Abstract

Objective: To propose appropriate measures for effective implementation of lean tools in small and medium companies.
Method/Analysis: At this context, a thorough study made on the performance of four sections namely plating, molding, stamping and assembly. Workers are made aware of the lean tools and implementation. Key Performance Indicators like DL(Direct Labour) Efficiency, TEEP(Total Effective Equipment Productivity) and OEE(Overall Equipment Efficiency) of these sections are measured.
Findings: It is found that although some manufacturing sections namely plating, stamping and moulding showed improvements by implementation of lean tools, assembly section had not shown any improvement. Subsequently Hoshin workshops and SMED(Single Minute Exchange of Die) classes are conducted. By these remedial measures appreciable increase in DL Efficiency, TEEP and OEE of assembly section is observed.
Application/Improvements: By the above revised lean tool implementation, operational excellence is achieved in all four sections.

Keywords: DL Efficiency, Lean Tools, OEE, Quality Factor, Small and Medium Scale Industry, TEEP

1. Introduction

Lean concept was introduced by Toyota manufacturing system in automobile industry in Japan\(^4\). Lean focuses on the following three aspects:

- Mudas (Waste) are to be eliminated from the system. By eliminating waste, the cost of the production was reduced and hence the products could be sold at a lower price with customer satisfaction.
- To minimize Mura and hence standardize the products reducing the high variation.
- To reduce Muri or unreasonableness. Lean was based on the concept that people were not problems, but they were the problem solvers.

Wastes were non value added activities and those activities were required for transforming materials into manufactured goods and there were mainly seven wastes namely:

- Over production - Over production refers to producing more than needed by next stage of operation.
- Waiting Time - this refers to idle time for workers and machines due to material shortage, non availability of tools and equipment.
- Inventory - refers to unnecessary high levels of raw material, works in progress and finished products.
- Transportation - this implies movement of parts of finished products into or out of storage between the processes that do not add value to the product.
- Excess Motion – it is includes the unnecessary motion of workers which diverts them from actual work place.
- Reprocessing – refers to a processing once more when it is done correctly for the first time.
- Defects – it refers to products which are below the standards laid by customers. Correcting them need extra labour and time.

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Lean Technology was implemented in Toyota production system at the initiative of Toyota developed a unique system of Lean Technology producing remarkable success. Thereupon several industrial firms all over the world started implementing lean tools with appreciable increase in Productivity and Efficiency. Lean was based on the point of knowing what a customer wanted values and works to find the best way to deliver that to them.

Lean tools were implemented to small and medium scale industries in early 2009. But in earlier periods; the lean tool implementation had not produced positive and sustained improvement. A systematic study was made on the effect of lean tool implementation on medium scale industry with the help of the questionnaire type survey made among the workers of the Connector manufacturing unit. The study was related to the following four aspects:

- Study to find how far the awareness of lean tools among workers influences implementing Lean Technology.
- Productivity, Efficiency, TEEP and OEE of various manufacturing sections of the company was measured before and after the lean tool implementation.
- Corrective measures were taken by the company to tone up the performance of the company.
- It was found that the appropriate measure to adopt for continual improvement of the Productivity, Efficiency and TEEP of every sections of the manufacturing department.

Medium and small scale industry especially electronic and electric industry had to survive the global competition within Indian manufacturing market. With the global competition, these industries faced grave challenges such as rising customer’s expectation, fluctuating demand and Quality. The earlier manufacturing style of making product available for the customer was enough to survive the above global competition. So lean technology with the emphasis on manufacturing excellence and continuous process improvement was introduced. In Lean manufacturing, products were manufactured only when needed and besides the products are made in tune with the specification and requirement of the customer. In Lean Technology, lean tools were implemented in every department of manufacturing unit so as to overcome the problems arising from global competition. The productivity, Efficiency, TEEP and OEE of every section was measured. In the electronic industry where this study was focused, lean tools were implemented in early 2009. It was found that some of the sections especially stamping and assembly sections had not attained the required level of increase, so remedial measures were adopted. Some of them were periodic study classes and seminars to working class for the awareness of the lean tools. As a result of the remedial measures, it was found that Productivity, DLEfficiency, TEEP and OEE of every department except assembly section had attained appreciable and sustained increase in (Productivity, DLEfficiency, TEEP and OEE).

2. Proposed Work-Measurement of Key Performance Indicators

When the Productivity, Efficiency, TEEP and OEE of moulding section and plating section of January 2014 to December 2014 were measured, it was obvious that productivity, Efficiency, TEEP and OEE of molding section and plating section have substantial and sustained growth by the application of lean tools. But TEEP and OEE of stamping section and assembly section had not shown steady and sustained growth.

Productivity of the moulding section and plating section of the manufacturing department of the company in 2014 Figures 1 and 2 indicates that stamping and assembly sections had not shown substantial and sustained growth, remedial measures were taken. To increase stamping OEE and TEEP, one of the remedial measures adopted was Kaizen workshop based on the weekly tool down time status. The purposes of Kaizen workshop are the following:

- For the top management, it implies innovation.
- For the middle management it implies continuous improvement.
- For the supervisor it implies maintenance.

![Figure 1. TEEP of Molding, Plating, Stamping and Assembly.](image-url)
From the workers it was expected drastic improvement in current processes, small continuous improvement in current processes and activities directed to maintain current technological, managerial and operating standard. Second remedial measure is the action to improve OEE. One of the reasons for low value of OEE is the high value of change over time. So SMED(Single Minute Exchange of Die) workshops are conducted to reduce the change over duration and to increase the frequency of change over. Therefore the SMED targets are:

- To produce every parts every day.
- To reduce the batch size and improve the production flexibility. The following SMED action reduced the change over time.
- Provide a change over trolley and this saved 8 minutes.
- Provided locating stoppers for easy alignment of the tool in this bed.

This saved minutes. By the SMED action, change over time is decreased considerably and thus OEE and TEEP of stamping section had been increased.

Figures 3 and 4 reveals that OEE and TEEP of stamping sections had not increased as a result of SMED workshops and TEEP and OEE in the months of 2014 in the case of the assembly section did not show appreciable and sustained growth. For improvement, the root cause of non improvement performance of assembly section is sorted and several workshops were conducted to find the root cause. One of the root causes was nest damage. Then the question of the nest damage arose. It was found that ribs of the nest got damaged. It was due to continuous use of nest and there was no timely replacement because high cost incurred for replacement and nest is machined in a single piece. The above problem was defined. It was inspected that rib damage occurs in insulating feeding section. Assembly inspector had detected the problem and this occurred in every shift and occurred 5761 PPM (Parts Per Million). It was detected by visual inspection. As the problem was detected and defined, corrective measures were taken. The following were some of the important causes of non improvement of performance of assembly section.

- Assembly cycle time is high.
- Internal PPM is relatively high.
- Lack of automatic packing machine.
- Internal defects of assembly machine.

Line balancing workshop is conducted to reduce the large cycle time from 50.50 sec to 7.014 sec. Because of the large cycle time productivity is very low, i.e 192 connectors/man hour. The salient features of balancing workshop are:

- Everyone is doing the same amount of work.
- Doing the same amount of work to the customer requirement.
- Variation is smoothened.
Table 1 indicates the measures taken to reduce the takt time. Another measure adopted was Hoshin planning workshop for toning up the performance of assembly section. The company used seven steps Hoshin planning process.

- Establish organizational vision. The relevant question under study was to explore the policies and procedures already existing to create and delay the objectives.
- Develop break through objectives which could be achieved in three to five years.
- Develop annual objective. The objectives that the company could achieve in that year so as to help to achieve the break through objective in three to five years.
- Develop annual objectives. Steps are sought out to turn the break through objectives into workable targets. Hence development was made at top level priorities and apply metric to them. Next business specific second and third level targets were created to improve the tie directly to the top level priorities.
- Implement annual objectives. This was the improvement executed using problem solving approach.
- Monthly review. The organizational meeting was held so as to review the progress of implementation of the objective.
- Annual review. At the end of the year, the organizational meeting was arranged to review the progress of operation, to know how far ahead or behind the target.

Another workshop conducted was 6σ which aimed at the absolute professionalizing the quality of management function. In 6σ the following key roles are identified for the successful implementation.

- Executive’s leadership and other members of top management are responsible for setting up a vision for six sigma implementation.
- Champions take responsibility for 6σ implementation across the organization in an integrated manner. Champions also act as mentors to black belts.
- Master black belts identified by champions act as in house coaches on 6σ. They develop their full time to six sigma implementation. They assist champions, guide black belts and green belts.
- Black belts operate under master black belts to apply 6σ methodologies to specific projects. They focus on six sigma project execution.
- Green belts are the employees who take up 6σ implementation along with other job responsibilities operating under the guidance of black belts.

After the implementation of the above mentioned remedial measures, OEE and TEEP of the assembly section for the month January 2015 to July 2015 were measured.

Figures 5 and 6 show that OEE and TEEP of assembly section record sharp and consistent improvement on implementation of lean tools with the above mentioned remedial measures.

### Table 1. Takt Time Calculation

<table>
<thead>
<tr>
<th>Shift Time (in Mins)</th>
<th>480</th>
</tr>
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<tbody>
<tr>
<td>No. of Shift Considered</td>
<td>2</td>
</tr>
<tr>
<td>Lunch/Dinner/Supper (in Min)</td>
<td>60</td>
</tr>
<tr>
<td>Tea Time (in Mins)</td>
<td>20</td>
</tr>
<tr>
<td>Breakfast Time (in Mins)</td>
<td>15</td>
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<tr>
<td>Shift End/Other (in Mins)</td>
<td>30</td>
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<tr>
<td>Available Time / Day (in Mins)</td>
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</tr>
<tr>
<td>Available Time / Day (in Sec)</td>
<td>50100</td>
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<td>No of Work Centre</td>
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<tr>
<td>Total Available Time / Day in Sec</td>
<td>350700</td>
</tr>
<tr>
<td>Customer Demand / Day</td>
<td>50000</td>
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<tr>
<td>Takt Time in Sec</td>
<td>7.014</td>
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3. Conclusion
The survey on performance measures of different manufacturing companies especially small and medium scale electronic and electric industry showed that, the performance toned up by effective implementation of lean tools, consistent follow ups in analysis of performance and remedial measures. By the introduction of lean tools, OEE and TEEP of stamping section haven’t shown appreciable improvement. As a result of various remedial measures like Hoshin workshops, Kaizen, continual improving operation, Line balancing operation, SMED programs, weekly meetings with the working class with analysis and review of the progress, OEE and TEEP got improved. It could be recorded that lean is a journey to look, see, understand, think, act again and again. Lean need to be seen as a continuous effort. It aims to have a continual improvement by successful implementation.

4. References