Lean Implementation in Manufacturing Industries: Benefits & Shortcomings

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Abstract— Manufacturing industries require continuous improvement process to perform better and withstand the intense global competition. Lean manufacturing or lean production is one of the most popular paradigms in process improvement. Lean philosophy is implemented by organizations worldwide but its implantation is snail-paced in India and needs to be augmented. Based on a systematic literature review and by performing a case study on lean implementation, this paper presents a detailed analysis of lean philosophy in manufacturing industries. Numerous benefits and shortcomings associated with lean implementation are explained in this paper. This paper presents the case studies on lean implementation performed by researchers over the years using various tools and methodologies for the review and understanding of most effective lean tools, benefits and shortcomings of lean production system (LPS). The authors have performed and presented a case study on lean implementation in a manufacturing industry to realize its benefits and shortcomings. The proposed work provides required preliminary information for lean implementation in manufacturing industries. Factors that hinder lean implementation are identified which must be sorted for successful implementation of lean principles in any manufacturing organization.

Key words: Lean Manufacturing, Process Improvement, Lean Production System, Benefits & Shortcomings, Kaizan, VSM, Kanban, JIT

I. INTRODUCTION

Due to intense global competition and variable customer demands, organizations need to improve their manufacturing processes and enhance product quality. Process improvement is not a fad but a necessity for the organizations. Organizations confront countless problems while manufacturing their products. Companies around the world are searching for new methodologies to improve their competitive position in the market [1, 2]. Terms like lean manufacturing, world class manufacturing, agile manufacturing, continuous flow manufacturing, and stockless manufacturing have emerged.

Lean manufacturing is defined as a production control technique for eliminating waste in the manufacturing process. It is synonymous to Toyota Production System (TPS). Lean aims at finding better, more efficient ways of accomplishing the same tasks. The motive behind lean manufacturing implementation is to identify and eliminate the non-value adding/ waste activities (muda) at operational level in order to improve the quality of the final product continuously and also to improve the production process so as to make it more efficient [3]. The production processes consist of activities that do not add value to the product, consume time and resources of the organization which leads to greater lead times and increased costs. These waste activities need to be eliminated to reduce cost and time incurred for manufacturing the product. Customer wants value and will pay for the value added to the product as desired. Customer is not supposed to pay for defects or extra cost of having large inventories, i.e., customer is not going to pay for the waste activities of the manufacturing firm. Lean philosophy adopts a customer value focus and asks "What is the customer willing to pay for?" Lean manufacturing leads to continuous improvement of the production processes in an organization. It aims to deliver better quality products at lower cost to the manufacturer and consumer. The ultimate aim of Lean Manufacturing is to speed up the process and increase productivity through proper utilization of firm's resources. Lean production is known as assembly line methodology as it was developed originally for automobile manufacturing in TPS. Lean does not have one particular definition; it is a continuously developing philosophy being applied in different situations and applications. Lean manufacturing has been deployed in various sectors; automobile sector, service sector, schools and hospitals, pharmaceuticals, electronics and electrical components manufacturing, defence sector, management, etc., and demonstrated immense benefits and improvements in radical ways. Removing all types of waste from all functions is the main purpose of the lean [4].

A. Forms of Waste (Muda) Targeted by Lean

In Japan, for product improvement three types of variations are studied. These include; muda, i.e., non-value added waste, muri, i.e., overburdening of people or process, mura, i.e., unevenness or fluctuating production volumes over a time period. Figure 1 demonstrates the waste generated by the three variations and relation between them. Lean manufacturing system considers the waste generated by these variations at workplace. muda means those activities that do not add value to the product during the conversion process; it is not the useless product or scrap. Due to immense competition in automobile industries in Japan, Toyota presented its 'seven waste' concept. Complete elimination of waste and maintaining product flow then started involvement of operations management [5]. Seven major forms [6] of non-value adding/ waste activities are identified. These forms of muda are explained in Table 1.

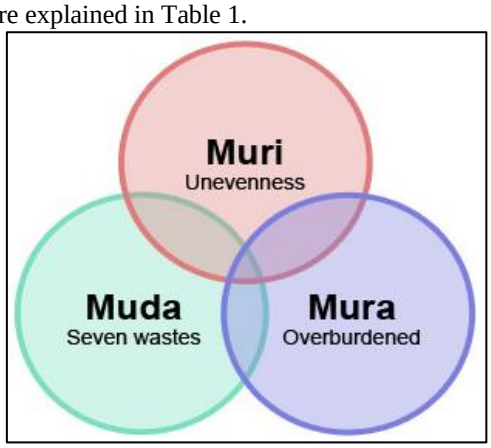

Fig. 1: Types of Variation

Form of Waste	Explanation
Excessive transportation	Transportation is interdepartmental movement of the product during the conversion process; movement beyond required is a muda.
Waiting	The product lead time includes waiting for next operation; value is not added during this period.
Over-production	Producing in quantities more than required by customer is overproduction; it consumes all the resources and time of the industry and gives no profit to the company.
Defects	Defective products would have consumed the organization resources and are a waste as customer is not willing to pay for them.
Unnecessary inventory	Excessive inventory results from overproduction and waiting; it hinders the smooth flow of material, consumes large plant space and increases lead time.
Unnecessary motion	Motion is related to ergonomics as it is related to the worker's limbs movement at a fixed place; any movement which doesn't add value to the product during the process is a waste.
Inappropriate processing	Any work done on the product which is not required by the customer is a muda; it is not going to add value to the product but consuming resources and time.

Table 1: Seven Forms of Waste Activities

These are the most common forms of muda. Any lean system aims for searching these waste activiites, their causes and eliminating them so that process can be improved and efficicency of the system can be enhanced. Some other forms of waste [7] are also identified recently. These forms of waste are explained in Table 2.

Form of Waste	Explanation
Confusion	Any missing or misinformation hinders the smooth working of an organization, thus acts as a source of waste.
Underutilized employee potential	A motivated and positive workforce is the backbone of a successful organization; not utilizing employee's potential is a waste.
Unsafe or unergonomic layout	Plant layout which causes fatigue to the worker and compromises their health affects their morale and thus efficiency of the system.

Table 2: Newly Identified Waste Activities

Elimination of muda is the function of lean manufacturing. It is possible by application of tools of lean manufacturing. Some key lean tools [8] are; 5S, Kaizen, Kanban, six sigma, just in time (JIT) production system, takt time, cellular manufacturing (CM), production leveling, work standardization, total productive maintenance (TPM), value stream mapping (VSM), poka-yoke, visual control, etc.

II. METHODOLOGY

A systematic literature review and a case study performed by the authors are presented to understand the concept, need and practical application of lean implementation in organizations. Literature review is focused on implementation of lean principles in manufacturing industries. Many researchers have worked on implementing lean principles in manufacturing industries using various tools and techniques. These case studies are referred to identify the benefits and shortcomings of lean implementation. After going through the review of literature, a case study on lean implementation in a manufacturing industry is performed to realize the benefits and shortcomings associated with implementation of lean manufacturing.

A. Review of Literature

Case studies of lean implementation performed by researchers using various tools and methodologies have been referred for the review and the understanding of most effective lean tools, benefits and shortcomings of lean production system (LPS). Out of the variety of approaches and methods, we only review the best one here. Information presented here is collected from journals, conference papers, books and internet sources.

Rahman et al. [9] have found that Kanban system is one of the manufacturing strategies besides other techniques like 5S, quality circles, continuous improvement, etc., for implementing lean production with minimum inventory and reduced cost. In this study, authors have performed a case study by implementing Kanban system which led to many benefits like minimized operational costs, wastes, scraps and losses; and controlled over production stocks with flexible work stations. The study also identified the factors that hinder Malaysian small and medium enterprises for implementing lean manufacturing through Kanban. The factors identified are; ineffective inventory management, lack of supplier participation, lack of quality improvement and quality control, lack of employee participation and top management commitment.

Anil S. Badiger et al. [10] performed a case study to determine the areas of improvement in equipment by implementing Kaizen and poka-yoke. The study intends for improving overall performance to enhance the productivity. Why-why method of root cause analysis is used to identify the causes. The OEE is increased from 49.9% to 74.68%. The improved OEE resulted in better utilization of resources, increase in availability, high quality products and also raised employee morale and confidence.

Intra et al. [11] have done thorough literature review and found that basic knowledge about lean production system (LPS) is given but particular methodology for its implementation on daily basis is not given in most of the cases. In this study, authors have talked about the transformation waves for powerful and holistic continuous improvement process (CIP) of a LPS in a case study done at MAN Truck & Bus AG. Transformation waves are employed for continuous improvement on the shop floor on daily basis.

Kumar et al. [12] have done a case study in an automobile company with aim to reduce cycle time of a truck body assembly by application of lean principles. Study was

mainly focused on assembly line. Cycle time reduction was done in two stages; first by line balancing and then by applying lean principles like 5S, VSM, etc. This study helps to identify the waste activities and eliminate it step by step, thereby reducing the cycle time by proper line balancing. In their work, they have increased line efficiency from 17.5% to 30.09%.

Haefner et al. [13] have presented a combined model of classical value stream mapping and quality management to address the issue of quality improvement with cost and lead time reduction in an automotive industry to remain competitive in the market. In quality value stream mapping, in addition of chasing the product, quality defects, quality inspection and quality control loops are also considered. Basically quality is improved simultaneously with waste reduction.

Gracanih et al. [14] have pointed out that only lead time reduction is not sufficient but cost reduction is also imperative for an organization to excel. They have combined VSM which is most efficient tool for identifying non-value adding activities and eliminating them with value stream costing and cost time profile. Value stream costing tries to eliminate the unnecessary cost associated with the processes mapped during value stream mapping.

Deif et al. [15] have assessed lean systems using variability stream mapping. They described two approaches to improve system productivity; one by focusing on waste reduction and increasing the value and quality and another by variability reduction as variability is a source of waste. A new tool variability stream mapping (VSMII) is used for capturing and reducing the variability in the production system as variability degrades the efficiency of a production system. A case study of a slug bracket and assembly manufacturer has been presented in the paper in which an analytical method to capture flow and inter arrival variability between various stations and methods to control it have been presented by applying lean techniques as well as production control policies.

Tyagi et al. [16] have tried to reduce the lead time of a product using VSM for lean implementation. They found that VSM is the most influential and important tool for realizing benefits of lean philosophy in an organization. A gas turbine product was chosen for the study and it was chased on the shop floor to draw the current state diagram. Through brainstorming various wastes and their root causes were identified. After removing the waste, final state map was drawn. It was found that lead time of the product was reduced by 50%.

1) Findings from Review of Literature

The review of literature illustrates that value stream mapping (VSM) is the most essential tool for lean implementation. Using VSM, we can trace the product from the beginning, when it is in form of raw material to the end, when it is ready for dispatch. All the processes associated with manufacturing of product can be observed and then optimized by eliminating muda using other lean tools like Kaizen, poka-yoke, etc. Literature review demonstrates that pull type system eliminates most of the problems that industries confront while manufacturing the products. Just in time (JIT) or Kanban system also lead to immense benefits including enhanced productivity, reduced costs and inventory levels. Implementation of Kaizen and poka-yoke results in increased overall equipment efficiency (OEE), better resource utilization and providing more safety to workers. Line balancing with other lean tools has proven beneficial in increasing line efficiency. VSM combined with quality management leads to waste reduction with improved quality of products and with value stream costing, it tries to remove unnecessary costs associated with the processes mapped during value stream mapping. A new tool variability stream mapping (VSMII) has also been deployed for reducing the variability in the production system to improve productivity as variability is a source of waste. The case studies referred for review of literature suggests that continuous improvement in the processes can improve the organization performance and generate huge profits.

Review of literature also introduces shortcomings associated with lean implementation in manufacturing industries. Manufacturing industries confront various factors that hinder lean implementation in their production system. These factors include; ineffective inventory management, lack of supplier participation, lack of quality improvement and quality control, lack of employee participation and top management commitment. In India, lean manufacturing is being deployed by industries at a very slow pace. In machine tool industries, 30% of industries have tried to implement lean manufacturing but remaining 70% have not implemented it yet. Resistance to change and above mentioned factors are the reason behind this

B. Case Study on Lean Implementation in Manufacturing Industry

The authors have performed a case study on implementation of lean manufacturing principles in an auto industry that manufactures automotive lighting for two wheelers, four wheelers and off road vehicles. Lean principles have been implemented to optimize the lead time of a tail lamp. The aim is to reduce the cycle time of assembly process of the tail lamp. The reason for selection of the product and process is the incapability of industry to fulfil customer demand on-time as cycle time for assembly process is greater than the takt time [17] and there are many waste activities (muda) associated with the assembly process which are increasing the cycle time of the process. These waste activities are needed to eliminate to reduce the lead time of the product. Work study has been performed to observe and record each and every activity of the assembly process. The activities are then deeply analyzed and non-value adding activities are categorized as muda activities. Lean tools like 5S, Kaizen and poka-yoke then implemented to eliminate the identified muda activities. This resulted in reduction of cycle time as the muda activities were consuming time for processing. The optimized cycle time is now following the takt time for assembly process and thus industry is now capable to fulfil customer demand on-time.

1) Findings from the Case Study

Implementation of lean manufacturing to optimize assembly process has resulted in reduced cycle time, throughput time and lead time; reduced costs associated with manufacturing of product; enhanced labour productivity and line efficiency; improved product quality; more safety to workers; on-time delivery and customer satisfaction. The case study performed by the authors emphasizes that continuously identifying muda activities in manufacturing processes and eliminating them by applying

one or more lean tools can help improving the performance of the industry. Implementation of lean manufacturing principles has proven beneficial for the manufacturing industry. The presented case study demonstrates that implementation of lean in a manufacturing industry requires cooperation from shop floor workers to the top level management.

III. Results & Discussions

From the literature review and the case study performed on implementation of lean principles in a manufacturing industry, we can conclude that lean philosophy can prove to be of immense benefits to the manufacturing organizations. Lean implementation intends for identifying and eliminating the waste activities/ muda, thus reducing the consumption of time and resources of the organization. Lean manufacturing principles if implemented continuously can generate huge profits for the industries and can help the industry to perform better. In spite of numerous benefits of lean manufacturing, it is being accepted by industries in India at a very slow speed due to the shortcomings associated with implementation of lean manufacturing. The results of the review of literature and case study performed are presented in terms of benefits and shortcomings of implementation of lean in manufacturing industries.

A. Benefits of Lean Implementation

The benefits of implementation of lean manufacturing principles based on the review of literature and the case study performed are summarized here. Lean implementation optimizes the manufacturing processes which results in:

- Reduced process cycle time
- Reduced manufacturing throughput time
- Reduced manufacturing lead time
- Reduced operational costs
- Reduced equipment
- Reduced inventory levels
- Reduced wastes, scraps and losses
- Better resource utilization
- Increased availability
- Flexible work stations
- Line balancing; workstations synchronization
- Increased overall equipment efficiency (OEE)
- Enhanced productivity
- Improved profits
- Increased line efficiency
- Improved quality of the product
- Continuous improvement process (CIP)
- Production system development
- Safer and cleaner working environment
- Raised employee morale and confidence
- Customer satisfaction; greater focus on desired features and on-time delivery.

B. Shortcomings of Lean Implementation

Shortcomings associated with implementation of lean manufacturing philosophy in industries are summarized here. Factors that hinder implementation of lean in industries are:

- Lack of proper methodology for lean implementation and resistance to change
- Lack of training and knowledge
- Lack of strategic focus
- Lack of top management commitment
- Lack of proper IT systems
- Cost of changing existing systems
- Lack of quality improvement and quality control
- Ineffective inventory management
- Lack of supplier participation
- Employee fear and lack of participation
- Red tapism hinders action and decision making
- Rejection of customer orders requiring immediate delivery due to minimal buffer stocks.

IV. Conclusion

Throughout this paper, authors have studied the lean manufacturing system and tried to present an overview of the benefits and shortcomings associated with its implementation in manufacturing industries. Lean manufacturing philosophy has numerous benefits and organizations need to deploy this philosophy for continuous improvement process and production system development, but its implementation is still in infantry stage in India which needs to be augmented. To contribute some effort to improve the manufacturing processes and to advance the implementation of lean in manufacturing industries in India, authors have presented the study performed by the researchers over the years and performed a case study by implementing most effective lean tools to successfully achieve the desired targets which have proven to be beneficial for the industry. The immense benefits of lean manufacturing and various factors affecting lean implementation in manufacturing industries have been explained. We believe this study will help in successful implementation of lean principles in manufacturing organizations.

References

[1] http://www.managementstudyguide.com/need-for-business-process-improvement.htm
[2] https://kanbanize.com/blog/how-continuous-improvement-can-benefit-your-business
[3] https://en.wikipedia.org/wiki/Lean_manufacturing
[4] Womack, James, P., Daniel, T., Roos, D., 1990, The Machine That Changed the World, based on Massachusetts Institute of Technology.
[5] Hines, P., Holweg, M., & Rich, N. (2004). Learning to evolve: A review of contemporary lean thinking. International journal of operations & production management, 24(10), 994-1011.
[6] Bhasin, S., & Burcher, P. (2006). Lean viewed as a philosophy. Journal of manufacturing technology management, 17(1), 56-72.
[7] http://www.systems2win.com/LK/lean/7wastes.htm
[8] http://www.leanproduction.com/top-25-lean-tools.html
[9] Rahman, N. A. A., Sharif, S. M., Esa, M. M., 2013, Lean Manufacturing Case Study with Kanban System Implementation, International Conference on Economics and Business Research, Vol.7, 2013, 174-180.

[10] Badiger, A. S., Gandhinathan, R., Gaitonde V. N. and Jangaler, R. S., 2010, Implementation of Kaizen and Poka-yoke to Enhance Overall Equipment Performance - A Case Study, Manufacturing and Industrial Engineering, vol. 1, issue 4, 24-29.
[11] Intra, C., Zahn, T., 2014, Transformation-waves–A Brick for a Powerful and Holistic Continuous Improvement Process of a Lean Production System, 47th CIRP Conference on Manufacturing Systems, Vol.17, 2014, 582-587.
[12] Kumar, S. S., Kumar, M. P., 2014, Cycle Time Reduction of a Truck Body Assembly in an Automobile Industry by Lean Principles, International Conference on Advances in Manufacturing and Materials Engineering, Vo.5, 2014, 1853-1862.
[13] Haefner, B., Kraemer, A., Stauss, T., Lanza, G, 2014, Quality Value Stream Mapping, 47th CIRP Conference on Manufacturing Systems, Vol.17, 2014, 254-259.
[14] Gracanih, D., Buchmeister, B., Lalic, B, 2014, Using Cost Time Profile for Value Stream Optimizaton, 24th DAAAM International Symposium on Intelligent Manufacturing and Automation, Vol.69, 2014, 1225-1231.
[15] Deif, A., 2012, Assessing Lean Systems using Variability Stream Mapping, 45th CIRP Conference on Manufacturing Systems, Vol.3, 2012, 2-7.
[16] Tyagi, S., Choudhary, A., Cai, X., Yang, K., 2015, Value stream mapping to reduce the lead-time of a product development process, International Journal of Production Economics, Vol.160, 2015, 202-212.
[17] Ali, R. M., Deif, A. M., 2014, Dynamic Lean Assessment for Takt Time Implementation, 47th CIRP Conference on Manufacturing Systems, Vol.17, 2014, 577-581.

