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A study on the Utilization of Lean techniques/tools in Indian SMEs

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Abstract
The Small and Medium Enterprises (SMEs) are the backbone of all the major economies around the world. Majority of these industries are facing tough environment for existence. The present study explored the most common and easily implementable Lean Tools/Techniques amongst the SMEs. This has been achieved via a detailed survey of SMEs in India. Study concludes with nine most common Lean Tools/Techniques implemented across the surveyed population of Indian SMEs.

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1. Introduction

SMEs focus on acquiring a high sales turnover with strategies that strongly emphasize increasing market share or entering new markets with current products. Small enterprises are constrained by capital, labor and limited resources to improve their technology. With a rapidly changing environment and successes, it is necessary to create certain "tools" for small enterprises with a limited budget. These tools should be implemented quickly and, most importantly, they should have a significant impact on the company at the time of implementation. There are more than a hundred common tools available and that there is no way to systematically undermine the production organization for its problems and possible tools to address these problems (Mathur et al., 2014). Bhasin and Burcher (2006) suggested that the company should implement all or most of the lean practices to succeed in the implementation of Lean. At the same time, the reviews show that SMEs cannot simultaneously implement all methods (Gunasekaran et al., 2000, Rose et al., 2011).

In India the enterprises other than Large are categorised as micro, small and medium enterprises and are addressed as MSME. However, these industries are addressed as SMEs in most of the countries and in research literature. Hence, the terminology used in this paper to address the enterprises under the study is SMEs.

2. Methodology

The present study on Lean tools/techniques used in Indian SMEs is a part of a survey based on the study which focused on the current status of Lean Implementation in the Indian small and medium enterprises (SMEs). The larger study has been conducted during and under the doctoral study by the authors amongst the SMEs in India.Owing to the size of questionnaire the sample size chosen was large.

A total of 149 feedbacks are received from Indian SMEs as a result of the survey conducted via internet and personal visits to the industries in central and west part of India.

The data collected is being analyzed using statistical methods.

3. Lean Tools

In order to simplify ensure effective implementation of Lean its fundamental concepts must be clear. Lean relies on several fundamental concepts:

- Customer focus – value is determined by the customer values.
- Eliminate waste – if anything does not add value then it is waste and must be eliminated.
- Smooth flow – level out any variations in process steps to achieve consistent flow of processes.

- Continuous improvement – continually find ways to make any type of improvements.

These principles are achieved using a set of tools focusing on any of these principles. The most commonly used tools (NSW Department of Education and Training, 2009) include:

Value Stream Mapping (VSM), 5S, Six Sigma, Kaizen (continuous improvement), Visual Workplace, Just in Time (JIT), and Poka-Yoke, or mistake proofing.

Rose et al. (2009) summed up the Lean practices suggested by various researchers as follows (Table 1).

Table 1. Lean Practices (Rose et al., 2009)

Researcher	Large organization			Small organisation	
	Mclahlin (1997) and Shah & Ward (2003)	**Bhasin 2006**	**White, 1999**	**Lee, 1997**	**White, 1999**
i	Set up time reduction	Set up time reduction	Set up time reduction	Set-up time reduction	Set up time reduction
ii	Kanban	Kanban	Kanban	Kanban	Kanban
iii	JIT/continuous flow production	Continuous improvement	Total Quality Control	Total Quality Control	Total Quality Control
iv	Small lot	Group technology	Group Technology	Small lot	Group technology
v	Total quality management	Process mapping exercise	JIT Purchasing	Multifunction Employee	Multifunction Employee
vi	Continuous improvement programs	Step change/ kaikaku	Multifunction Employee	Group Technology	JIT purchasing
vii	TPM	5S and visual management	Quality Circles	JIT purchasing	Quality Circles
viii	Multifunction employee	Value and seven waste	Uniform workload	Uniform Workload	Uniform Workload
ix	Self-directed work teams	Supplier development	TPM	TPM	TPM
x	Focused factory	Supplier base reduction	Focused Factory	Focused Factory	Focus factory
ix		TPM			

Pirraglia, A., Saloni, D., and Van Dyk, H. (2009) in a detailed study on the Status of Lean manufacturing implementation on secondary wood industries, have reported the results in the form of a figure (Figure 1). The researchers have found a high usage of 18 workplace organization (5S) technique as 73.3 percent respondents have validated its usage.

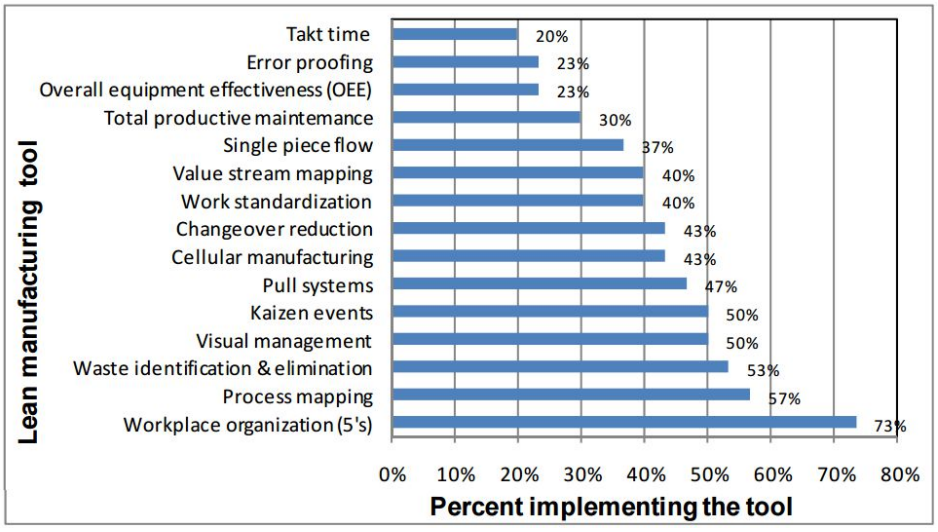

Fig. 1. Lean Manufacturing tools usage (Pirraglia et al., 2009)

Following are the definition or explanation of the key or the technical terms used in this thesis from a variety of Lean resources (Claire Biggs, 2009, Bicheno, 2000; Hines et al., 2004; Hines and Taylor, 2000; Womack and Jones, 2003; and Vorne Industries Limited at-

http://www.Leanproduction.com, 2011-16.)

5S - A simple tool to make a workplace suitable for Lean production and visual control. It consists of five steps. The name of each stage begins with S in Japanese, the place of its origination and the same have been translated into 5 words in English that also begin with letter S to maintain its essence.

- Seiri – Sort - eliminate that which is not needed.
- Seiton – Set in order – put the remaining items in sensible locations, and mark them.
- Seiso – Sweep and shine – cLean and inspect work area.
- Seiketsu – Schedule - create standards for above.
- Shitsuke – Stick to it - maintain the above system and arrangement.

5S Eliminates waste that results from a poorly organized work area (e.g. wasting time looking for a tool).

Cellular manufacturing – An arrangement of production floor where all the work centers required for manufacturing one family of products are arranged in order in one area or cell, enabling better flow of the processes, reducing travelling within the factory and making one-piece flow easier.

Gemba (The Real Place) – A philosophy that reminds us to move out of our offices and spend time on the plant floor – the place where real action occurs. It promotes a deep and thorough understanding of real-world manufacturing issues – by first-hand observation and by talking with plant floor employees.

Heijunka (levelling) – A form of production scheduling that purposely manufactures in much smaller batches by sequencing (mixing) product variants within the same process. It reduces lead times (since each product or variant is manufactured more frequently) and inventory (since batches are smaller).

Jidoka (Autonomation) – To design equipment to partially automate the manufacturing process (partial automation is typically much less expensive than full automation) and to automatically stop when defects are detected. After Jidoka, workers can frequently monitor multiple stations (reducing labor costs) and many quality issues can be detected immediately (improving quality).

JIT – Just in time – closely related to pull systems. Minimizing inventories and work-in-progress, synchronization of processes.

Kaikaku (sometimes known as Kaizen blitz) – Large "shake-up" changes such as a shift to visual control, changing to cellular manufacture, implementing one-piece flow.

Kaizen (Continuous Improvement) – by virtue of which many small improvements can collectively result in large benefits. Kaizen seeks ideas for improvements from people on the job, using their experience, knowledge, common sense and intuition to understand the process, identify the value-add and identify wastes.

Kanban – It is pull-system for components and subassemblies, setting maximum and minimum limits for the inventory, visually. A method of regulating the flow of goods both within the factory and with outside suppliers and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed.

It eliminates waste from inventory and overproduction. It can eliminate the need for physical inventories (instead relying on signal cards to indicate when more goods need to be ordered).

Lean – A strategy for doing business efficiently, with the workforce involved in making improvements continuously, making exactly what the customer wants when they want (and not before), and minimizing waste of all kinds.

Muda – the Lean term for wastes. Anything in the manufacturing process that does not add value from the customer's perspective. The elimination of muda (waste) is the primary focus of Lean manufacturing.

Poka-yoke – "Mistake Proofing" or "Error Proofing" - designing tools etc. in such a way that mistakes are impossible to happen (e.g. making a jig so that it is impossible to put a part into it the wrong way around).

Pull / push – In a pull system, customer orders "Pull" work through the process, in a push system, work is "pushed" through in batches to build up stock, and is then held pending orders.

Rightsizing – Making equipment the right size for the flow of work, so that batch flow is not necessary.

Root cause analysis (five whys) – A problem solving methodology that focuses on resolving the underlying problem instead of applying quick fixes that only treat immediate symptoms of the problem. Go for gemba (wherever the problem is occurring) and a common approach is to ask why five times, each time moving a step closer to discovering the true underlying problem..

Single piece flow – Products are made one by one instead of in batches. Reduces inventories, reworking and scrap (because mistakes are caught after only a few products have been made wrongly rather than a whole batch), handling, errors in identification.

Six Sigma – Under this tool statistical analysis is availed to find ways to improve process capability.

SMED (Single-minute exchange of dies) – Reduce setup (changeover) time to less than 10 minutes. Techniques include:

- Make setup steps to be external (performed while the process is running).
- Easy internal setup (e.g. replace bolts with knobs and levers).
- Eliminate non-essential operations.
- Create Standardized Work instructions.

Smoothing – Planning production levels so that there is the same amount of work every day and everyone is always busy but all orders leave on time.

Takt time – The pace of production (e.g. manufacturing one piece every 34 seconds) that aligns production with customer demand. It is calculated as Planned Production Time / number of products demanded by Customer Demand. It provides a simple, consistent and intuitive method of pacing production. Is easily extended to provide an efficiency goal for the plant floor (Actual Pieces / Target Pieces).

TPM (Total Productive Maintenance) – Planned maintenance schedules are devised to keep all equipment running at 100% of the time. It's a holistic approach to maintenance that focuses on proactive and preventative maintenance to maximize the operational time of equipment. TPM blurs the distinction between maintenance and production by placing a strong emphasis on empowering operators to help to maintain their equipment.

Turn-back analysis – Analysis of how often work is turned back to an earlier stage of the process for reworking.

Value stream mapping – Value Stream Mapping (VSM), where value (what is valued by the customer) is identified throughout a process and non-value (waste) can be reduced. Identifying families of products, then for each fami-

ly identifying each step in their manufacturing process and highlighting which steps are not adding value and thus constituting a muda in one of the categories.

Visual control – All controls and measures (eg. flow of work, order progress, stock levels, call for replenishment of stock) are done visually, using control boards (including Andon boards), coloured cards and markers, kanban/two-bin etc.

Visual Factory – Visual indicators, displays and controls used throughout manufacturing plants to improve communication of information. This makes the state and condition of manufacturing processes easily accessible and very clear– to everyone. These may be figures, painted lines, signs, signals or shadow boards to indicate where things should be stored, diagrams showing correct procedures, real time displays of productivity data, visual systems for scheduling and progressing work flow.

Based on the literature review and ease of implementation following tools have been included in the survey questionnaire prepared by the research scholar of this study:

- Value Stream Mapping (VSM),
- Kaizen,
- Work Standardization,
- Six Sigma,
- Error Proofing (Poka Yoke),
- Workplace Organisation (5S),
- Visual management,
- Kanban (Pull),
- SMED,
- Process Mapping.

The application of tools or techniques requires understanding and expertise in the area of its application. As the present study is focused on SMEs, a thorough understanding of the definition, scope, importance, impact of SMEs on industry and economy need to be addressed.

3.1. Lean Tools suitable for SMEs

A number of Lean tools have been developed by researchers and implementers in last three to four decades. Having automobiles as the source of these initiations, many of the tools are mass production specific. In order to make Lean implementation a success story with the SMEs, the tools specific to mass production and which are resource hungry need to be identified. And the tools which are generic in application nature and do not demand investment to implement them need to be precipitated for SMEs.

Upadhye et al. have suggested certain set of tools suitable for implementation in SMEs (Table 2). They have presented a case to demonstrate the improvements achieved in an Indian medium size auto component's manufacturing unit after the implementation of Lean manufacturing system (LMS).

Rose et al. (2011) have also suggested a set of tools suitable for SMEs. The proposed practices were based on three categories: least investment, feasible to apply in SME and recommended by researchers. There are seventeen Lean practices which could be considered are feasible and relevant to the MSME characteristics (Table 3).

Table 2. Lean Manufacturing Tools suitable for SME **(**Upadhye et al., 2010)

Sr. No.	Attributes	Lean tools/techniques to Identify, Measure & Eliminate waste
1	**Shop Floor**	
	a. Availability of drawings, Jigs/Fixtures and Measuring instruments.	5S, Shop Layout, House-Keeping
	b. Change over time	Ishikawa diagram, SMED, Standardized parts
	c. Lead time of product, cycle time of the processes	5 Why, Planning and scheduling-, Cells and cellular layout, Continuous Flow, Elimination of Seven Wastes
	d. Quality/rejection level	Six sigma, Quality Tools, Process charts, SPC, SQC Jidoka, Poka Yoke (Mistake Proofing), Elimination of Seven Wastes
	e. Breakdown maintenance	5 Why Preventive Maintenance
	f. Employee involvement	Kaizen, suggestion schemes, Quality circles
2	**Inventory**	
	a. Stores inventory management	ABC Analysis, 5S
	b. WEEP	One-piece flow, shorter lot sizes
	c. Finished goods {Ancillaries only}	Make to order
	d. Returned/Rejected components	Elimination of Seven Wastes
	e. Material Yield	Value analysis
3	**Man Power**	
	a. Poor morale	Empowerment & Training
	b. Incapability, Inefficiency	Training, Problem solving approach
	c. Low reliability	Job satisfaction, Job assurance, and Incentive scheme and merit rating

Matt & Rauch (2013) have deduced a selection of suitable/recommendable methods for small enterprises. Their paper analysis is aimed at small enterprises in Italy. These are following:

1. First-in-first-out (FIFO).
2. 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke).
3. Benchmarking.
4. Kaizen - Continuous Improvement meetings.
5. Just in Time delivery.
6. Pull-principle and Kanban.
7. Visual Management in Production.
8. Zero Defect through process-integrated failure control.
9. Idea Management to utilize the worker's Know-How.
10. Setup Time Reduction to reduce waste.
11. Value Stream Mapping.
12. Efficient and ergonomic work stations.
13. Poka Yoke and standardisation in product and process.
14. Cellular Manufacturing and autonomous teams.
15. Job rotation to avoid monotonny.
16. Low Cost Automation ("keep it smart and simple").

Table 3. The list of selected practices for SME Implementation by Rose et al. (2011)

Criteria Practices	Less investment	Feasible to implement	Recommended to SME
Set up time reduction	Y	Y	X
Visual control	Y	Y	X
Cell layout	Y	Y	X
Standard operation	Y	Y	X
Kanban	Y	Y	X
Continuous flow	Y	Y	X
Uniform workload	Y	Y	X
Small lot size	Y	Y	X
TQM/TQC	Y	Y	X
Continuous improvement	Y	Y	X
5S	Y	Y	X
Quality circle	Y	Y	X
Multifunction employee	Y	Y	X
Training	Y	Y	X
Teamwork	Y	Y	X
Supplier management	Y	Y	X
Preventive maintenance	Y	Y	X

Various Lean tools which have been found useful for MSMEs as per the literature review are made a part of the question related to the Lean tools used. These tools are: Value Stream Mapping, Kaizen, Work Standardization, Six Sigma, Error Proofing, Workplace Organisation (5S), Visual Management, Kanban, SMED, Process Mapping and an option is kept open for the respondent to mention any tool vital to implementation according to them. Following is the analysis of the responses.

4. Results and discussion: Utilization of Lean techniques/tools

Following given Figure 2 presents the survey feedback on the various Lean Techniques used during the implementation of Lean.

The figure 2 shows that the percent of responses from Medium, Small or Micro category of industries utilizing various Lean tools.

VSM – 69% of the Medium enterprises, 65% of the Small enterprises and 50 % Micro industries are using VSM as an important Lean Tool.

Kaizen – 88% of the Medium sized enterprises, 100% of the Small enterprises and 100% of the Micro enterprises are using Kaizen tool under Lean Implementation.

Work Standardization - 88% of the Medium sized enterprises, 92% of the Small enterprises and 100% of the Micro enterprises mentioned that they are using Work Standardization.

Six Sigma – Responses on the usage of this Lean tool were 13% by the Medium enterprises, 2% by the Small enterprises and 0% by the Micro industries. This means tools requiring special training on a tool were applied least.

Error Proofing – This tool found acceptance in 88% of Medium enterprises, 95% of Small enterprises and 50 % of Micro enterprises. Work Place Organisation or 5S is being utilized by 88% Medium, 100% Small and 50% Micro industries.

Visual Management – This tool found high acceptance levels among all the three categories of enterprises. 88% of the Medium sized enterprises, 91% of the Small enterprise and 100% of the Micro enterprises mentioned that they are using Visual Management techniques to improve their productivity.

Kanban – The tool to ease out material replenishment was adopted by 56% of Medium-sized enterprises, 39% of Small enterprises and 100% of the Micro enterprises.

SMED – This Lean tool developed by Shigeo Shingo which strives for Single digit Minute Exchange of Die is being used by 69% of Medium enterprises, 93% of Small enterprises and 50 % of Micro enterprises.

Process mapping – Process mapping is used by 69% of Medium enterprises, 56% of Small enterprises and 100 % of Micro enterprises.

Other – 38% of the Medium enterprises, 18% of the Small enterprises and 0% Micro industries mentioned other Lean tool being used in their Lean implementation.

Fig. 2. Lean Tool Utilization in SMEs

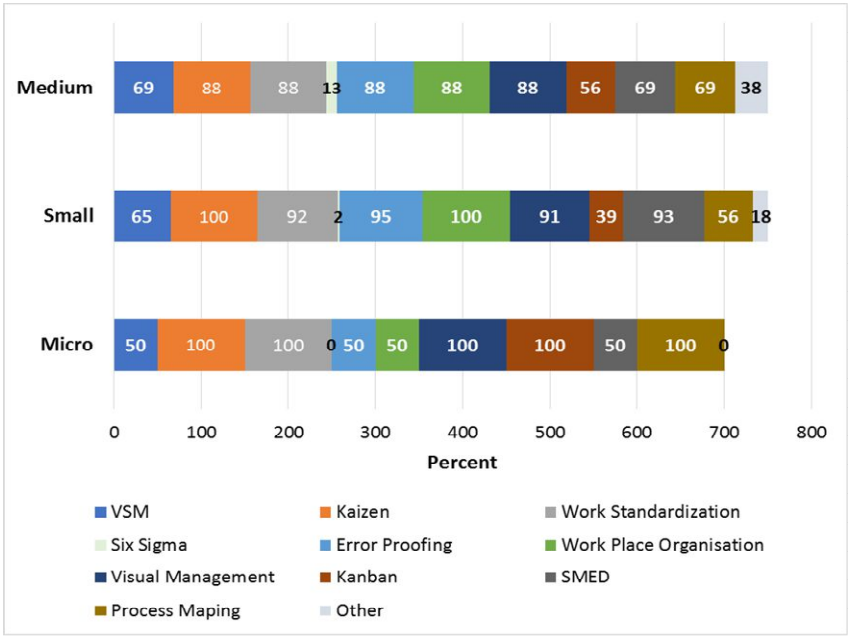

Table 3 categorizes the Lean techniques/tools as per their utilization in SMEs. The Lean techniques/tools most popular and being utilized highest has been placed on the top as rank 1. The table also shows the overall utilization of the Lean tools. The Lean tools making deep roots in the Indian MSMEs are Kaizen (98.7%), Work place organization (98%), Error Proofing (94%), Work Standardization (1.3%),

Visual Management (90.6%) and SMED (89.9%). Other techniques doing fairly well are Value Stream Mapping (65.1%) and Process Mapping (57.7%). Kanban fared with 41.6% utilization. Utilization of Six Sigma (3.4%) is a surprising outcome.

Table 3. Ranking of the Lean techniques/tools as per their utilization in SME (Source: Analysis of survey data by Authors)

Factors Enterprise	Micro	Small	Medium	Overall
Kaizen	100	100.0	87.5	**98.7%**
Work Place Organisation	50	100.0	87.5	**98.0%**
Error Proofing	50	95.4	87.5	**94.0%**
Work Standardization	100	91.6	87.5	**91.3%**
Visual Management	100	90.8	87.5	**90.6%**
SMED	50	93.1	68.8	**89.9%**
VSM	50	64.9	68.8	**65.1%**
Process Mapping	100	55.7	68.8	**57.7%**
Kanban	100	38.9	56.3	**41.6%**
Other	0	17.6	37.5	**19.5%**
Six Sigma	0	2.3	12.5	**3.4%**

5. Summary and conclusion

As per the discussion in section 3 the importance of Lean tools and techniques like *Value stream mapping, Kaizen, Work standardization, Error-proofing, Workplace organization (5S), Visual management, and SMED* are same among ***micro, small and medium*** category of industries.

This means that these Lean tools have similar acceptability and utilization among ***micro, small and medium*** category of industries. That is these tools are common to all the MSMEs.

The importance of Lean tools and techniques like *Process mapping*, *Kanban and Other* have significant difference among micro, small and medium category of industries.

The study evolves with a very specific and small set of tools and techniques to implement Lean. These are common to most of the SMEs. The conclusion is very useful towards initiation of Lean in SMEs. The set of these tools and techniques is small and thus does not demand huge investment, hence is very pertinent to convince SMEs to adopt Lean Implementation.

The present study being spread over a large sample and variety of industries, is generic in nature. And so are the results. The future studies may also be done on specific sector of industries to churn out more specific results.

Future studies may also aim at the investment required towards the training and installation of these techniques.

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关于利用中小企业精益技术/工具的研究

關鍵詞
精益技术/工具
精益实施
中小企业（SMEs）

摘要
中小企业（SMEs）是世界上所有主要经济体的支柱。这些行业中的大多数都面临着艰难的生存环境。本研究探讨了中小企业中最常见且易于实施的精益工具/技术。
这是通过对印度中小企业的详细调查实现的。
研究总结了印度中小企业调查人群中实施的九种最常见的精益工具/技术。