

Lean Practices in Small and Medium Manufacturing Enterprises – A Structured Literature Review

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Abstract: Small and Medium Manufacturing Enterprises (SMMEs) today need to be highly performance oriented and effective to fulfill their role as important links in supply chains. To do this, there is a need for them to become lean. Lean is a philosophy which focusses mainly on the identification and elimination of waste from a system or process, thereby making it more efficient. There are numerous lean practices which have proven successful. However, SMMEs are usually constrained financially and resource wise. It is, therefore, not possible for them to adopt all of the lean practices that bigger organizations can. Various practices of lean specific and applicable to SMMEs like Kanban, Continuous Improvement, JIT, TPM, 5S etc. help to achieve this leanness. The objective of this paper is to understand the different aspects of lean manufacturing as a philosophy as well as a system and how it can be applied and practiced specifically for Small and Medium Manufacturing Enterprises. The paper discusses the goals, the practices and tools, the benefits and the barriers to implementation, in general as well as for SMMEs specifically.

1. INTRODUCTION

In today's world of manufacturing competitiveness, every organization needs to adapt and practice systems that help it to deliver its products with higher efficiency, higher productiveness and lower costs. The philosophy of Lean and its practices have emerged as one of the most successful and widely used systems in today's world. Many researchers around the world have recommended Lean as a very effective system for making an organization better and more capable. Papadopoulou&Ozbayrak (2005) [33] suggested that lean manufacturing could be a cost reduction mechanism and if well implemented, will be a guideline to making an organization world class. According to

Dankbaar (1997) [15], there is no alternative to lean manufacturing. In theory, lean manufacturing can be applied to all industries (Billesbach 1991 [8], Womack et al 1990 [51]).

Lean as a philosophy illuminates and eliminates non-value adding steps. When applied properly, Lean methods will make any shortcomings in the system appear quickly and they will have a profound impact (Bhasin, 2011, [40]). The main goal of a lean manufacturing system is to produce products of higher

quality at the lowest possible cost and in the least time by eliminating wastes (Dennis, 2007, [16]). The ultimate goal is the elimination of waste, as it can account for between 55% and 95% of the manufacturing process (Bicheno et al., 2009, [7]).

Small and Medium Manufacturing Enterprises (SMMEs) are an integral part of the Indian economy, contributing significantly to the economic development of the country. However, globalization has thrown the Indian Industries against a competitive market, where imported products and multinational companies are the biggest threats. To combat this, SMMEs have to come up with ways to personalize the customer experience while getting close to the customer as well. This is in addition to them adopting the lean philosophy to deliver their products more efficiently and with higher productivity. A wide range of practices specific to SMMEs like JIT, Kanban, TPM, Total Quality Control etc. have been suggested to bring about the leanness required. Consequently, these practices aid to reap the benefits that lean proponents advocate; namely shorter cycle time, shorter lead times, lower WIP, faster response time, lower cost, greater production flexibility, higher quality, better customer service, higher revenue, higher throughput and increased profit (Bhasin, 2011, [40]).

2. LEAN MANUFACTURING

The concept of lean manufacturing was introduced in Japan, and Toyota was the first to use lean practices in the form of the Toyota Production System. Lean is a production practice that integrates a manufacturing system comprised of principles, practices and techniques (Karlsson& Ahlstrom, 1996, [25]). It considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target for elimination. Thus, the objective of lean is to identify and eliminate waste throughout the organization from ordering raw materials to delivering goods to customer (Ahmad Nasser Mohd. Rose et al., 2009, [3]). Simply put, Lean is the set of "tools" that assist in the identification and steady elimination of waste.

Essentially, lean is centered on preserving value with less work. The core idea is to maximize **customer value** while minimizing waste. Simply, lean means creating more value for customers with fewer resources. This is accomplished by eliminating waste along entire value streams and creating processes that need less human effort, less space, less capital, and less time. Lean manufacturing when implemented successfully results in an increase in production output per person and a reduction in the finished goods inventory and work in process (Seth & Gupta, 2005, [41]).

Karlsson & Ahlstrom (1996) [25], outlined the following nine principles which they deemed necessary in assessing lean performance:

- i) Elimination of waste
- ii) Continuous improvement
- iii) Zero defects
- iv) JIT deliveries
- v) Pull of materials
- vi) Multifunction teams
- vii) Decentralization
- viii) Integration of functions
- ix) Vertical information

3. SMALL AND MEDIUM MANUFACTURING ENTERPRISES

Small and Medium Manufacturing Enterprises or SMMEs are one of the most important links in supply chains today. They are responsible for driving the competition and innovation in any economy. They form the backbone of a country's manufacturing industry. Even though they face stiff competition from large organizations, they are essential components in a supply chain. To survive the manufacturing race of today, there is a dire need for SMMEs to go lean and practice lean tools and philosophies as soon and as much as possible. The definition of SMMEs vary widely. According to the Development Commission, Govt. of India, Small Manufacturing Enterprises are those where the investment in plant and machinery is more than 25 lakh rupees but does not exceed 5 crore rupees. Medium Manufacturing Enterprises are those where the investment in plant and machinery is more than 5 crore rupees but does not exceed 10 crore rupees. The European Commission has defined SMMEs on the basis of the number of workers. Small Manufacturing Enterprises can employ up to 50 workers. Medium Manufacturing Enterprises can have up to 250 employees. Researchers agree that there is a real potential for implementing Lean philosophies and practices used by large organizations in SMMEs, although there may be a need to tailor some practices while implementing them. Various barriers may arise as well. According to Achanga et al. (2006) [2], there are four main factors which decide the success of lean implementation in SMMEs:

- Leadership and management
- Financial strength
- Organizational structure
- Skill and expertise

4. LEAN PRACTICES IN SMMEs

There are numerous Lean tools and practices that proponents advocate. Among the most popular are practices like Quick Changeover techniques, JIT, Lot Size reduction, TQM, Self-directed work teams, Small Lot, Continuous Improvement, Focused Factory etc. Gupta & Jain (2013) [43], in their paper, highlighted the following steps for implementing lean manufacturing in an organization:

- Identification of wastes in the system.
- Recognize the types of waste and their causes. Lean manufacturing believes in treating the causes and curing the problems permanently. There are various tools and techniques that are quite helpful in reducing or eliminating these types of waste.
- The next step is to find the solution for the root causes. One must stick to basic lean concepts to identify the root causes.
- The final step in the lean implementation process is to find the solutions and test the solutions first. Once solutions are tested then they should be implemented.

Usually, researchers in the field suggest that all of the lean practices be applied in large organizations. In fact, evidence does suggest that when organizations applied most or all of the lean practices, there was a greater improvement in performance than when only a few practices were applied. However, in the case of SMMEs, it is not feasible for them to implement all of the Lean practices, mainly because of financial constraints. According to Lee (1997) [28], SMMEs should strive to apply only the feasible practices, now all the tools at once. This view was supported by White et.al (1999) [49] in their publication.

The following are among the most common Lean practices and tools for SMMEs that different authors have highlighted:

Table 1. Various Barriers that different authors have highlighted.

Sl.	Barriers	Authors
1	Just-In-Time (JIT):	Burcher, P. et.al (1996), Gupta & Jain (2013), Karlsson and Ahlstrom (1996), Upadhye, N. et.al (2004), Womack, J.P. and Jones, D.T. (1996).
2	Kanban	Ahmad Nasser Mohd. Rose et al.,

		(2009), Burcher, P. et.al (1996), Gupta & Jain (2013), Lee, C.Y. (1997), Mclachlin, R. (1997), Shah, R. and Ward, P.T. (2003), Upadhye, N. et.al (2004), White, R.E. et.al (1999), Womack, J.P. and Jones, D.T. (1996).
3	5S	Ahmad Nasser Mohd. Rose et al.(2009), Bhasin (2011), Burcher, P. et.al (1996),Gupta & Jain (2013), Lee, C.Y. (1997),Upadhye, N. et.al (2004), Upadhye, N. et.al (2010).
4	Total Productive Maintenance (TPM)	Burcher, P. et.al (1996), Lee, C.Y. (1997), Upadhye, N. et.al (2004), White, R.E. et.al (1999).
5	Continuous Improvement or Kaizen	Bhasin (2011), Burcher, P. et.al (1996), Hopp, W., & Spearman, M. (2004), Gupta and Jain (2013), Mclachlin, R. (1997), Shah, R. and Ward, P.T. (2003), Russell, RS and Taylor, B.W. (1999), Upadhye, N. et.al (2004), Upadhye, N. et.al (2010).

1. **Just-In-Time (JIT):** This is one of the most vital Lean tools in a manufacturing organization. As stated by Gupta & Jain (2013) [43], JIT is a tool of lean manufacturing that stands on the pillars of successful planning and the execution of events necessary to produce a final product. Karlsson and Ahlstrom (1996) [25] have suggested that each event and process should be processed in the right form, in the right necessity to produce goods and with the right timing. Basically, JIT ensures that there is a continuous movement/flow of product and information through the system. JIT sets out to cut costs by reducing the amount of goods and materials a firm holds in stock. JIT involves:

- producing and delivering finished goods 'just in time' to be sold
- partly finished goods 'just in time' to be assembled into finished goods
- parts 'just in time' to go into partly finished goods
- materials 'just in time' to be made into parts.
- The principle that underlines JIT is that production should be 'pulled through' rather than 'pushed through'. The ultimate objective is to provide every process with one part at a time, exactly when there is a need for that part.

2. **Kanban:** The principle of Kanban is based on JIT. However, the implementation of the techniques is slightly different. Kanban is a simple parts-movement system in which material movement between workstations in a production line is based on cards. In its simplest incarnation, a Kanban system consists of a big board on the wall with cards or sticky notes placed in columns with numbers at the top. The cards represent work items as they flow through the development process represented by the columns. Limiting the amount of work-in-progress (WIP), at each step in the process, prevents overproduction and reveals bottlenecks dynamically so that they can be addressed as soon as possible. Thus, a supplier should only deliver parts to the production line as and when they are required, so that there is no storage of parts in the production area, which is the basic need of the Kanban system.

3. **5S:** This is a system used in workplaces for organizing and maintaining a productive work environment. The system uses a list of five Japanese words, all beginning with S, to efficiently organize the workplace. The phases in 5S are:

- Sort: eliminate unnecessary obstacles to ensure smooth flow
- Systematize: maintain a system so that everything is within easy reach
- Sweep: keep the workspace clean and tidy
- Standardize: have a definite system for maintaining the workspace
- Sustain: maintain the high quality of the workspace

According to Gupta & Jain (2013) [43], 5S is the basic starting tool used to make companies neat and standardized. Increase in safety levels, cleaning of workspace, enhanced productivity and preventive maintenance are some of the results of a 5S program.

4. **Total Productive Maintenance (TPM):** TPM is a holistic approach to equipment maintenance that strives to achieve a perfect production environment. This entails no breakdowns, no small stops or slow running and no defects. The goal is to keep all equipment in top condition to avoid breakdowns and to get operators involved in maintaining their own equipment and emphasizing preventive and proactive maintenance. There are many steps involved in implementing a TPM plan in an organization:

- Introduce the idea and launch a formal education program for employees.
- Establish the basic plan to deploy the system.

- Improve the effectiveness of each piece of equipment. A project team can do this to identify exactly where the defects are and how to improve them.
 - Develop an autonomous maintenance program for operators. This is to give the operators more freedom and greater responsibility in operating their equipment.
 - Develop a planned or preventive maintenance program. This means to schedule maintenance tasks based on predicted and/or measured failure rates. This significantly reduces instances of unplanned downtime.
 - Develop a quality maintenance program. This is to design error detection and prevention into production processes.
 - Develop an early equipment management program. This directs practical knowledge and understanding of manufacturing equipment gained through TPM towards improving the design of new equipment.
5. **Continuous Improvement or Kaizen:** Gupta & Jain (2013) [43] suggested that Lean be viewed as a CI process. Continuous Improvement (CI) means that organizations should run on activities that strive to continually improve all functions, involve everyone from top management to the bottom layer and ultimately, eliminate all waste from the system. Continuous Improvement is a very important tool in lean manufacturing because it is used in every other lean practice to aid it. The philosophy of Kaizen is also based on the concepts of the continuous improvement system. These methodologies include lean manufacturing, six-sigma, lean six-sigma and the balance score card. It was found by Hopp and Spearman (2004) [22] that continuous improvement efforts are means to achieve high levels of pull production (production is based on actual daily demand) through eliminating variability in the system and thereby reducing defects in the organization.

5. BENEFITS OF LEAN

Numerous benefits of the Lean system have been advocated by researchers. They have been variously categorized as well, from operative to administrative to specific benefits for SMMEs. According to Bhasin (2011) [40], shorter cycle time, shorter lead times, lower WIP, faster response time, lower cost, greater production, flexibility, higher quality, better customer service, higher revenue, higher, throughput and increased profit are some of the typical improvement from implementing Lean.

The following are the various benefits of implementing Lean systems that different authors have highlighted:

Table 2. Various Benefits that different authors have highlighted.

SI	BENEFITS	Authors
1	Improvements in Quality	Alukal, G., & Manos, A. (2002), Bhasin (2011), Ferdousi, F. and Ahmed, A. (2009), Hines, P., Found, P. et al. , Lewis, J. (2008), Gupta & Jain (2013),Mazany, P. (1995),Pavnaskar, S.J., Gershenson, J.K. and Jambekar (2003), Ransom, C. (2008), Womack, J., Jones, D.T. and Roos, D. (1990), NIST report (2003).
2	Reduction in Lead time	Ferdousi, F. and Ahmed, A. (2009), Hines, P., Found, P. et al. (2008), Lewis, J. (2008), Koenigsaecker(2005),Lathin, D. (2001),Ransom, C. (2008), Nystuen, T. (2002), Russell, RS and Taylor, B.W. (1999).
3	Reduction in Cycle time	Bhasin (2011),Ferdousi, F. and Ahmed, A. (2009), Hines, P., Found, P. et al. (2008) , Lewis, J. (2008), Ransom,C.(2008), Russell, RS and Taylor,B.W. (1999),NIST report (2003).
4	Improvements in Productivity	Alukal, G., & Manos, A. (2002),ClaudiusConsulting.(2004), Ferdousi, F. and Ahmed, A. (2009), Lathin, D. (2001),NIST Report (2003), Nystuen, T. (2002), Sanidas, E. (2000), Ransom, C. (2008).
5	Lower Work-In-Progress(WIP) Inventory	Bhasin (2011),Hines, P., Found, P. et al. (2008) , Lewis, J. (2008), Ransom, C. (2008), NIST report (2003),Seth,D., &Gupta,V. (2005).
6	Increase in Customer Responsiveness	EPA. (2003), Hines, P., Found, P. et al. (2008), Lewis, J. (2008),Mazany, P. (1995),Ransom, C. (2008), NIST report (2003).
7	Higher Profits	Alukal, G., & Manos, A. (2002), EPA. (2003),Hines, P., Found, P. et al. (2008), Lewis, J. (2008), Ransom, C. (2008).
8	Reduction in Space requirements	Claudius Consulting (2004),Koenigsaecker(2005),Lathin, D. (2001), NIST report (2003), Nystuen, T. (2002).

The following are the most popular benefits that Lean organizations gain:

1. **Improvements in Quality/Productivity:** Lean manufacturing can lead to major improvements in the quality, both of the product manufactured and of the organization as a whole, including the manufacturing process and the efficiency of workers. Researchers agree that implementation of Lean leads to an almost 70-90% increase in quality.
2. **Reduction in Lead and Cycle Time:** Implementation of Lean also results in a reduction of the lead and cycle times of an organization. Products move faster in the manufacturing cycle. A study on a Novartis International AG – A Switzerland-based company, introduced lean picking system for the movement of the goods from the warehouse to the packing lines. By using this system they were benefited in terms of waste elimination from the redesigned material supply process.
3. **Lower Work-In-Progress (WIP) Inventory:** Lower inventory costs result when Lean systems are implemented because of lower cycle times and higher customer responsiveness. Chihuahua, the producer of world class power and signal distribution system of Mexico, reviewed its existing manufacturing system and identified the need for improvements. The company introduced lean with a view to improve the current performance. It is documented from the study that implementation of lean brought 34% reduction in inventory over a 12 months period and 93.5% uptime.
4. **Reduction in space:** As a result of Lean systems, optimization of space occurs in the organization due to more efficient machines and devices which take up less space on the work floor. A case study was conducted on a Malaysian automobile company, Proton, to develop an understanding of a Malaysian version of JIT. The company uses robots and automation in production processes. It introduced Kanban- various types of containers for holding components or movement of components as well as several supporting mechanisms to complement the use of JIT system. All these reduced 50% of space required, work in progress from three months to one month of supply and brought improvement in inventory turns from 15 to 31.

According to Womack & Jones (1994) [50], firms in several industries in North America, Europe and Japan followed the path of going lean and doubled their performance through reduction of inventories, throughout times and errors.

Ferdousi & Ahmed (2009) [17] surveyed 9 Bangladeshi garment manufacturing firms, which fall into the category of SMMEs, which implemented Lean and found the following manufacturing performance improvements:

Savings resulting from lean practices: Almost 44% of the sample companies made significant savings over a period of 12 months through the reduction of labor costs in the production process.

- Reduction in Production Costs
- Total Productivity Improvement
- Lead Time reduced within the range of 13-105 days.
- Quality Improvement
- Reduction in Manufacturing Cycle Time

6. BARRIERS IN IMPLEMENTING LEAN

There are numerous benefits of adopting Lean systems in organizations as seen above. However, there are some barriers which arise in implementing Lean as well. The following are the barriers that SMMEs might encounter while implementing Lean systems that different authors have highlighted:

Table 3. Various Barriers that different authors have highlighted.

Sl	Barriers	Authors
1	Insufficient funding	Abdul-Nour, G. et.al (1998), Achanga, P. et.al (2006), Ahmad Nasser Mohd. Rose et al., (2009), Bhasin (2011), Chong, S. (2007), Cusumano, M. A. (1994), Gupta & Jain (2013), Inman, R. A. et.al (1990), Golhar, D. Y. et.al (1990), Lee, C.Y. (1997), White, R.E. et.al (1999).
2	Lack of understanding of lean concepts	Achanga, P (2006), Ahmad Nasser Mohd. Rose et al., 2009, Crute, V., Ward, Y (2003), James, T. (2006), Lee, C.Y. (1997), White, R.E. at.al (1999).
3	Lack of training or of skilled resources.	Abdul-Nour, G. et.al (1998), Achanga, P. et.al (2006), Ahmad Nasser Mohd. Rose et al., (2009), Bhasin (2011), Chong, S. (2007), Cusumano, M. A. (1994), Inman, R. A. et.al (1990), Golhar, D. Y. et.al (1990), Lee, C.Y. (1997), White, R.E. et.al (1999).
4	Inadequate understanding of the potential benefits	Achanga, P (2006), Ahmad Nasser Mohd. Rose et al., (2009), Bhasin (2011), Lee, C.Y. (1997), White, R.E. (1999).
5.	Lack of top management commitment	Achanga, P (2006), Ahmad Nasser Mohd. Rose et al., (2009), Bhasin (2011), Crute, V., Ward, Y (2003), James, T. (2006), Lee, C.Y. (1997), White, R.E. et.al (1999).

1. **Insufficient funding:** Most SMMEs have a limited budget and limited resources. Due to this, they may not be able to afford to implement the required Lean practices either completely or successfully. This can also lead to implementing one practice without another essential one due to lack of necessary funds. For example, setting up the Kanban practice without first setting up the Just-In-Time (JIT) system. This can do more harm than good in the long run.
2. **Lack of understanding of lean concepts:** Another barrier may arise in the fact that the concept of Lean may not be completely understood by the top management, which may lead to unsuccessful or wrong implementation of the lean practices. Also, if lean concepts are not properly understood, there may be arise problems in selecting the appropriate lean tool for an organization. If a wrong tool is selected and implemented, this may damage the organization.
3. **Lack of training or of skilled resources:** Proper training in the ways of Lean production systems has to be imparted to the management and to the workers. If not properly trained, there is a possibility that an implemented system may break down in the process somewhere due to insufficient knowledge of a worker or because of improper management principles which do not abide by the Lean principles. Again, if there is a lack of training, there will be a lack of skilled workers which may be not able to perform tasks according to lean principles.
4. **Inadequate understanding of the potential benefits:** There is also a possibility that the management might not understand or recognize the potential benefits that Lean could bring about in their organization and so, fail to implement Lean when it actually might be needed. To prevent this, management should be fully cognizant of the benefits, short and long run, that Lean systems might bring about, weigh it against the potential barriers and then make a decision whether or not to implement Lean.
5. **Lack of top management commitment:** The top management might simply give up, at some point of time, the process of implementing Lean in their organization. They might do this because they might feel the benefits may not be worth the arduous process, or that funding may fall short, or that they might just not go through with the whole idea and leave it midway. Implementing Lean takes time. Anywhere between 3-5 years, most researchers agree, is the usual timeframe to successfully completing the transformation to a Lean organization. Thus, the top management needs to have patience and full commitment to implement Lean successfully and completely.

7. CONCLUSION

The concept of Lean is one of the most effective and widely used across organizations today. Numerous researchers have

touted it as being the most successful in making an organization more profitable and efficient. Lean should be viewed more as a philosophy than as a system. Small and Medium Manufacturing Enterprises (SMMEs) need to implement the Lean philosophy nowadays because of increasing competition from globalization. They need to become more efficient in producing their products as well as making sure the products reach the customers. There are many practices that can help them to become lean. However, SMMEs cannot implement all of the practices due to financial constraints. Some of the more popular and effective practices for SMMEs are Just-In-Time (JIT), Kanban, 5S, TPM, Kaizen, etc. The benefits to implementing Lean in an organization are increased quality of the products, reduction in lead and cycle times, lower Work-In-Progress (WIP) inventory, increased customer responsiveness etc. There are some barriers to implementing lean as well, like insufficient funding, lack of understanding of lean concepts, lack of training, lack of top management commitment among others. However, the barriers and problems far outweigh the benefits of lean, making it beyond doubt a necessity for successful and top class organizations. It is highly recommended that organizations shed their conservative practices and attitudes and adopt lean practices and tools to compete effectively with today's global manufacturing scenario.

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