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Lean Six Sigma in Chennai Automotive Industry Cluster

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Abstract

Lean Six Sigma manufacturing concepts have been widely recognized as an important tool in improving the competitiveness of Industries of Automotive Components Manufacturing Industry (ACMIs) in Chennai. The objective is to study on five Six Sigma tools like Define, Measure, Analyze, Improve and Control (DMAIC) and 15 Lean Manufacturing Tools. The methodology adopted is collection of primary and secondary data from Chennai ACMI and Secondary data from Government of India publications. To conclude, Chennai ACMI are in the 5.0 sigma level before the implementation of Lean Six Sigma and reached to 5.8 sigma levels after the implementation of Lean Six Sigma. It has to reach the six sigma levels. The Lean Six Sigma Model helped Chennai ACMI to think on innovation and Quality Management a necessary condition for sustainable development of automotive industries in India. This Auto Components are manufactured in India and supplied to Original Equipment's Manufacturers in India.

Keywords: Lean Six Sigma Tools- Indian Automotive Cluster

1. Introduction

Over the past century, various quality methodologies have come and gone, but some basic principles have endured. Shaffie and Shahbazi states that in 1913, when young Henry Ford developed his assembly-line system, he focused on standardization and taking waste out of the car manufacturing process[1]. Over the years, the world of quality has ultimately converged on the principles that are known today as Lean and Six Sigma. Lean, with its simple approach that focuses on improving the speed and efficiency of processes provides breadth in problem solving. On the other hand, Six Sigma is more sophisticated and offers a method for drilling deep into complex issues. Six Sigma also has a very structured approach to problem solving that is absent in Lean. As a result, these two methodologies offer complementary tool kits; they help address the root cause of different business challenges. For example, if the goal is reducing manufacturing cycle time, Lean principles can help identify areas of 7 wastes to be eliminated as shown in Figure 1. On the other hand, if the goal is to reduce defects in manufacturing, Six Sigma 5 innovative tools provide the better fit with understanding root causes as shown in Figure 1.

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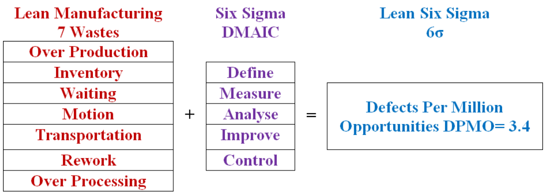


Figure 1. Lean Six Sigma Model.
Source: Developed by Self, the Researcher

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. Until the 1990s it was really only the automotive industry that had adopted lean manufacturing. Since then it has spread to aerospace and general manufacturing, consumer electronics, healthcare, construction and, more recently, to food manufacturing and meat processing. Every company will have its own set of objectives; however, a study by Hendricks & Singhal, explores the hypotheses that implementing effective total quality management (TQM) programs improves the operating performance of firms[2].

Peter et al reveals about twelve key to success,

- The Six Sigma Efforts to Business Strategy and priorities,
- Position Six Sigma as an improved way to manage for today;
- Keep the message simple and clear;
- Develop your own path to Six Sigma;
- Focus on Short-Term Results;
- Focus on Long-term growth and development;
- Publicise results, admit setbacks, and learn from both;
- Make an investment to make it happen;
- Use Six Sigma tools wisely,
- Link customers, process, data and innovation to build the Six Sigma System,
- Make top leaders responsible and accountable,
- Make learning an ongoing activity[3].

Pries states that Six Sigma was not the first quality concept introduced to business. It could probably trace the first real attempts to polis processes to Henry Ford at the beginning of the twentieth century. The Ford assembly lines were the product of never-ending attempts to optimize the process. Ford didn't stop with the assembly lines- he also improved the product, sometimes with innovative new substances[4].

Bhaskaran study reveals from the technical score and ranking of auto component manufactures, it is found that there is significant increase in technical efficiency of Auto Components Industry (ACI) after the Cluster Development Approach (CDA) when compared to before CDA[5].

Bhaskaran reports that there is increase in technical efficiency of not only Chennai auto cluster in general but also Chennai auto components industries in particular[6].

He did study on 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 Aiema Technology Centre-Lean Manufacturing Cluster (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 [7].

Shaffie and Shahbazi reveal that in real terms, the rollout of a Lean Six Sigma (LSS) effort has three distinct phases. In the first phase, the Quality Leader aligns the effort with the company's mission, selects a focus area, and forms the organization. During the second phase, champions are trained, metrics are developed, and projects are identified. In the third and final phase Black and Green Belts are trained and start executing the projects[1].

Study made by Bhaskaran in 2013, 2014 for inclusive growth and sustainable development reveals thatinefficient Automotive Component Cluster (ACC) should increase their turnover and exports, as decrease in no. of enterprises and employment is practically not possible[8].

He concludes, for inclusive growth and sustainable development, the inefficient Textile Cluster should increase their Sales /turnover and Exports, as decrease in number of enterprises and Employment is practically not possible[9].

It is also found out that the variables are highly correlated and the inefficient automotive components manufacturing industries should increase their gross output or decrease the fixed assets or employment. Moreover for sustainable development, the cluster should strengthen infrastructure, technology, procurement, production and marketing interrelationships to decrease costs and to increase productivity and efficiency to compete in the indigenous and export market[10].

According to Ministry of Micro, Small and Medium Enterprises (2013), the 4 Automotive Component Clusters (ACC) in India got funds under Lean Manufacturing Competitiveness Scheme which 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[11]. There is need for study on Lean Six Sigma Implementation in these clusters.

3. Objective of the Study

The objective is to study on the following five distinct problems- innovative solving phases of Lean Six Sigma tools like Define, Measure, Analyze, Improve and Control(DMAIC) for the Automotive Components Manufacturing Industries (ACMI) in Chennai by removing Lean Manufacturing 7 Wastes like Over Production, Inventory, Waiting, Motion, Transportation, Rework and Over Processing.

- To Define (D) the problems of the Automotive Components Manufacturing Industries in Chennai.
- To Measure (M) the problems of the Automotive Components ManufacturingIndustries in Chennai and also to measure sigma level.
- To Analyse (A) the problems of the Automotive Components Manufacturing Industries in Chennai and also to analyse the sigma level.
- To Improve (I) the problems of the Automotive Components Manufacturing Industries in Chennai.
- To Control (C) the problems of the Automotive Components Manufacturing Industries in Chennai.

4. Methodology of the Study

The methodology adopted is collection of primary data from Automotive Components Manufacturing Industries in Chennai and secondary data from Ministry of Micro, Small and Medium Enterprises (2014). The data were analyzed using Innovative Lean Manufacturing Tools and Techniques according to Ministry of Micro, Small and Medium Enterprises (2014) like 5S;Visual Control, Standard Operating Procedures (SOPs), Just in Time (JIT), KANBAN System, Cellular Layout, Value Stream Mapping, Poka Yoke or Mistake Proofing, Single Minutes Exchange of Dies or Quick Changeover (SMED), Total Productive Maintenance (TPM), Kaizen Blitz or Rapid Improvement Process and Six Sigma[12].

5. Lean Six Sigma Implementation

According to Ministry of Micro, Small and Medium Enterprises (2014), the cluster named "Chennai Manufacturer Cluster" comprised a total no. of 8 units and was manufacturing fuel pipes, sheet metal components, fabricated components, link rods, fuel pipes, bumper assembly, castings and fabrication and assembly components. It was promoted by Tractors and Farm Equipment's Limited (TAFE), Chennai. The units were mainly vendor of TAFE. The structure of the auto components manufacturing industries areit is established in the year 1985, under the type of unit called Small, with 112 workers and Turnover of Rs. 10 crores, got ISO 9001-2000 Certificate, vendors of Greaves Cotton India Ltd & Brakes India Ltd, and manufacturers Bar stock, machining cold forged / hot forged parts, fasteners, fulcrum pins, pull rod, clevis and other parts.The complete Lean Six Sigma Model of 5 steps are given below

5.1 Phase I: Define (D)

The first step of Lean Six Sigma is to define the problems.

The problems of ACMI are:

- During the diagnostic study, it was found that setup changes were done frequently as the number of components produced was high but the production batch size was small.
- The time taken for setup changes considerably reduced the time available for production while also increasing the cost of the cutting tools.

5.2 Phase II: Measure (M)

The Lean tools used for measurement of the problems are:

- SMED,
- Kaizen,
- 5S,
- VSM,
- Kanban,
- FMEA,
- TPM,
- Visual Control,
- SPC.

5.3 Phase III: Analyse (A)

The problems were analysed. 5S stands for Sort, Set in order, Shine, Standardize & Sustain. The Figure 2 shows implementation of 5S before and after the application of Lean Manufacturing techniques. The 5S scalesare also given in Table 1.

Table 1. Improve the Problem

BEFORE5S SCORE	AFTER5S SCORE
42 on 100 scale.	86 on 100 scale.

The setup time data of all the machines for a period of one month was collected. The machines were categorised into 3 different categories based on setup time and number of set-ups in a month. The total set-up time per month for all the 3 categories of machines was found to be 6800 minutes. It was observed that various activities were done after the set-up change process was initiated; as a result the set-up time as high. Root causes were identified and action plans were developed to address the concerns. The team then observed and studied the above action plans for a period of 1 month and analysed the results. A reduction in setup time was observed as the setup time reduced to 5400 minutes, saving 1360 minutes in a month.

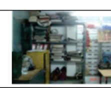
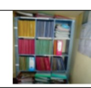
Automotive Components Manufactured	BEFORE5S	AFTER5S
		
		

Figure 2. Analyse the Problem.

5.4 Phase IV- Improve (I)

The improvement made are given in Table 1. Mostly 5 S is implemented in the automotive components industry and the other tools like Kaizen, Single Minute Exchange of Dies, CLITO (Clean, Lubricate, Inspect, Tighten and Oil) techniques, Total Productive Maintenance (TPM), Improved Layout, Inventory, cost reduction, Standard Operating Procedure, Visual Control, Value Stream Mapping, Statistical Process Control etc. are also implemented.

5.5 Phase V: Control (C)

The tools used for control are given in Table 2. After improvement the process were controlled and standardized. There were savings in each of the ACMIs after the implementation of Lean Manufacturing Techniques. The cycle time is also reduced considerably. Tool life monitoring chart was designed to keep track of tool usage. The savings per Year had been estimated to be around Rs. 50,469/-.5S implementation was taken up to bring in a culture of cleanliness and good housekeeping which improved visual appearance of the shop floor.

The overall benefits obtained are:

- Reduced Setup time- 20% ,
- Overall tool cost reduced by 5.5% per month,
- 110 kaizens were evolved,
- Estimated Savings was Rs. 40,000,
- Annual Savings of Rs.1.5 lakhs..

This Cluster is very near to 6 sigma level and they should reach it at 6 sigma level. The calculation of sigma level for unit is given in Table 3.

6. Findings and Suggestions

The objective is reducing manufacturing cycle time by innovative methods. Innovative Lean principles have helped to identify the following areas of 7 wastes to be eliminated.

- *Defects*: Any nonconformance that leads to redoing, reworking, recontacting, or reviewing. The defects were identified and rectified.
- *Waiting:* Any time during which work is not being performed on the customer request. Waiting time of parts manufactured was identified.
- *Over Production*: Producing more than required more than a process step has the capacity to handle, resulting in the building of inventory. Here the inventory is reduced.
- *Unnecessary Transportation*: Movement of raw materials, process and finished goods. With every movement, the risk of loss or delays in processing is identified.
- *Inventory:*Work-in-process, representing unrecognized potential revenue. Parts waiting for processing are identified.
- *Over processing*: Doing more than is required from a customer's perspective and over processing is controlled.
- *Motion*: Movement to transport automotive components. Inefficient process layout is identified.

Table 2. Control

Activity	Concern	Action Plan
Bringing tool from store	Tool searched & brought from store after starting setup change	Tool to be brought from store before starting setup change
Bringing drawing from QC area	Drawing brought from QC area after producing first piece	Drawing to be brought from QC before starting set up change
Bringing raw material from store	Raw material brought from store after starting set up change	Raw material to be from brought store before starting set up change
Bringing measuring instrument from QC area	Vernier brought after producing first piece	Measuring instrument be brought before starting setup change.

Table 3. Six Sigma Calculation.

Before Lean Six Sigma Implementation	After Lean Six Sigma Implementation
Units = 1,000,000	Units= 1,000,000
Total number of defects= 253	Total number of defects=8
DPMO= (253 / 1,000,000)* 1,000,000= 253	DPMO= (8 / 1,000,000)* 1,000,000= 8
Z score (using Z table) = 5.0 sigma	Z Score (using Z table) = 5.8 sigma

DPMO= (Total Defects / Total Opportunities)* 1,000,000
DPMO- Defects per Million Opportunities
Source: Computed Data, Developed by Researcher

The five distinct problems solving phases of Six Sigma like Define, Measure, Analyze, Improve and Control. (DMAIC) using Lean Six Sigma Tools were studied using innovative methods and the following results were obtained.

- *Define*: The problem Statement, the goal, and the financial benefits are defined using the diagnostic study.
- *Measure:* The current performance of the process and required data are collected.
- *Analyze*: The root cause of the problem are analyzed using innovative Lean Tools.
- *Improve*: The process to eliminate errors and instability and to improve the process is identified.
- *Control*: The performance of the process are controlled and ensured that the improvements are sustained.

The Key Deliverables of SIX SIGMA Implementation in Automotive Components Manufacturing Industries are

- *Improved Service reliability*: Consistency of performance and delivered the service right the first time.
- *Improved responsiveness:* Timeliness of the response and readiness provided to the service when the customer wants it.
- *Improved assurance:* Created trust and confidence in the customer's base.
- *Reduced expenses:* Improved the effectiveness and accuracy of business processes.
- *Increased revenue:* Understood what their customer wants, when they want it and what the right price is.

The main deliverables on the implementation of Lean in Automotive Components Manufacturing Industries are:

- Reduction in work in process (WIP), or the backlog.
- Increased productivity.
- Increased process capacity,
- Improved area and / or organizational layouts for optimization.
- Standardized operations and processes.

7. Conclusion

The dynamism of Auto components manufactures participation has been mainly responsible for the success and sustainability of Lean Six Sigma Implementation. The participatory initiatives by the Ministry of MSME, NPC and LMC has changed the innovation, and quality of these auto components manufacturing enterprises. Managing Director of Unit said, "It is pleasure that we have improved our production through Lean manufacturing. Through this we have improved our quality and reduced cost of production. We are thankful as our entire management system is in good shape for the last one year because of this scheme". The Productivity has been improved considerably after implementation of Lean Six Sigma Manufacturing

Techniques. The initiatives are sustainable and can be replicated in other auto components manufacturers for sustainable development of Automotive Industries in India. The Lean Six Sigma Model helped Automotive Components Manufacturing Industries to manufacture less defective parts and also improves from 4.6 sigma levels to 5.8 sigma levels. If this trend continues, the other Automotive Components Manufacturing Industries in India will reach six sigma levels in near future. Lean Six Sigma implementation could pave way for Quality Management and Innovation, a necessary condition for sustainable development of automotive industries in the India.

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