive industries while at the small scale level enterprises – they lack in finance. Furthermore, it is yet to penetrate as a concept / system / process/ in both manufacturing arena and service sectors as it limits to financial constraint and Top-management support. But when it overcomes these constraints we can see great rewards in manufacturing arena as well as in service sectors.

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