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CASE STUDY

Lean Manufacturing Auto Cluster at Chennai

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Abstract Due the presence of lot of automotive Industry, Chennai is known as Detroit of India, that producing over 40 % of the Indian vehicle and components. Lean manufacturing concepts have been widely recognized as an important tool in improving the competitiveness of industries. This is a continuous process involving everyone, starting from management to the shop floor. Automotive Component Industries (ACIs) in Ambattur Industrial Estate, Chennai has formed special purpose vehicle (SPV) society namely Ambattur Industrial Estate Manufacturers Association (AIEMA) Technology Centre (ATC) lean manufacturing cluster (ATC-LMC) during July 2010 under lean manufacturing competitiveness scheme, that comes under National Manufacturing Competitiveness Programme of Government of India. The Tripartite Agreement is taken place between National Productivity Council, consultants and cluster (ATC-LMC). The objective is to conduct diagnostic study, study on training and application of various lean manufacturing techniques and auditing in ten ACIs. The methodology adopted is collection of primary data/details from ten ACIs. In the first phase, diagnostic study is done and the areas for improvement in each of the cluster member companies are identified. In the second phase, training programs and implementation is done on 5S and other areas. In the third phase auditing is done and found that the lean manufacturing techniques implementation in ATC-LMC is sustainable and successful in every cluster companies, which will not only enhance competitiveness but also decrease cost, time and increase productivity. The technical efficiency of LMC companies also increases significantly.

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Introduction

Chennai, known as Detroit of India due to presence of automotive industry producing over 40 % of the India's vehicle and components [1]. Lean manufacturing concepts have been widely recognized as an important tool in improving the competitiveness of auto component industries. This is a continuous process involving everyone from management to the shop floor. Lean manufacturing or lean production, which is often known simply as LEAN, is a production practice that 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.

The benefits of lean manufacturing can be summarized as follows: reduction in waste; improvement in productivity and quality; introduction of innovative practices for improving overall competitiveness; induce good management practices; increase in manufacturing output; reduction in customer complaints; better and improved adherence to delivery schedule; reduction in quality rejection at every stage of production process; lesser inventory requirements at every stage of production; optimum utilization of resources in terms of space, manpower, material, equipment utilization and energy consumption; orderly work place; and imbibe a culture of continuous improvement [2].

Literature Survey

Lean manufacturing was developed by the Japanese automotive industry, principally Toyota, following the challenge

to re-build the Japanese economy after World War-II. The development of lean was little known or understood outside Japan until the 1970s. Britain gained early experience of lean manufacturing from the establishments of Toyota, Nissan and Honda plants in UK. Nevertheless, until the 1990s it was really only the automotive industry that had adopted lean manufacturing. Since then it has been spread across aerospace and general manufacturing, consumer electronics, healthcare, construction and, more recently, to food manufacturing and meat processing. The thought process of lean was thoroughly described by Womack et al. [3]. In a subsequent volume, Womack and Jones [4] distilled these lean principles even further to five:

- Specify the value desired by the customer;
- Identify the value stream for each product providing that value and challenge all of the wasted steps (generally nine out of ten) currently necessary to provide it;
- Make the product flow continuously through the remaining vale-added steps;
- Introduce pull between all steps where continuous flow is possible; and
- Manage toward perfection so that number of steps and the amount of time and information needed to serve the customer continually falls.

Automotive Component Industries (ACIs) in Ambattur Industrial Estate, Chennai has formed SPV society namely ATC lean manufacturing cluster (ATC-LMC) during July 2010 under lean manufacturing competitiveness scheme comes under National Manufacturing Competitiveness Programme (NMCP) of Government of India. The Tripartite Agreement is taken place between National Productivity Council (NPC), consultants and cluster units (ATC-LMC) [5].

Objective of the Study

The objective is to

(i) Conduct diagnostic study on the areas of improvement in lean manufacturing cluster under phase I.
(ii) Study about the training and application of various lean manufacturing techniques in lean manufacturing cluster under phase II.
(iii) Study about auditing the implementation of lean manufacturing techniques in lean manufacturing cluster under phase III.

Methodology of the Study

The methodology adopted is collection of primary data and details from ten ACIs and analyzing using 5S chart by way of marking pattern and finding the technical efficiency (before and after implementation) of lean manufacturing techniques using BCC model of data envelopment analysis.

Lean Manufacturing Tools and Techniques

Phase-I: Diagnostic Study

During the year 2004, the interrelationship among auto components manufactures and the implementation of the Industrial Infrastructure Upgradation Scheme (IIUS) [6] results sustainable development in efficiency. Then the lean manufacturing competitiveness scheme of Government of India was implemented. In the first phase, baseline/diagnostic study is done and the areas for improvement in each of the cluster member companies are identified. The areas under improvement for cluster units are 5S, daily work management program which is about establishing systems for measuring, monitoring and improving (MMI), the major parameters of a manufacturing in the areas of productivity, quality, cost, delivery, morale and safety (PQCDMS), Plan-Do-Check-Act (PDCA) and Standardize-Do-Check-Act (SDCA) cycle, plan for team work, Kaizen (continuous improvement) blitz or rapid improvement process, layout modifications to improve the flow and reduce operator walking distance and space. Single minute exchange of dies or quick changeover (SMED), visual control/management, total productive maintenance (TPM), problem solving tools (PST), value stream mapping (VSM), POKAYOKE (mistake proofing), standard operating procedures (SOPs), just in time (JIT), KANBAN system and cellular layout have subsequently employed.

Phase- II: Training and Implementation

In the second phase, training programs on above mentioned areas and 5S are provided for 700 employees (executives, staff and workmen) as shown in Fig. 1.

5S Systems

The 5S systems are a workplace organization which helps in getting the "junk" out of the work area and set of procedures to keep it that way. 5S stands for sort, set in order, shine, standardize and sustain, which have been explained in the following section [7].

Sort: Eliminate the clutter—"When in doubt, throw it out".
Set in order: Organize and label, set boundaries and limits—"A place for everything and everything in its place".

Fig. 1 Lean manufacturing and Kaizen

Shine: Clean everything inside and out—"Inspection through cleaning".
Standardize: Keep checklists, charts, etc. and make them visual—"Everything in a state of readiness and service".
Sustain: Maintain discipline through the implementation of continual improvements systems and culture.

The 5S concepts consistently produce an organized workplace, results increase in quality and productivity, a cleaner and safer work place and reduction in required floor space. Ultimately, housekeeping and workplace organization are directly linked in achieving discipline in manufacturing. Lean manufacturing cannot be achieved without the discipline and culture of 5S in place. Before and after lean manufacturing is also shown in Fig. 1 [8–10].

Some success stories quoted by the cluster members following the practical implementation of 5S program in the cluster organizations are (i) few lorry loads of items got disposed of (ii) disposal of unwanted items, obsolete and scrap components (iii) about 25 % of space got vacated (iv) now we know what is there and what is not there (v) now the tools, dies and stores are neatly arranged (vi) it gives a feeling like "after hair dress" and (vii) we knew 5S earlier, but we realize the benefit of 5S now.

Daily Work Management (DMW)

Daily work management is about establishing systems for MMI the major parameters of a manufacturing in the areas of PQCDMS. During diagnostic study, it was noted that many organizations were lacking in DMW. Hence a program on DMW was conducted. About 60 participants (supervisors, managers and heads of the units) from cluster companies attended the program. They were taught about PDCA cycle, SDCA cycle, MMI, PQCDMS, ways and means of improving PQCDMS performance. The participants had a lot of "take-home" points, committed and implemented in their respective organizations (Fig. 2).

The cluster companies started selectively best practices and systems by the knowledge acquired through trainings. DMW created a huge change in the daily activities of cluster employees. Daily production plan versus actual, quality issues, line rejections, reworks, rejections, customer complaints are monitored and measured through shop floor meetings. Targets are set to improve the highlighted issues. Moreover problems are quickly identified and immediately solved [11].

Pilot Projects Selection and Building the Team

Apart from training and implementation of general lean concepts and systems like 5S, DMW, for achieving focused improvement activities in each organisation, project based implementation methodology has been initiated. Each organization has chosen two pilot projects which are important to the respective organisation's operational performance. Teams were formed, goals (project targets) set, weekly meetings initiated [12].

Fig. 2 DMW program

Lean Manufacturing and Kaizen

Kaizen is a Japanese word meaning "improvement" that calls for never-ending efforts to improve, inviting each and every one in the organization to take part. Doing "little things" better everyday defines Kaizen—slow, gradual but constant improvements-continuous improvement in any area that will eliminate waste as shown in Fig. 3 and improve customer satisfaction. Problem-solving under the Kaizen concept is seen as a cross-functional, systematic, and collaborative approach. It is a strategy that puts every member of the organization, from top management down, continuously on the watch for improvement options. This is done using systematic reviews and auditing procedures, brainstorming, and group decision tools to see where improvement opportunities may lie. All operations of the organization are subject to improvement, and the kaizen approach is that nothing has improved sufficiently to stop improving it. The target of kaizen is cost reduction through the elimination of waste at all levels in the manufacturing process.

The program was conducted at ATC in four batches. The program was attended by about 400 employees from all the cluster member units. Each session was inaugurated and attended by the chief executives of the cluster units. The contents of the program are (i) what is lean manufacturing and how it can help SMEs (ii) what are seven wastes and how to eliminate waste and improve profitability (iii) layout changes and flow improvements (iv) what is Kaizen (continuous improvement) and how to implement Kaizen programs systematically. Participants got many ideas from the program and started implementing the knowledge gained in their respective organizations.

The progress of the lean activities carried out in one cluster unit is (i) as part of the unit specific project, reducing the internal rejections was taken up. By the aggressive action of the team, 5 % reduction in parts per million achieved within a month. Action is on to reduce by another 20 %. (ii) Layout modifications finalized to improve the flow and to reduce space and operator walking distance. 100 sqft space is saved. (iii) 5S initiative launched in a structured way using zones, red tags, red tag areas etc.

Some of the "Kaizens" done in cluster companies is shown in Fig. 3. New loading tray designed and developed. Benefit: loading cycle time reduced from 60 to 25 s. Productivity increased.

Before: loading of tablets done directly in the mold cavities. Loading time: 60 s once tablets loaded, press is started for curing.

After: loading of tablets is done separately in the aluminum loading tray during press curing cycle. Once the curing is over, ram is moved down, and cured parts are remolded. Mould is cleaned for next loading. Aluminum tray with carbon tablets is placed over the mould. Bottom plate of the loading tray is pulled which places the carbon tablet in the respective mould cavities. Loading time: 25 s [13].

New method of storing chuck jaws in cluster companies is shown in Fig. 4. Benefit: searching time minimized. Visibility improved. 10 % setting time reduced.

Before: all the machine chuck jaws stored without identification. Operator searching for jaws takes more time.

After: all the chuck jaws are separated and stored according to the machine name in a wooden board. Visibility improved. Searching time for jaws reduced. 3D space utilized [13].

Single Minutes Exchange of Dies or Quick Changeover (SMED)

SMED is one of the many lean production methods for reducing waste in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product. This rapid changeover is key to reducing production lot sizes and thereby improving flow (Mura) The phrase "single minute" does not mean that all changeovers and startups should take only 1 min, but that they should take less than 10 min (in other words, "single digit minute"). Primarily it enables a manufacturing

Fig. 3 Kaizens in cluster companies

Fig. 4 5S systems in cluster companies

organisation to move from a "minimum batch quantity" approach to a "batch of one" approach, but this also facilitates level scheduling, which in turn helps low work-in process and Kanban implementations. Changeovers are analyzed into "external" elements, those which can be performed offline whilst the machine is running and "internal" elements which have to be performed when the machine is stopped. As many internal elements are converted to external elements as possible and then both internal and external elements are streamlined as far as possible. The benefits of SMED are: increased machine work rates from reduced setup times even if number of changeovers increases; elimination of setup errors and elimination of trial runs reduces defect rates; improved quality from fully regulated operating conditions in advance; increased safety from simpler setups; simplified housekeeping from fewer tools and better organization; lower expense of setups; and lower skill requirements since changes are now designed into the process rather than a matter of skilled judgment.

The flagship training program is attended by 80 employees from all the cluster member units at ATC as shown in Fig. 5. The contents of the program include SMED; Determination of loss due to high changeover times and how lack of SMED leads to TIMWood methods for systematic analysis and improvement and various techniques to reduce the change over time [14].

Visual Management/Control

In the said training program, visual management concept was explained which refers to representation of objects to surface. During the training, different processes of quick performance review, application of visual management in business performance improvement and improving employee participation were discussed [14]. Visual systems are a form of communication and can be used to direct flow and identify problems/needs/status with minimal interaction from a person. Typically these can be no or low-cost solutions and can be quickly implemented to improve people, information, and documents flows. Visual communication uses specific methods and techniques to provide fast, two-way communication between teams, shifts, coworkers, and management and can be used anywhere in the organization. Simple signals that provide an immediate understanding of a situation or condition such as charts, light signals, lane marking on floor, safety instructions, warning signs etc. They are efficient, self-regulating, and worker-managed. Visual communication may be used to identify missing tools or materials and is extremely effective in pull system and implemented in LMC. The participants got many ideas from the program and started implementing the knowledge in the respective organization.

Fig. 5 SMED and visual management training program

Total Productive Maintenance (TPM)

TPM focuses on the objective of zero breakdowns. Significant emphasis is given on first line preventive maintenance by operators, which is then supported by a regime of preventive maintenance provided by specialists. In order to make planned or preventive maintenance work successfully, it is often necessary to separate it organizationally from breakdown maintenance. The benefits of TPM implementation are: improve productivity; reduce breakdown leading to zero breakdown concept; leads to multi-

Fig. 6 TPM and PST

Fig. 7 VSM and Poka-Yoke or mistake proofing

Table 1 5S auditing for ATC-LMC

Name and address of the cluster unit		Date	Ref. no.	
			Rev. no.	
		Separate marks		
		No system		0
		Not correct		1
		Needs improvement		2
5S	Mark sheet	Satisfaction		3
	Inspection sheet	Appreciation		4

		Average for ten industries			
No.	5S	Before LMC (2010)		After LMC (2011)	
1	Seiri—sort out				
a	Records/files/miscellaneous	1		3	
b	Expired documents	1		4	
c	Defective gauges	2		2	
d	Defective equipments/tools	1		3	
e	Broken parts/dirt/pieces	2		3	
2	Seiton—set right				
a	Files/registers/things	2		3	
b	One product one place and hold in same place	2		3	
c	Identifying shelves	1		3	
d	Keeping work related product in right place	2		3	
e	W.I.P. tools keeping in safe place	3		3	
3	Seiso—shine every thing				
a	Keeping work place clean	2		3	
b	No hindrance in work place	2		3	
c	Cleaning shelves and tables	2		3	
d	Keeping place, floor and wall clean	2		3	
e	Cleaning machines	2		3	
4	Seiketsu—standardisation				
a	Enough place and light	2		3	
b	Work safety details and announcement	2		3	
c	Foot path markings visible	2		3	
d	Cleaning work to be standardized	2		3	
e	Visual details of work to be done	2		3	
5	Shitsuke—self discipline				
a	Knowing 5S thoroughly	0		3	
b	Safety rules announcement/follow-up	1		3	
c	Keeping all products visible	1		3	
d	5S audit control	0		4	
e	Follow up of PQCDMS system.	0		3	
Total marks		39		76	
Position	Very good	Good	Satisfactory	Dis-satisfactory	Maximum
Marks	80–100	60–79	40–59	Below 40	100
Present position		*			72
Prepared	Audit-every wednesday auditor			Approved	

Source: Developed by Researcher

* denotes the present position is good for ATC-LMC

skilling of workers; better safety; and improve quality of products.

Training programs were also conducted on TPM (autonomous maintenance) where loss of organizations due to breakdowns, objectives and benefits of TPM, process to reduce breakdowns through autonomous maintenance (daily checking of equipments), "My machine" concept and, method of TPM implementation [15] were discussed.

Problem Solving Tools

Training program (as shown in Fig. 6) is conducted on objectives and benefits of Problem Solving Tools (seven QC tools), and stratify data, cause and effect diagram, root cause analysis and other tools, quality control circles and systematically solving quality issues like rejection, rework, customer complaint etc. [15].

Value Stream Mapping

VSM is a lean technique used to analyze the flow of materials and information currently required to bring a product or service to a consumer. VSM is commonly used in lean environments to identify opportunities for improvement in lead time. Although VSM is often associated with manufacturing, it is also used in logistics, supply chain, service related industries, product development etc. [16].

Poka Yoke or Mistake Proofing

It is a Japanese technique used to prevent errors occurring at their source of origin, and it finally leads to a "Zero defect" situation. The idea behind Poka-Yoke is to free a person's mind from maintaining repetitive vigil which may be practically not feasible. It is extremely cost-effective lean manufacturing tool, using very simple devices to prevent the production of defective products.

Training on "VSM and Poka-Yoke" was conducted at ATC and about 100 employees from all the cluster member units attended the program as shown in Fig. 7. The contents of the program include VSM, how to get the overall view of the manufacturing lead time, benefits of VSM and how to improve processes through VSM [16] Training of Poka-Yoke (mistake proofing) is conducted on Poka-yoke application, types and levels of Poka-yoke, and how to avoid customer complaints and process rejections. After the program the member cluster units started implementing it in better way.

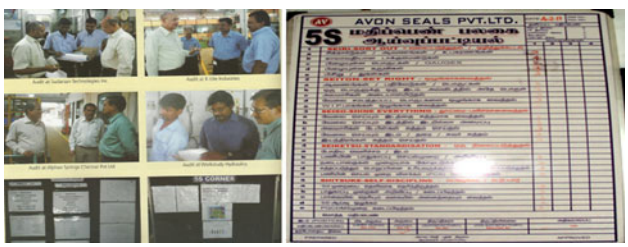

Fig. 8 Auditing by NPC

Phase III: Auditing and Technical Efficiency

Auditing is done for ten cluster units on 5S and the detail is given in Table 1. Figure 8 shows the auditing team inspecting the cluster units and in one company the 5S board is displaced with marking pattern [17]. As per the mark obtained by ten cluster units the position is improved from dissatisfactory level (mark 39) to good (mark 76). Using Banker- Charnes- Cooper model (BCC-Model) of data envelopment analysis [18] it is already found that the technical efficiency of Automotive Industry Cluster in Chennai increases and now it is found that technical efficiency before LMC implementation is 95 % and after LMC implementation is 99 %.

Conclusion

The 5S, daily work management program, plan for team work, lean manufacturing and Kaizen blitz or rapid improvement process, SMED, visual control/management, TPM, PST, VSM and Poka-Yoke (mistake proofing) were implemented successfully in each industry. SOPs, JIT, Kanban system, Cellular layout and Six Sigma concept are also under implementation. After auditing it is found that there is improvement in position from dissatisfactory to good.

To conclude, lean manufacturing techniques implementation in ATC-LMC is sustainable and successful in every cluster industries, which will not only enhance competitiveness but also decrease cost, time and increase productivity. It also increases technical efficiency of each industries and cluster as a whole.

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