International Journal on Emerging Technologies **3**(1): 185-192(2012) **ISSN No. (Print): 0975-8364**
ISSN No. (Online): 2249-3255

An Empirical Study on Role of Lean Manufacturing in Manufacturing Industry

***Rajeev Choudhary*[*], *Pushpinder Kaushik*[*], *Neeraj Nirmal*[**] and *Vinod Dhull*[***]**

Department of Mechanical Engineering,
[*] *Geeta Engineering College, Panipat, (HR)*
[**] *P.D.M. College of Engineering, Bahadurgarh, (HR)*
[***] *Hindustan Institute of Technology, Bahadurgarh,(HR)*

(Received 15 April, 2012 Accepted 4 May, 2012)

ABSTRACT: Customer-defined product quality plays a very important role in the successiveness of a manufacturing industry. Due to this reason most of the manufacturing firms continually implements newer technologies to improve their quality standards. Product manufacturing firms believe that the way to rebound the market for their products and services is through improvements in quality, and each has outlined specific changes to their operations. A number of different types of materials, machines, tools, skill levels, and inputs have to be employed n production system and more market uncertainties because of scarcity of resources and rapid product innovations, add to the decision-making complexities in the manufacturing system. Achieving higher levels of productivity in this complex environment requires a system to rapidly adjust itself to complexities, uncertainties, and changes. Due to that reason most of the manufacturing industries are focusing on strict quality standards in their production process and implementing a quality program called Lean Manufacturing Process. This paper includes the lean practices in details from the extant literature and their benefits to present-day industries.

Keywords: Lean production, waste, customer focus, Overproduction, Inventory and Waste

I. INTRODUCTION

Often, key questions in examining manufacturing processes are: what are the value-added ratio of these supporting processes to the organization and the current plans of manufacturing. The plan of manufacturing may remain internal or extend i.e. outsourced. Principally the decision in this regard is of strategic nature therefore, the manufacturing has to be maintained inside the plant, except any change in volumes and may constraint to push the partial production outside and also the equipments, which have become redundant, may not be replaced. Lean means “Producing components without any waste.” Waste is anything other than least amount of effort, equipment, materials, components, and time that are actually required for production. Lean as a practical or operational viewpoint aims at reducing various types of waste within the organization and its supply chain by utilizing certain shop floor tools and techniques.

In present scenario, the main focuses on improved system productivity with concentration on improving quality, delivery and cost. This is essential to survive in the present competitive market where in the costs are major concerns. Therefore, in order to remain competitive, waste from inventory must be identified and eliminated so to run system with maximum efficiencies. Lean manufacturing systems are highly flexible and responsive to customer requirements. Lean manufacturing is a multi-dimensional approach that encompasses a wide variety of management practices, including just-in-time, quality systems, work teams, cellular manufacturing, supplier management, etc. in an integrated system Shah and Ward, [22]. The core thrust of lean manufacturing is that these practices can work synergistically to create a streamlined, high quality system that produces finished products at the pace of customer demand with little or no waste. The difference between traditional and lean manufacturing is shown in Table 1.

Table 1: Traditional manufacturing v/s lean manufacturing.

Parameters	Traditional Manufacturing	Lean Manufacturing
Production	Made to Stock	JIT(Customized)
Manufacturing lead time	Long	Short
Both quantity	Large	Small
Scheduling	Push	Pull
Inspection	Sampling	100% at source
Layout	Activity based	Cellular type
Inventory twins	Low	High
Flexibility	Low	High
People empowerment	Low	High

Lean production makes optimal use of the skills of the workforce, by giving workers more than one task, by integrating direct and indirect work, and by encouraging continuous improvement activities. Lean production is able to manufacture a larger variety of products, at lower costs and higher quality, with less of every input, compared to traditional mass production: less human effort, less space, less investment, and less development time. In today competitive age, most of the manufacturing organizations require the significant competitive advantage; hence the need to change their organizational structures through upsizing or downsizing or by empowered new teams for the purpose to improve the performance and goodwill of the organization is increased day by day.

II. LEAN MANUFACTURING: CONCEPT & BEYOND

Lean is a systematical approach to identify and eliminate waste through continuous improvement following the product at the pull of customer in pursuit of perfection. In lean manufacturing, the value of product is defined solely by the customer. Goal of lean manufacturing is to reduce the wastage in any form such as human effort, inventory, time to market, space to become highly responsive to customer demand. Value added activities make the product more closely resemble what the customer wants. Non value added activities do not create customers value. Anything that is not adding value is defined as waste. The processing in small batch sizes necessitates the adjustment in the flow of production through different processes as per their processing speeds. In addition it requires close monitoring of processes to reduce process variability (defect free production), efficient planned maintenance of all machines (for increased availability) and reduction in non value added activities such as setup times, movement of material in between the work processes and additional processing of material. The efficient utilization of machines while producing in reduced WIP inventories, reduced throughput times and reduction in lead times leads to competitive manufacturing. The details of Lean wastes generally TIMWOOD as given below:

1. Transportation: Unneeded movements of material occur when, instead of processes being sequential or positioned next to each other, they are physically far apart, and require moving and handling devices to be repeatedly repositioned for next step in the process.

2. Inventory: The stock of raw material that is sitting without providing value to a product accumulates cost. This is usually a costly way to cover up quality problems, such as rework and defects, manpower or production scheduling problems, excessive lead-time, and supplier problems.

3. Motions: Unnecessary movement of people, product, or equipment does not add value to a product. For example, workers walking back and forth from the work area to the supply area, moving around unneeded equipment, or performing redundant motions can be completely eliminated or automated to speed up the process.

4. Waiting: It includes delays coming from people, processes, or Work-in-Progress (WIP) inventory sitting inactive while waiting for instructions, information, raw materials, or any other resources. Wasteful waiting ties up capital, increases the risk of obsolescence or damage, and often requires additional handling and movement of goods.

5. Over-processing: It is basically adding unnecessary features that are not value adding. Poor process design can lead to producing better products or services than a customer needs or is willing to pay for.

6. Overproduction: It consists of making either unneeded, excess goods, or making needed goods too early or in excessive quantity. It is also described as making goods just-in-case rather than Just-In-Time (JIT). Traditionally, manufacturers have used the concept of Economic Order Quantity (EOQ), which is also known as economic lot size or minimum cost order quantity, to determine their optimal manufacturing batch and lot sizes.

7. Defective: The existence of defective units in a process is typically the result of a poor preventive quality system. When an error or defect is passed onto the nextoperation, or even worse, to the customer, a loss is inevitably occurred. As a result, something has to be manufactured, assembled, or serviced twice, whereas the customer will rightfully only pay once for the goods or service. Thus, doing everything right the first time is the most efficient, least wasteful way.

The scheme of classification for lean manufacturing tools and allied detailing is proposed and the basic structure of this classification is around on seven levels: system, object, operation, activity, resource, characteristic and application. Each level is linked systematically so that lean manufacturing tools are classified in a meaningful and logical way.

Later, the effects of three contextual factors, plant size, plant age and unionization status, on the likelihood of implementing lean production systems was examined.[23] Findings results in four "bundles" of inter-related and internally consistent practices; these are just-in-time (JIT), total quality management (TQM), total preventive maintenance (TPM), and human resource management (HRM). Results are empirically validating these bundles and investigate their effects on operational performance.

A majority of articles on the topic of lean production system focus on the relationship between implementation of lean and performance. Thus, lean is basically all about getting the right things, to the right place, at the right time, in the right quantity while minimizing waste and being flexible and open to change. The following are the five lean manufacturing principles are as under: [8]

1. Accurately specific values from the customer's perspective for both products and services.
2. Identify the value stream for products and services and remove non-value-adding waste along the value stream.
3. Make the product and services flow without interruption across the value stream.
4. Authorize production of products and services based on pull by customer.
5. Strive the perfection by constantly removing the waste.

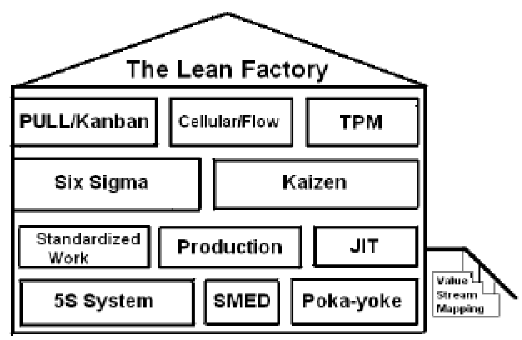

Fig.1. Lean Manufacturing Key Tools.

The importance of customer order driven planning concepts over forecast driven processes to minimize demand uncertainty was emphasized [28]. Production environment is restructured (by using new production concepts e.g. JIT, Time based manufacturing) in such a way that a customer order driven production becomes possible and economical. Later, the research is going on the role of organization culture for the successful implementation of lean initiatives [5].

The analysis intimate that the major difficulties encountered by companies to apply lean are, lack of direction, a lack of planning and a lack of adequate project sequencing, lack of clarity of vision and leadership.

A survey on Lean implementation shows the problem lies primarily with an aging and high seniority hourly workforce and a lack of committed leadership at this research site [24]. For example, salaried employees consistently provided higher positive ratings of continuous improvement initiatives. In addition, higher seniority was directly correlated with negative ratings. Finally, the study found that employees do not feel valued when they contribute to the improvement processes and that 100 per cent of the hourly male employees disagreed that ''The Company considers the employees as the most important asset and will do whatever they can to keep their people.

In further research on lean manufacturing, the critical factors for successful implementation of lean manufacturing within SME's environment are described. The factors like Leadership and planning, ideal management, financial organization culture and skill and expertise are required for successful adoption of lean manufacturing within SME's environment [2].

It was also reported during research on lean manufacturing that some companies have misapplied lean tools and techniques during the conversion to a lean organization. The misapplications can be identified as "use of a wrong tool to solve a problem, use of a single tool to solve all of the problems and use of all the tools (same set of tools) on each problem". Applying lean tools incorrectly results in a waste of an organization's time and money as well as reduced confidence by employees in lean techniques and philosophy [18]. Identified 101 lean manufacturing tools and a Seven-stage classification scheme to categorize these tools is the best way to implement the Lean Manufacturing. Implementing the future state design without validating the design a contributing factor in the poor performance in newly designed lean systems.

III. ANALYSIS

The quality Guru's have suggested various quality improvement techniques which have been applied from 1980 onwards. Implementation of QC tools can be effectively worked out through modeling.

The success of these quality models has to match the organizational culture and its people for ultimate success. The success of quality denotes market superiority of an organization. S.C. Wheelwright has identified six characteristics so far as competitive advantages are concerned. These characteristics are

(a) It is driven by customer needs. The company is to provide value to its customers which are not addressed by competitors.

(b) It makes a significant contribution to the success of the business.

(c) Every organization has its unique resources and opportunities and no two companies can have the same resources, strategies for effective resource utilization.

(d) A superior R&D department can help in developing new products and processes to be part of competitive market.

(e) It provides a basis for further improvement.

(f) It provides direction and motivation to the entire organization.

In this study, 20 research papers have been reviewed to identify Lean tools. These papers provide an idea about implementation Lean manufacturing in detail including its principles, tools and technique, benefits to any industry and its scope. Table 2 shows the use of different tool by the different researchers. The research strategy is classified in four categories (Dangayach and Deshmukh, 2001) as given below:

- **Conceptual:** Basic or Fundamental concept of Quality Engineering.
- **Empirical:** Data for study has been taken from existing database, review, case study, taxonomy, or typological approach.
- **Exploratory cross sectional:** Objective of study is to become more familiar through survey, in which information is collected at one point of time.

Exploratory Longitudinal: Survey methodology, where data collection is done at two or more points over time in the same organization **Exploratory Longitudinal:** Survey methodology, where data collection is done at two or more points over time in the same organization.

The data from the above table establishes that Lean Manufacturing is most important to develop quality systems and policies. The analysis also confirms that Lean tools such as JIT, Kanban, and TPM appeared in manufacturing as compared to other tools. Table 3 shows the appearance of Lean Manufacturing Tools.

Table 2: Lean practices and their appearances in key references.

Lean variables	**Holmstriim (1994)**	**Warneck et al. (1995)**	**Miltenburg et al. (1996)**	**Sohal (1996)**	**Ahlstrom (1998)**	**Zapfel (1998)**	**Bicheno et al. (2001)**	**Sanchez & Perez (2001)**	**Pavnaskar et al. (2003)**	**Comm et al. (2005)**	**Emiliani et al. (2005)**	**Achanga et al. (2006)**	**Bhasin et al. (2006)**	**Conti et al. (2006)**	**Rivera & Chen (2007)**	**Olivela et al. (2008)**	**Moyad & Shell (2009)**	**Murugaiah et al. (2010)**	**Chen and Meng (2010)**	**Khatri et al. (2011)**
Group technology		*			*				*				*							
Lead time reduction				*			*	*	*		*	*	*		*					*
Lot size reductions					*	*	*	*												*
Training and education				*					*	*			*				*			
Reduce WIP	*			*	*			*				*					*			
Cycle-time reductions	*		*									*		*				*		
Communication	*	*					*													
Kanban				*	*	*	*					*	*	*					*	*
Throughput time reduction	*					*														
Task rotation					*			*						*		*				
Integrate new technologies	*									*										
Set-up Reduction				*	*		*	*					*	*			*			
Fool proofing									*					*						
Kaizen					*							*	*	*	*			*	*	
TQM			*									*		*						
Preventive Maintenance					*		*	*					*	*	*		*		*	*
Teamwork		*			*	*								*			*	*	*	
JIT	*		*	*	*	*						*			*		*			*
5S													*		*				*	*
SMED													*				*	*		
Quality circles		*								*						*				
Employee's Participation					*			*		*										
Leadership					*						*		*							

Table 3: Appearance of Lean Manufacturing Techniques.

Quality Improvement Tools	No. of	% age Appearance
Lead Time Reduction	9	45
Kanban	9	45
Preventive Maintenance	9	45
JIT	9	45
Set-up Reduction	7	35
Kaizen	7	35
Teamwork	7	35
Reduce WIP	6	30
Lot size reductions	5	25
Training and Education	5	25
Cycle-time reductions	5	25
Group technology	4	20
Task rotation	4	20
5S	4	20
Communication	3	15
TQM	3	15
SMED	3	15
Quality circles	3	15
Employee's Participation	3	15
Leadership	3	15
Throughput time reduction	2	10
Integrate new technologies	2	10
Fool proofing	2	10

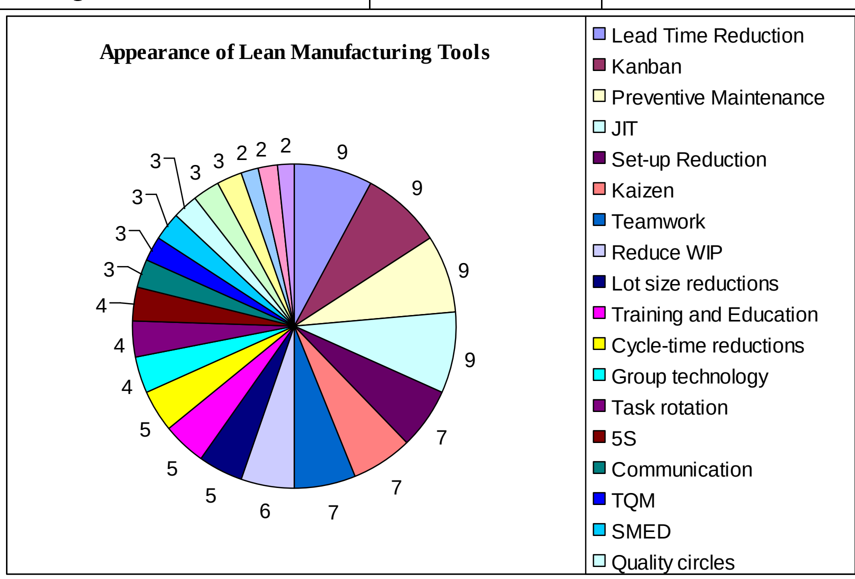

Fig. 2. Pie chart for Lean manufacturing techniques appearance.

IV. CONCLUSION

The strength of any business organization is related to availability of cash. Materials are the major constituent of the products and hence lot of engagement of funds, which need to be controlled for effective functioning. One of the biggest concerns of product manufacturers and company employees is eliminating Lean waste. It is very important to do away with this waste and reduced the cost of final product. Since Quality Improvements in manufacturing industries is a continuous process therefore, the focus is on human resources, waste elimination, costs and simplicity through application of Lean tools. The application Lean tools need a very low investment whereas the results are exuberant in terms of capacity utilization, negligible the rejection and rework including high morale of workforce and the cost savings. In further, these tools help in making the workforce participative and decision making process fast enough to achieve organizational objectives, since the effectiveness of the tools is concerned with the attitude of workforce.

In this paper, literature review on 20 papers published on Lean Manufacturing has been studied and It has been concluded from this paper that the Lean manufacturing tools such as Kanban, TPM, JIT etc. have focused on cost reduction by identifying and eliminating non-value added activities. These papers are either empirical or conceptual or case studies covering a wide range of industries and especially the business houses engaged in manufacture of automotive and plastic components.

REFERENCE

[1] Abdulmalek, F.A.and Rajgopal, J. (2007), “Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study”, *International Journal of Production Economics*, Vol. 107, pp. 223–236.

[2] Achanga, P., Shehab, E., Roy, R. and Nelder, G. (2006), “Critical success factors for lean implementation within SMEs”, *Journal of Manufacturing Technology Management*, *Vol*. **17**, No. 4, pp. 460-471.

[3] Ahlstrom, P. (1998), “Sequences in the Implementation of Lean Production”, *European Management Journal*, Vol. 16, No. 3, pp. 327–334.

[4] Alexander, G.and Williams,J.H.,(2005), “The impact of an accelerated improvement workshop on ordering and receiving”, *Library Collections, Acquisitions, & Technical Services*, Vol. 29, pp. 283–294.

[5] Bhasin, S. and Burcher, P. (2006), “Lean viewed as a philosophy”, *Journal of Manufacturing Technology Management*, Vol. 17, No. 1, pp. 56-72.

[6] Bicheno, J., Holweg, M. and Niessmann, J. (2001), “Constraint batch sizing in a lean environment”, *International Journal of Production Economics*, Vol. 73, pp 41-49.

[7] Burton, T.T., Boeder, S.M. (2003), “The Lean Extended Enterprise: Moving beyond the Four Walls to Value Stream Excellence,” *APICS*, The education society of resource management.

[8] Chen, L. and Meng, B. (2010), “The application of VSM based Lean Production system”, *International Journal of Business and Management*, Vol. 5, No. 6, pp. 203-209.

[9] Comm, C.L. and Mathaisel, D.F.X., (2005), “A case study in applying lean sustainability concepts to universities”, *International Journal of Sustainability in Higher Education*, Vol. 6, No. 22, pp. 134-146.

[10] Conti, R., Angelis, J., Cooper, C., Faraghar, B. and Gill, C.(2006), “The effects of lean production on worker job stress”, International Journal of Operation & Management, Vol. 25, No.9, 1013-1038.

[11] Dangayach, G.S. and Deshmukh, S.G (2001). “Manufacturing Strategy: Literature review and some issue”, *International Journal of Operation and Production Management*, Vol. 21, No. 7, pp. 884-932.

[12] Emiliani, M.L. and Stec, D.J (2005), “Leaders lost in transformation”, *Leadership & Organization Development Journal*, Vol. 26, No. 5, pp. 370-387.

[13] Holmstriim, J. (1994), “The relationship between speed and productivity in industry Networks: A study of industrial statistics”, *International Journal of Production Economics*, Vol. 34, pp 91-97.

[14] Khatri, D., Dhull, P., Kumar, R. and Dhull, V. (2011), **“**Reduce the Work In Progress by using Value Stream Mapping (A Lean Manufacturing Key Tool)”, *International Journal of Mechanical Engineering Application Research*, Vol. 2, No. 2, pp. 78-84.

[15] Kosonen, K. and Buhanist, P. (1995), “Customer focused lean production development”, *International Journal of Production Economics*, Vol. 41, pp. 211-216

[16] Miltenburg, J. and Sparling, D. (1996), “Managing and reducing total cycle time: models and analysis”, *International Journal of Production Economics*, Vol. 47, pp. 89-108.

[17] Moayed, F.A. and Shell, R.L. (2009), “Methodology and theory COMPARISON and evaluation of maintenance operations in lean versus non-lean production”, *Journal of Quality in Maintenance Engineering* ,Vol. 15, No. 3, pp. 285-296.

[18] Moriones, A.B., Pintado, A.B. and Cerio, J.M. (2010),"5S use in manufacturing plants: contextual factors and impact on operating performance", *International Journal of Quality & Reliability Management*, Vol. 27, pp. 217-230.

[19] Murugaiah, U. and Muthaiyah, S.(2010), “Scrap loss reduction using the 5-whys analysis”, *International Journal of Quality & Reliability Management*, Vol. 27, No.5, pp. 527-540.

[20] Olivella, J., Cuatrecasas, L. and Gavilan, N. (2008), “Work organization practices for lean production”, *Journal of Manufacturing Technology Management*, Vol.19, No.7, pp. 798-811.

[21] Pavnaskar, S.J., Gershenson, J.K. and Jambekar, A.B. (2003), “Classification scheme for lean manufacturing tools”, *International Journal of Production Resources*”, Vol. 41, No. 13, pp. 3075–3090.

[22] Pool, A. and Wijngaard, J. (2010), “Lean planning in the semi-process industry, a case study”, *International Journal of Production Economics*,

[23] Riveraa, L. and Chen, F.F. (2007), “Measuring the impact of Lean tools on the cost–time investment of a product using cost–time profiles”, *Robotics and Computer-Integrated Manufacturing*, Vol. 23, pp. 684–689.

[24] Sanchez, A.M. and Perez, M. (2001), “Lean indicators and manufacturing strategies", *International Journal of Operations & Production Management*, Vol. 21, No.11, pp 1433-1451.

[25] Saurin, T.A. and Ferreira, C.F. (2009), “The impacts of lean production on working conditions: A case study of a harvester assembly line in Brazil”, *International Journal of Industrial Ergonomics*, Vol. 39, pp.403–412.

[26] Shah, R. and Ward, P. T. (2007), “Lean manufacturing: Context, practice bundles, and performance”**,** *Journal of Operations Management*, 21 pp.129-149.

[27] Sim, K.L. and Rogers, J.W. (2009), “Implementing lean production systems: barriers to change”, *Management Research News*, Vol. 32, No. 1, pp. 37-49.

[28] Sohal, A.S. (1996), “Developing a lean production organization: an Australian case study”, *International Journal of Operations & Production Management*, Vol. 16, No.2, pp. 91-102.

[29] Warnecke, H.J. and Huser, M. (1995), “Lean production”, *International Journal of Production Economics*, Vol. 41, pp 37-43.

[30] Womack, J.P., Jones, D.T. and Rose, D. (1990), “The Machine That Changed the World”, *Harper Perennial*, New York.

[31] Zapfel, G. (1998), "Customer-order-driven production: An economical concept for responding to demand uncertainty?", *International Journal of Production Economics*, Vol. 56, pp. 699-709.