The Perception & Methodology of Lean Manufacturing: A Review paper

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Abstract— In the present global and competitive environment all organizations needs to perform efficiently with higher productivity. For performing efficiently with higher productivity there are so many tools and techniques. Lean is one of them it means using only what is necessary. Lean manufacturing techniques aim to significantly identify waste and eliminate it from the manufacturing processes. The paper is based on a discussion of literature review that shows how the completion of Lean could find importance to the organization processes and contribute for live in competitive environment by fast full benefits i.e. lead time, set-up time, reduction in inventory etc.

Index Terms— Lean manufacturing, 7 wastes (MUDA), Non value added activity, lean Implementation, Toyota Production System

I. INTRODUCTION

Lean is first evolved by Toyota in Japan by **Eji Toyoda**, **Taichi Ohno** and **Shigeo Shingo** as a business strategy after visiting Ford at America is called as a **Toyota Production System (**TPS) and TPS is beginning due to limited recourses in Japan [1].

Lean is a manufacturing or management philosophy that shortens the lead time between a customer order and the shipment of the parts or services ordered through the elimination of all forms of waste. "A planned systematic implementation of lean leads to improved quality, better cash flow, increased sales, greater productivity and throughput, improved morale and higher profits" [2].

Lean is concentrate on expenses of resources for any purpose other than the creation of Worth for the end customer to be uneconomical, and thus a target for **Elimination of wastes**.

Less	Space
	Movement
	Stock/ Scrap
	Overproduction
	Waiting
	Rectification
	Finance
Enhance	Quality
	Safety
	Performance
	Service
	Flexibility
	Productivity/ Improvement
Analyze	Proficiency
	Process
	5S
	Standardized work
	Delivery waste
Numerical control	Trends
	Performance
	Process
	Status
	KPIs
	Visual management

Figure: 1 Concept of Lean

II. WHAT IS LEAN?

Lean manufacturing can best be described as **eliminating waste** in a production process, anything that does not add **value** to the end product is **waste**.

The nucleus idea is to maximize customer value by providing Quality, Safety, Performance, Flexibility etc while minimizing waste [3]. Simply lean means create more value to the customer with smaller amount resource by using of different lean tools like 5S, Single minute of exchange of die (SMED), Kaizen, Visual Management, Key performance indicator(KPIs) etc. Figure 1 shows the one concept of Lean.

III. LITRATURE REVIEW

The result of lean manufacturing on cost of production has been addressed by a number of researchers.

Joing (1995) says that on-time delivery and customer satisfaction enhanced while lead times and inventories dropped extensively [4].

Kilpatrick (1997) highlights that inventory escalating lead to always increasing costs in the form of invested capital, damaged finished goods, scrapped product, and costly inventory control system [5].

Czarnecki and Loyd (1998) have present definition for lean manufacturing: "It is a methodical approach to identify and eliminate waste (non-value added activities) through continuous improvement by following the product at the pull of the customer in pursuit of perfection" [6].

Singh (1999) says that all types of companies, manufacturing, process, distribution, software development or financial services can benefit from adopting lean philosophy as long as a company can identify a value stream, from when the customer's order product to when they receive it, lean principles can be applied and waste removed [7].

Abdullah (2003) explain that the driving force behind implementing lean in the US was the cost reduction for the steel companies [8].

Yamashita (2004) concluded that higher quality products with less resources and capital are achieved by implementing lean manufacturing and lean manufacturing leads to reductions in scrap, rework, returns, and waste [9].

Koh et al. (2004) has conclude that lower production costs can be achieved when lean production manufacturing practices, such as,TQM and JIT, are used.

Liker (2004) defines lean manufacturing is: "Adding value by eliminating waste, being responsive to change, focusing on quality, and enhancing the effectiveness of work force" [10].

Berg and Ohlsson (2005) stated that overproduction is the most serious waste because it contributes to the other six wastes where production costs money and there is no reason to produce items that are not demanded [11].

McGrath (2007) construct that both Irish companies have made some great improvements in terms of the value streams of their respective plants and also in the reduction of waste and inventory. Another result has been reached that lean manufacturing is a considered as a strategic tool to improve the competitive position of the organization [12].

Czabke (2007) concluded that all plants became more efficient and hence more cost effective and profitable after implementing lean manufacturing in the US and Germany [13].

Piercy and Rich (2008) illustrated that services call centers for the studied 3 financial services companies in the UK can serve the traditionally competing priorities both of operational cost reduction and increased customer service quality [14].

Rathi (2009) accomplished that unneeded processing, transportation of materials and WIP inventory wastes are significant in job type PI and raw material inventory was the most common waste for the process industry sector [15].

Hallgren and Olhager (2009) present that lean manufacturing has a significant impact on cost performance for the studied plants in 7 countries, whereas agile manufacturing has not, and agile manufacturing has a stronger relationship with volume than does lean manufacturing [16].

Enaghani, et al. (2009) illustrated that lean is a culture for quality improvement starting with revolutionizing the minds of employees [17].

El-Kourd (2009) concluded that using lean construction in Gaza Strip reduced the number of steps in the whole project by 57%, the non-value added decreased from 81% to 14% in the project duration, and the total cycle time of the project was reduced by 75% [18].

Minggu (2009) A lean organization can make twice as much product with twice the quality and half the time and space, at half the cost, with a fraction of the normal work-in-process inventory. Lean management is about operating the most efficient and effective organization possible, with least cost and zero waste [19].

Forrester et al. (2010) stated that managers of the agricultural machinery sector in Brazil have supported a transition towards the adoption of lean manufacturing practices and they have shown a significant improvement in their business performance including the production cost [20].

Nitin Upadhye et al, (2010) descried major actions taken by the company to implement lean thinking to improve its efficiency and effectiveness. This lesson attempted to point out various wastages and issues to implement the lean manufacturing systems in MSME. Lean tools like kaizen, JIT, VSM, 5S, SQC, preventive maintenance, total employee involvement, and SMED were used to find and abolish the wastages in a MSME. The implementation of lean tools and techniques will be victorious only if these are used sensibly. Lean management is the most suitable improvement strategy for all manufacturing industries like OEMs and component manufacturing industries [21].

Mr. Vijayendra Singh Sankhla et Al. (2012) prepares interview questions. In order to answer the question what should a small industry focus on to implement the Lean Production concept successfully? To prepare interview questions, author has investigate the thoughts behind why Pyrotech Pvt. Ltd. At Udaipur, Peacocke Furniture and plastic Pvt. Ltd., Pacific Mines Pvt. Ltd. companies choose to implemented lean concept, how they work with it and what results. The questions were developed based on

14 principles liker writes about and these are related to four parameter company goal, implementation, results and research strategy. According to these three parameter these questions gives recommendation that Why should a company start to implement Lean Production and under this, company have which strategically goal? How should a company implement Lean Production? Which benefits could a company gain when changing into Lean Production? [22].

Maxwell L. Smith et al. (2012) have documented the effectiveness of lean quality improvement in changing anatomic pathology patient safety. Through culture change and implementation of specific work process changes, lean implementation improves pathology patient safety, change in condition that contributes to patient safety [23].

Dombrowski et al. (2013) derives definitions of Lean Leadership and identifies five fundamental principles. Five principles are evaluated by an international survey among 91 enterprises. Lean leadership is the missing link between toolbox lean and the learning and continuously improving organization of lean thinking. Lean leadership is a methodical system for the sustainable realization and continuous improvement of LPS. Figure 2 show the five principles in the Lean Leadership Model and exhibit the central role of the Team. Five basic principles are Improvement culture, Self development, Qualification, Gemba and Hoshin kanri. Author has concluded, to achieve a better improvement culture, the lean leader needs to be a role model for his employees. The enterprises have realized the importance of lean leadership but they have not adapted their leadership system so far [24].

Nitesh Mundhada et al. (2013) utilized 5S lean technology for achieving project objectives. 5S is typically the first lean method which organizations implement to facilitate the application of other lean techniques that improve/optimize process structure and parameters [25].

Peetu Paul et al. (2013) represent the application of work study and seven wastes of lean manufacturing for the optimization of cellular manufacturing layout of relay assembly in an industry. The goal of cellular manufacturing is having the flexibility to produce a high variety of low demand products and maintaining the high productivity of large scale production [26].

Mohammed Ali Almomani et al. (2013) have developed proposed approach based on the conventional SMED and Multiple Criteria Decision-Making Techniques (MCDM). The proposed approach provides a systematic procedure for selecting the best setup technique among the available alternatives and takes also into consideration other factors that affect the decision-making process including: cost, energy, facility layout, safety, life, quality and maintenance. Author concluded using proposed approach setup time reduce and that leads to an improvement in the machine utilization, and thus enhancement of the productivity of the whole facility [27].

Samuel Jebaraj Benjamin et al. (2013) has studied the lean manufacturing single minute exchange of dies (SMED) technique in manufacturing industry to reduce or eliminate the small stop time loss. The overall equipment effectiveness (OEE) is measured before and after the implementation of the improvement using SMED. Author has concluded the elimination of the small stop has resulted in a valuable 2.08 percent improvement of XYZ's OEE. SMED was originally designed to reduce setup and changeover time loss [28].

M. Bala kumar et al. (2013) has studied Improving the Productivity of the Compressor assembly plant by reducing the cycle time using lean tools. This study is doing in Screw Air Compressor Assembly Line. After implementing kaizen the cycle time of the assembly operation were reduced from 92 min to 80 min. [29].

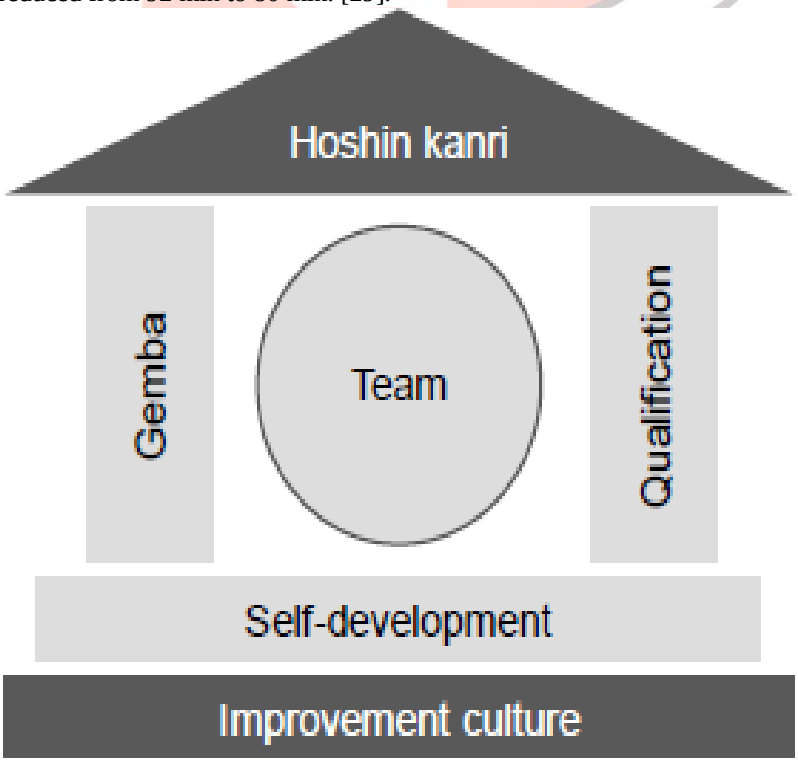

Figure: 2 Five Principles in the Lean Leadership Model (Dombrowski, 2013)

Mohd Anees Siddiqui (2013) present case study of an automotive industry in which the Kaizen improvement activity is performed in the shop floor and the kaizen target are made. Kaizen means a constant effort not only to maintain but also upgrade standards. It means continuous improvement. Author has initially design kaizen targets like Reduction of customer complaints,

Improvement in 5S level, Reduction in PPM level, Material handling improvement, System improvement. The Situation before and after kaizen shown in Table: I. [30].

TABLE: I SITUATION BEFORE & AFTER KAIZEN

	Before Kaizen	After Kaizen
1	Maximum work on floor	Work bench made
2	No 5S and No housekeeping	5S and housekeeping concept introduced.
3	No identification mark and No traceability system of Dies	Identification & traceability system of Dies implemented.
4	No layout on shop floor	Layout for shop floor made.
5	No KAN-BAN system exist	KAN-BAN system implemented
6	No standard worksheet & No SWS available on shop floor.	Standard worksheet & SWS made available on shop floor.
7	No Poka-Yoke for critical dimension for critical part	Poka-Yoke for critical dimension for critical parts made.
8	No proper layout of Quality Room.	Proper lay-outing of Quality Room made.
9	No identification and No maintenance on machine.	Identification & maintenance due dated template made.

IV. LEAN METHODOLOGY

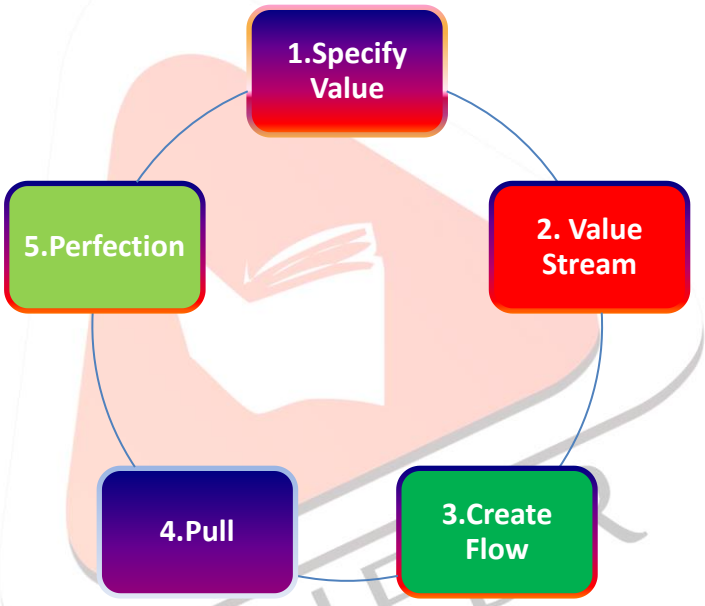

Figure: 3 Lean Management Principles (Womack & Jones)

Mwacharo (2013) says that there are a number of approaches to lean implementation. Implementing lean generally depends on a company. The approach to lean be supposed to be based on the requirements of the company (different sized companies producing different types of products or services in different volumes will inherently have different approaches to lean implementation). There is therefore no one perfect way to lean implementation [31].

There is a one methodology of lean implementation according to lean principles (figure: 3) developed by Womack & Jones [32].

The first principle is to "specify value from the point of view of the customer" Manufacturers will give to their customers what is suitable for them, or imagine as cheap for the customers. It is imperative to know who the customer is: the final customer, next process, next company along the supply chain, or the customer's customer [33].

The second principle is the Value Stream. This refers to the series of processes from raw resources to the final client, or from the invention to its market open. The value stream should permit for unobstructed material, information, and people flow; the material flow focuses on the flow of materials from raw to ending product, the information flow focuses on the communication flow of customer necessities and orders within a supply chain, and people flow focuses on how people are able to move within and around the processes [33] [34].

The third principle is Flow. Batch and queue processes should be avoid or continuously compact so that there is a smooth and quick flow of information, products, and services. "Flow requires much preparation activity. But the most important thing is vision" [33].According to Trent When looking through the point of view of an entire supply chain, it makes sense for activities to be organized in a way that allows for uninterrupted flow of work at the rate of demand pull from the customer. Disruptions to the supply chain flow affect the supply chain throughput, capacity, and cycle time and it ultimately "adds little value that the customers appreciate" [35].

The fourth principle is Pull. "Pull means short-term reply to the customer's rate of demand, and not over produce". [33]

The fifth principle is Perfection. Having worked one after the other through the previous four principles, a company would now be able to see that perfection within the company processes is now possible. This not only means a imperfection free company – but also means "delivering exactly what the customer desires, exactly when, at a light price and with smallest amount waste" [33].

V. MUDA, MURI, AND MURA

Muda, Muri, and Mura (1988) are Japanese words that were regularly used by Toyota through their development of Lean. Muda means waste, Muri means overburden, and Mura means unevenness. Variation in the order arrival rate and deviation in the capacity is unevenness (Mura). Capacity is straight connected with overburden. Mura and Muri lead to Muda". According to Ohno Muda is categorized into seven wastes Figure: 4. Wastes are [36],

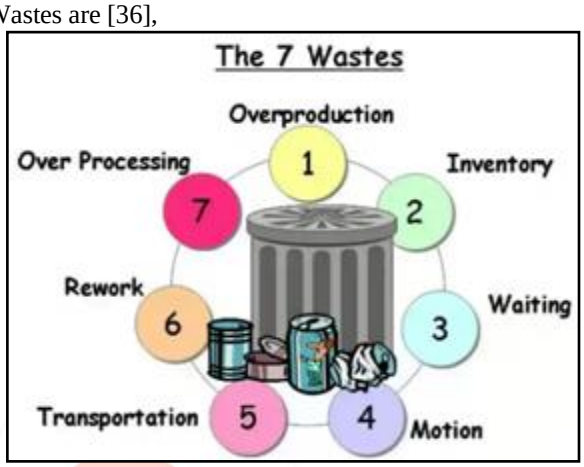

Figure: 4 Seven Wastes (Muda)

1. **Overproduction/early production**—producing what the customer does not want.
2. **Waiting**—idle time when no value is being added to the product or service.
3. **Transportation**—unnecessary moving or handling, delays in moving material.
4. **Inventory**—unnecessary stored materials, WIP, finished products.
5. **Motion**—movement of equipment, inventory, or people that adds no value.
6. **Over processing**—unnecessary processing and procedures that add no value.
7. **Defects**—producing defective products.

VI. CHALLENGES IN LEAN IMPLEMENTATION

The challenges face in the procedure of implementing and maintain lean is a boring job as the concept relate to time, cost, awareness, and participation, the concepts that jointly support the new revise for growth in an firm. The following important factor of resistance to change in manufacturing sectors is

- Fear to change the bequest system with the new winning trend and methodologies
- Not utilize the opportunity and return of the new policy
- Market damage will lead to force the change, which will be in a non-standard format. [31]

The forces opposing and driving a change to lean [37] is shown in Figure 5.

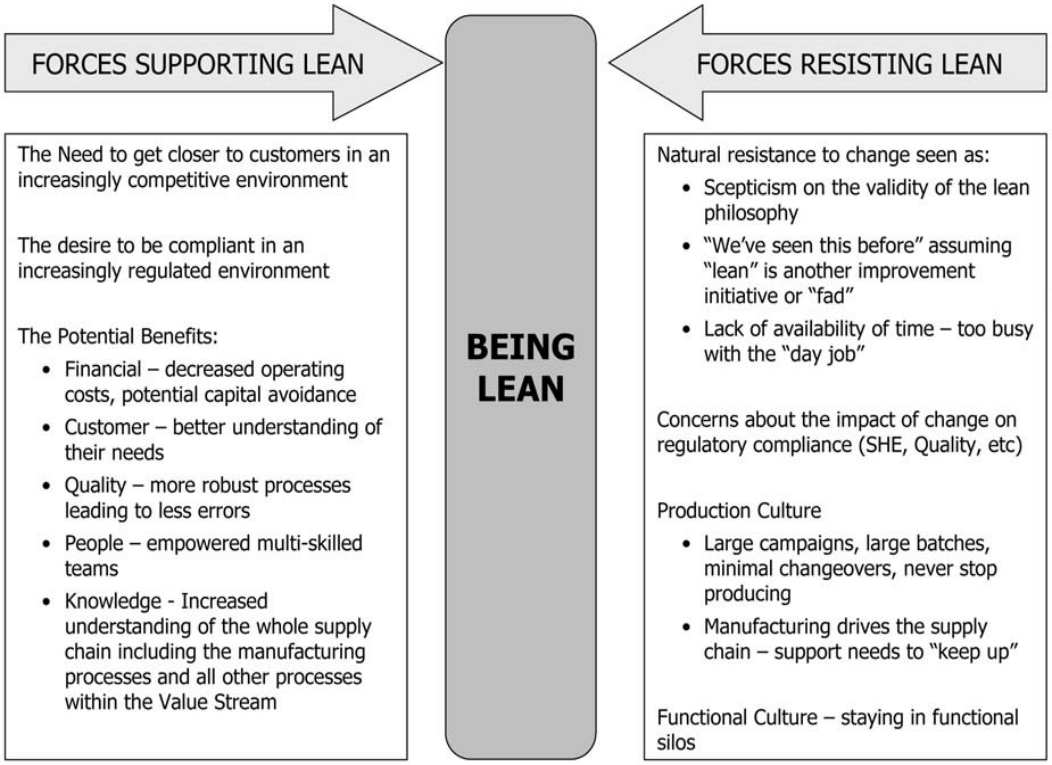

Figure: 5 The Forces Opposing and Driving a Change to 'Lean' (T. Melton 2005)

VII. Benefits Resulting From Lean Manufacturing

Lean manufacturing has a group of benefits for the growth of organization. The establishment of lean manufacturing will provide the following benefits for a particular organization [38]

1. Waste reduction by 75%-80%
2. Production cost reduction by 30%-40%
3. Manufacturing cycle time reduction by 60%-70%
4. Labor reduction by 55%-65%
5. Inventory reduction by 40%
6. Capacity increase by 40%-50%
7. Production of better quality

VIII. Conclusion

From the literature, it can be concluded there is a vast literature available on lean manufacturing, which gives an extensive outlook of past practice and research approved away across the area. This review paper present the fact that lean techniques and its application is very adaptable in today's world. It can be apply not only to manufacturing industries but also in service organizations, health care centre and etc. So more research is necessary which might improve the knowledge aspect.

The main objective of lean tool is to identify non- value-added activity, eliminate it and increase the productivity. Lean technique like continuous improvement (KAIZEN), Single minute exchange of die (SMED) and other techniques must be essential for achieving the better result. Simply lean is all about streamlining the flow of value through an organization. If it does not create worth in the customer's eyes, it is a waste. Improved bottom line performance, greater productivity, increased quality, cost reduction, customer satisfaction, and greater market share are some of the results. But most significantly, all of these tie into an increase in shareholder prosperity in the companies.

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