

## A Literature Review on Lean Implementations – A comprehensive summary

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### Abstract

The available research papers in area of Lean are studied to know the implementation level of different lean tools, barrier and benefits of implementation are also considered in the review. The commonly used lean tools in the various organization, most common barriers and benefits have been identified and listed in this paper. Most common barrier are also components of quality of work life.

**Keywords:** Quality work life, Lean Manufacturing, Toyota production system, Kanban

### I. Introduction

Lean manufacturing is an important tool used across the industries in the recent scenario. At present the industries are facing a higher level of competition because of the globalization. In this context, to remain and compete in the market, companies need to deploy certain tools and techniques which are useful to the uplift their performance and to respond rapidly to the customer's needs. The fundamental concept of lean manufacturing is to provide a quality product while also ensuring that the product does not cost too much to the customer.

In this paper an attempt has been made to present a review of the literature to identify the important and useful contributions to this Lean concept.

Lean manufacturing utilizes a wide range of tools and techniques; the choice of tools is based on the requirement. Many parameters contribute success of lean. Organizations which implemented lean manufacturing have higher level of flexibility and competitiveness. However, lean manufacturing provides an environment that is highly conducive to waste minimization.

### II. Objectives of the Paper:

- To find the level of Lean implementation in different sectors.
- To find out the tool used most and least under Lean implementation.
- To examine the benefits and barriers of Lean implementation in manufacturing.
- To evaluate the implementation of the Lean manufacturing

### III. Results and Discussions

The research papers related to Lean manufacturing from various reputed journals have been considered for the review. After doing thorough study of the Lean implementation, (Annexure 1) the

results of the research papers considered for the review. The considered review papers have been grouped based on awareness about the Lean, lean implementation, Barrier and benefits of Lean and performance. There are quite a good number of studies available in the body of literature focusing on the awareness and Potential for implementation of Lean tool in different sector. The one important such study is discussed below.

**Roba Salem et al, (2015)** studied on the level of recognition of lean concepts, principles, tools, and techniques in different industrial sectors in Qatar, to assess lean awareness and to know the perception about lean benefits and lean challenges. Data were collected from 333 organizations from various sectors like oil and gas, academic institutions and service sectors through an on-line survey. Results showed that industries in Qatar need to give more credit to lean thinking in order to strategically advance current efficiencies as well as cope with competition at global level. Research also reveals that there is a differences on the levels of awareness, recognition and appreciation of lean concepts in different industrial sectors.

**Chaple (2014)** investigate the enablers and barriers in implementing the Lean principles and lean diffusion in Indian manufacturing industries. Result shows that the trend in lean manufacturing for research now is focused on lean assessment. Leanness attracts focus to answer specific questions of different levels of managers responsible for lean implementation to assess the lean implementation level and to justify spending over lean implementation. He worked on multiple criterion decision-making (MCDM) for lean assessment to assess lean performance holistically & popularity of lean in India; but when it comes to success, its only start of journey. Other than automobile and

electronics industry, others are having medium to low diffusion of lean in India.

**Pratik Chikhalikar (2015)** study focused on the implementation of the lean in the engine manufacturing unit in India. Research identified the important lean tools and time horizon to implement the same. Study revealed that following factors effects on lean implementation they are 7 Types of waste, Lack of information transmission, Improper inventory management, Bottleneck operation, Material flow and transportation problem, JIT, Kanban, Kaizen, TPM, 6 sigma, 5S, Single Minute Exchange of Die.

**Rakesh kumar and vikas kumar (2015)** conducted a study to establish the significance of Lean Manufacturing elements related to Indian manufacturing industry, study also list the benefits gained-, major obstacles faced- and identifies the adverse impact such as over cost cutting, exceptionally low inventories, over dependence of Lean guideline, physical and mental health, society, product quality.

**Sudipta Chowdhury (2015)** conducted a study to improve the productivity of the furniture manufacturing industry in India. Various lean strategies such as Single-Minute Exchange of Dies (SMED), Gemba (The real place) and Short Interval Control were implemented. Result revealed that significant improvement in both monetary terms and also in reduction of processing time of different lots. Study also reveals that Overall Equipment effectiveness increased in a higher multifactor productivity of 2.26. It was realized through this study that lean strategies can successfully be implemented in furniture manufacturing industry.

**Youssef Larteb et al (2015)** study identified that success parameters of lean implementation are top management engagement, commitment, allocation of time and resources for improvement projects, strong management's leadership, and employee's development program. Study used a structure questionnaires' it includes seven parameters of lean implementation they are, personalized demarche, top management commitment, allocation of resources, strong communication, structural methodology, multifunctional teams, and continuous performance measurement.

**Neha Verma et al (2015)** conducted a study to identify waste related problems like cause of equipment failure, bottleneck problems and rectify them in lean manufacturing implementation in small scale industries. Process was analyzed in concern with rejection control, inventory control, waiting

time, set time and eliminating non value added time / activities. In this study no new machines were purchased nor were operators expected to work faster or harder; only procedures and layouts were changed to allow the product to flow more smoothly through the manufacturing process.

**Nordin Norani et al(2010)** research identified the, main reason for failure of implementation of Lean manufacturing is due to the letdown in managing the change process during a lean manufacturing transformation, organizational change management. Serve as the basis for further empirical research and validation. Provide practitioners with a better understanding of lean transition and unambiguous guidance, and/or tools to minimize the resistance and conflicts of implementing a lean manufacturing system. In the present research 11 critical factors were studied, and proposed framework of organizational change is intended to provide practitioners with a better understanding of the lean transition and a clear guidance to minimize the resistance and conflicts for the implementation of lean and thus improves its chance of success.

**Azharul Karim et al (2013)** conducted a research to develop an effective methodology for implementing lean manufacturing strategies and a leanness, following are the methodology are adopted for the present study they are Production and process details, Lean team study, Performance variables. VSM and MTM together and offered a new approach to reduce lead time and to measure productivity based on Lean principle and standardized processes.

**George L. Hodge et al(2011)** conducted a research to identify lean tool for textile industries to eliminate waste and non-value added activities in US to enhance the customer satisfaction, Author identified the following barriers for implementing lean manufacturing they are resistance to change both shop floor employees and management; shop floor employees are reluctant to offer suggestions for improvements; disconnect among marketing, sales, product and development; shop floor personnel are not native English speakers; so training needs to be multilingual.

**Richard lee Storch et al (1999)** paper deals with, lean ship production requires continuous and uniform process flows, build strategies must be established and followed which reflect the proper work breakdown, especially block breakdown, even at the expense of design convenience ( design for manufacturing) .It involves integration and balance between hull, outfit, and painting work; facilitation of continuous and uniform work flows within manufacturing levels; maximum use of group

technology advantages. Three metrics are proposed to monitor lean process flows in ship production are: work-in-process (WIP) inventory level; leveling factor index; and throughput.

**Giuliano Almeida Marodin et al (2015).** Study reveals, there are seven factors that affect the use of LP practices in Manufacturing Cell (MC): (i) the reason for adopting LP, (ii) the experience of the company with LP, (iii) the need for involvement of the supporting areas in some LP practices, (iv) the interdependence of some practices, (v) the variety of product models produced bin the MC, (vi) the synergy between LP and MC attributes, and (vii) the size of the equipment used in the MC. Qualifying attributes for LP in MC are 1. Team work and leadership (TWL), 2. CI-continuous improvement, 3. MCT- Multi functionality and cross training. 4. WAU-Worker's autonomy. 5. STW-Standardized work, 6. WHK Work place housekeeping, 7. PULL-Pull production, 8. SPR-Smoothed production, 9. QST-Quick setups, 10. TPM, 11. LME-Lean Performance Metrics, 12. VPC-Visual mgt of production control, 13. VQC-Visual management of production control. 14. EQA- Equipment automation, 15. ONE-One piece flow, 16. VIS-Visibility and information exchange. 17. LSS-Layout size and shape. 18. ODF-Organization by the dominant flow.

**Anna Dorota Rymaszewska (2013)** The drive of this research is to identify the lean manufacturing implementation challenges in small and medium enterprises (SMEs). By comparing the different manufacturing environments as well as organizational characteristics, the potential challenges of lean adoption are outlined. "Doing more with less." Compares between the two industries of boat and furniture. Also considers internal operations/ like Standardization, Material replenishment, Work load leveling, QA, Visual control, Reliable technology. Research identifies Influencing factors as philosophy, know how, Employee relations, communication, financing, value creation, organizational learning, Hijunka and JIT, and Internal implementation facilitating/ reinforcing factors are communication, partner/suppliers, quality. He adds, 1. The challenge of Long term orientation, 2. The challenge of becoming a learning organization, 3. The challenge of leveling out workflow. 4. Supplier buyer relations and JIT. 5. Employee empowerment and standardization of the work procedures. The validity of the findings can be improved by adding more empirical evidence.

**Vinodh et al (2011).** The purpose of this research is to analyze lean manufacturing practices in different industries and to identify the critical factors for its

success implementation. A Structural Equation Modelling technique is used to build the measurement and structural models. Later, statistical estimates are used to validate the model that has been built. For data collection a questionnaire was prepared based on four enablers, namely management responsibility leanness, manufacturing management leanness, manufacturing strategy leanness, and technology and workforce leanness. The current study also calculated the R2 value, which also indicates a good deal of influence yielded by management responsibility leanness, manufacturing leanness, manufacturing strategy leanness, and technology and workforce leanness on organizational performance. Finally totally committed management, highly trained, motivated and empowered employees working in a team. Internal integration of operations with suppliers and customers. Promotion of creativity and innovative culture. Streamlining of processes and waste elimination are the important parameter for lean implementation.

**Dave et al(2015)** study deals with Lean Construction along with information and communication systems. Study reveals that by adopting techniques such as process modelling, lean principles and process analysis techniques, the manufacturing industry maintains a well performing process.- process standardization across the industry will highly effective and efficient.

**Rakesh et al (2014)** Study identified that though the implementation of lean manufacturing can improve the organizational performance, but still most of the Indian industries currently use as improvement tool instead of adopting this concept as a culture. If focus on full scale as organizational culture it can produce significant improvement overall performance. The principal implications are, Batch production method is replaced with one piece or single piece flow method, Scheduling is done at one point from where material is pulled throughout the value stream and rate of flow depends on demand from customer, There is lesser material in waiting for processing between work stations; hence work in process (WIP) inventory is reduced, Inspection becomes an integral part of production activities hence product is not waiting for quality approval from line inspector, Reference for manufacturing is changed from production and Supply to customer demand. Mainly Top management issues for lean implementation is also very important and top management policies and attitude towards lean implementation need some improvement in Indian industries. Research suggest the seven major attributed barriers of LPI are Management, Resource, Knowledge, Conflicts, Employee morale, Financial, Past experience. Out of this Top management is rated 3.9/5 and others are

less. Also suggests supposed to initiate the awareness and participation of senior leadership team to create learning culture within the organization and develop effective communication to organize transformation in the industry with the help of effective implementation of Lean Manufacturing.

**Giuliano Almeida Marodin et al(2014)** conducted a research to classify the risks that affect the lean production implementation process and to demonstrate how that classification can help to identify the relationships between the risks. Researcher used multiple sources of evidence for the present study such as interviews, observations and documents analysis. In this study risks that affect LPI were grouped into three categories: management of the process of LPI, *top* and middle management support and shop floor involvement. Mainly classification and relationship between risks were given major importance. 14 risks were identified, the collected data was analyzed using an exploratory factor analysis (EFA). The limitations of this study should also be emphasized. First, it did not include external risks in LPI, but only internal ones. Second, it does not deal with two risk management stages: response and monitoring.

**Rahul Sindhwani et al (2015)** study reveals that, LI will improve the manufacturer and consumer relation by meeting the latest demand of consumers. Typical seven parameters like Overproduction, Processing Waste/over processing, transportation, Waiting/delays, Inventory waste, Motion waste, defects are used. Follows tools and technique for eliminating wastes were- Pull system/KANBAN, VSM,5s, By applying the lean and agile principles of one piece flow, pull system and value streaming the production rate of the lower frame was increased. The pull system utilized to understand that there is need to increase the production rate. VSM was done to identify the constraints and one piece flow to achieve the required cycle time.

**Ramune Ciarniene et al 2014** research reveals the challenges and barriers to be faced and overcome while implementing lean concept. Lean enterprise or simply "Lean", is a practice, which regards the use of resources for any work other than the creation of value for the end customer, as waste, and thus a target for elimination. Research depicts the following three types of barriers they are the people issue, The process issue, The sustainability issue. Study suggested that first use the tools and techniques instead of sufficient consideration to personally related issues. Trust issue, human motivation and commitment are the real constraints. Secondly clearly understood by top management maintained properly, thirdly, LI have to be incorporated into the

company's strategy. Concluded remarks- specific value to the customer, VSM waste elimination, CI, continuous flow and pull driven system.

**Eida Nadirah Roslin et al (2014)** Studies suggests, LM approach does not allow these organizations to fully explore and exploit the system's effectiveness; neither do they experience any massive improvements when measured against L M success standards. Up to so many days pick and choose concept were used, The Obstacles of LMI Grouped in to 3 levels, attitude of shop floor employees and middle management, Inability of quantify benefits, and Lack of top management/Senior management commitment. Conceptual model of full blown Implementation of LMS-Influence factors, Lean Manufacturing and Organizational performance. Here implementation difficulties, perceived barriers, work culture, monetary restraints, knowledge and its understanding at every level.

**Nirav Patel et al (2015)** LM can be considered as a business strategy and it has been proved to be an effective management philosophy for improving business by eliminating non value added waste and improving in process operations.VSM can be an extremely powerful tool, combining material processing steps with information flow as well as other important related data. Parameters used were Cost Rate, Material Cost, Duration (min), and Predecessors, its inter relationship between them with the money and time. Application of tools were Process activity mapping, Demand amplification mapping, quality filter, production variety funnel, value adding time profile and related parameters. VSM works in any of the sector such as hospitality, manufacturing, service industry, automobile, machining and casting, transportation etc.

**Shams Rahman et al (2010)** purpose of this research is to examine the extent to which LM practices are adopted by manufacturing organizations in Thailand and their impact on firms' operational performance. The operational performance is measured by four parameters such as quick delivery compared to competitors, unit cost of products relative to competitors, overall productivity and customer satisfaction. Results indicate that three constructs play a vital role- JIT, Waste elimination, Flow management. It identified 13 out of 21 practices as the lean practices such as (1)Reducing production lot size; (2) reducing setup time; (3) focusing on single supplier;(4) implementing preventive maintenance activities;(5) cycle time reduction;(6) reducing inventory to expose manufacturing, distribution and scheduling problems; (7) using new process equipment or technologies;(8) using quick changeover techniques;(9) continuous/one piece

flow; (10) using pull-based production system/Kanban;(11) removing bottlenecks; (12) using error proofing techniques/Pokayoke; and(13) eliminate waste. Using multiple regression models the effect of LP on operational performance were investigated for both categories of firms – size and ownership. Companies appear to be maintaining a higher level of supply of materials and a higher level of finished products to satisfy both internal and external customers and are not totally becoming lean in their operations.

**Kashif Mahmood(2014)** research aims to provide a better understanding of LP approach in order to enhance productivity, reduce cost and maximize customer value while minimizing waste during the production processes. "Productivity is a relationship (usually a ratio or an index) between output (goods and/or services) produced by a given organizational system and quantities of input (resources) utilized by the system to produce that output". The input are usually classified as labor, capital, material (inventory) and energy. Successful lean efforts are – Quality, Cost, Flexibility, Delivery reliability, Delivery time. Other factors that makes lean more effective and related to strengthening the workforce's welfare, driving force, motivation and influence. Examples-Reduced stress, Increased competence, Improved cooperation, Reduced Frustration, Improved customer communication, Broader and more developing tasks, Improved safety at the workplace, Job Security. People must be ready to change the whole organization, not only production lines. Sales, Logistics, Marketing, Product development departments will be affected by this change and if one of them does not follow, Lean will not sustain.

**Natasa Vujica Herzog et al(2014)** the results shows that the developed variables can be important both for understanding 'lean' and measuring the degree of lean implementation within existing manufacturing systems. Research divided in to three phase 1.An analysis of existing literature was made to determine the major dimensions of LM manufacturing; 2.a questionnaire was designed, pre-tested on experts and pilot- The questionnaire contained 59 items, designed according to the Likert scales, ranging from 'strongly disagree' to 'strongly agree'; 3.The resulting data were examined through reliability and validity analyses, and then analyze. Three different types of validity are typically measured: content validity, criterion related validity, and construct validity. JIT ascribed to lean by four variable: the existence of on time deliveries, cooperation of the suppliers, a reduced number of parts and cleanliness inside the plant. The other two variables employee cooperation and team.

**Gulshan Chauhan et al( 2012)** research depicts about, Elimination of waste, JIT, and CI. Driving parameters towards LM are vertical information system, integration of functions, decentralization, multifunctional teams, Pull, JIT deliveries, zero defects, CI and Elimination of waste. JIT is top priority, then CI. He follows SPSS correlation method to find the importance of implementation.

**Naga Vamsi Kishna Jasti etal 2014** research identifies the existing lean product development frame work that is useful in implement LMS. Researcher done validity and reliability analysis using questionnaire survey. Respondents are from Top and middle level management determined through Cronbach's alpha value. The LPD framework can be categorized under two broad areas, namely: 1. researcher/academic-based; 2. consultants/experts-based. The study has identified 40 elements from eight frameworks, which reflects these are playing an important role in the implementation of LPD frameworks.

**Mohammad Said Obeidat et al (2014)** research identifies five types of waste are identified and analyzed in the sewing line with the aid of VSM: defects, inventory, overproduction, transportation, and waiting time. Applied lean manufacturing techniques include line balancing, layout redesign, and quality at the source. Impacts of implemented lean techniques on production are analyzed, and an improved future-state value stream map is developed. Results show approximately 96% reduction in production wastes in addition to 43% reduction in lead time. Here process measures must be defined and the cost of processing must be quantified. Line productivity is based on the number of line workers and product cycle time. To increase workers' productivity, calculates Line target, work station target and work efficiency will be done separately. using this cost per hour calculates. Line balancing concept is test for each line, redesign of the layout will be done. LP without high investment in machining, technology, or human training.

**Wagner Cezar Lucato et al (2013)** study explore the Lean implementation performance- considered 51 industries of different sizes, from several industrial segments, nationals and multinationals, utilization of two concepts: the degree of leanness (DOL) of an element of J4000 and DOL of a company, Also three hypotheses were tested, trying to establish the relationship among the DOL and firm ownership, their size and respective industrial sector. Briefly discuss the benefits and limitations of LI. Element studied are Management/trust, People, Information, supplier/organization/customer chain, product and

process flow. The validity of DOL measurement used here should be verified by further research comparing with it with similar LI measures that are already there.

**David D. Ciemnoczowski et al (2013)** research suggests, In LM, milk run (MR) systems represent route-based, cyclic material handling systems that are used widely to enable frequent and consistent deliveries of containerized parts on an as-needed basis from a central storage area to multiple line sided deposit points on the factory floor a central storage area (the ‘supermarket’) to multiple line-side deposit points on the factory floor. Here Kanban with simulation method followed to work on bottleneck stages. If a single tugger does not meet the demand on a particular route, an alternative solution that is also found in practice is to add more tuggers to the same route, which leads to the ‘chase method.’ The dynamic interaction between the tuggers serving the same route, and their impact on WS starvation, would also be a promising avenue for future research.

**Sourabh Sharma(2014)** main goal of study the potential benefits and limitations of lean standards and certification and analysis that whether the standardization would be helpful in implementing lean principles or not, so before starting the surveying; Company should first know the opinion from lean practitioners about how standardization will help to eliminate major problems in implementing the lean tools and their principles. Through survey, they have a chance to quantify various motives and objectives of individual industry and lean professionals. The biggest problem in lean

implementation- Lack of implementations know-how, Middle management resistance, Employee resistance. Sources for survey distributions-Lean organizations, Corporations, Online sources and other sources( Industry magazines, authors, academics, Personal contacts). Among group managers 50%, 24% staff,11% senior management, directors 8%. Introducing lean standards more difficult, participants from companies with less lean experience show higher support for standardization, more experienced companies are less supportive about standardization. There is less consent on the benefits of Lean certifications for individuals.

**Pius Achanga et al (2005)** research identified the critical factors that constitute a successful implementation of LM within manufacturing SMEs. Leadership, management, finance organizational culture and skills and expertise, amongst other factors; strong leadership and management permeates a vision and strategy for generating, while permitting a flexible organizational structure. Good leadership ultimately fosters effective skills and knowledge enhancement amongst its workforce.

Form the available literature it is clearly concluded that some of the lean tool like Standardizing Work/ cycle reduction, Kanban, continuous smooth flow/ cell design, Value stream mapping, TPM/TPS,JIT, Kaizen, SMED-Single Minute Exchange Die, Poke yoke, Visual Management/Control are most commonly used lean tools across the various sectors. Table 1.1 depicts the frequency of different lean tools used by the organization.

Table 1.1 Lean tools studied by Researchers.

Tools	Number of research papers.	Tools	Number of research papers.
Standardizing Work/ cycle reduction	23	Cellular Manufacturing	7
Kanban	22	Cycle reduction	7
Continuous smooth flow/Cell design	19	Heijunka-Lead scheduling/ Re Engineering Production Process	7
Value stream mapping	17	One Piece flow	6
TPM/TPS	16	FMS/PDCA	6
JIT	16	Batch size/Volume Reduction	5
5 S	16	Empowerment	4
Kaizen	16	Safety improvement program	4
SMED-Single Minute Exchange Die	14	Layout Improvement	4
Poke yoke	12	Takt time	3
Visual Management/Control	12	Cross training	2
TQM/ SQC/ Gemba/ QMS	12		

Form the available literature it is clearly concluded that main benefits of lean implementation are Reduction of waste, Inventory reduction, Productivity, cost related parameters, Effectiveness etc across the various sectors. Table 1.2 depicts the frequency of benefits of lean implementation identified by the different researchers.

Table 1.2 Lean implementation Benefits.

Benefits	Number of research papers.	Benefits	Number of research papers.
Reduction of Waste	24	Improved flexibility	5
Inventory reduction	19	Travel distance (Material movement)	3
Productivity	13	Lead time	3
Costs related parameter	11	Profit maximize	3
Effectiveness	11	Set Up time reduction	2
Improved Quality	10	Improved Cash Flow	2
Cycle time	9	Safety of working conditions	1
W I P	6	Internal Promotion	1
Floor space	5	Efficiency	1

Form the available literature it is identified that some for the barriers for the implementation of lean tools are Management Involvement, Employee involvement, communication, Lack of training, culture issues etc. Table 1.3 depicts the frequency of different barriers for lean implementation identified by the researchers

Table 1.3 Barriers for Lean implementation

Barriers	Number of research papers.	Barriers	Number of research papers.
Management involvement	22	Past Experience	7
Employee involvement	20	Resources utility	4
Communication	14	Knowledge	4
Lack of training	12	Budgets	4
Culture issue	10	Scared of failure	4
Lack of Know how	10	Conflicts	2
Financial	7	Improper Utilization of potential capacity of workers	2

#### IV. CONCLUSION

Lean is applicable for all the type of the organization irrespective of their size, lot of work has been carried out in manufacturing sector that to in different functional areas, the level of implementation varies across the sectors and their size. It is evident from the research paper studied that kanban, continuous flow and TPS are the most commonly used lean tools in the organization. The Reduction of waste, Inventory reduction and Productivity improvement are commonly cited benefits across the lean implemented firms. Apart from these management of employee involvement are the most commonly cited barriers across the implemented organization. These parameters are also component of the quality of work life, so it can be concluded that QWL needs to be studied across the lean implemented firms in order to get higher light on the issue also to reveal the linkage between QWL dimensions with the lean implementation.

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