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A Rational Approach of Lean Tool Implementation to SME - A Case Study

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Abstract

Objective: To analyse the existing method of manufacturing and suggest to implement the appropriate lean tools in small and medium scale industries to improve their efficiency. **Method/Analysis:** At this context, an assessment is being carried out on productivity and quality factor in various manufacturing sections of a connector manufacturing company with the help of a survey conducted by the research group. **Findings:** It is observed that manufacturing sections namely plating, stamping and moulding sections showed improvements by implementation of lean tools whereas assembly section does not register any improvement. **Application/Improvements:** Appropriate remedial measures are taken to get continual improvement. So the necessary suggestions are given to measure the effectiveness of implementation of lean tools.

Keywords: Assembly Section, Continual Improvement, Lean Tools, Productivity, Quality Factor

1. Introduction

Lean Manufacturing (LM), strategy of reducing product cost by eliminating wastes in manufacturing process, with an emphasis on quality factor of products, was introduced by Toyota manufacturing system[1,2]. With the tremendous success of lean manufacturing, most of industrial concerns of the world started implementing lean tools with marginal increase in productivity and quality factor[3,4]. But medium and small scale industries especially electronic industry in India, could not sustain the improvement of efficiency of performance. By reducing waste in manufacturing, creating effectiveness and efficiency in all areas of business, building capability among labourers to work as a team and in calculating ability to identify issues and solve them, modifying the operations to the need of customers, increasing the quality of products, Toyota developed a unique system of lean technology producing tremendous success[5,6]. In the version of Toyota Group, lean technology is the systematic elimination of waste with the continual improvement in productivity and quality. In Toyota system, there was a healthy collaboration between Production and Management departments to ensure that required resources are provided timely and adequately and employees are judiciously engaged to implement Lean tools with adequate training programmes to support them. Lean utilises less or minimum of everything required for a product or a service[7]. Lean Technology is a strategy and its success is on the attitude of employees. So it was realized that success of lean implementation requires the engagement of people to know the real purpose and implication of the business. Lean should start from the point of knowing what a customer wants, values and needs and works to find the best and fastest way to deliver that to them. Lean implementation

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to small scale industries started towards the latter half of 1st decade of 21st century[8,9]. Lean tools were introduced by the connector manufacturing company in 2009 and this is evident from the annual report of the company in 2009. When lean technology applied to large scale industry, there was tremendous improvement in productivity and quality. But at first lean tool implementation when applied to SMEs(Small and Medium Enterprises), had very little impact on productivity and quality[10,11]. Medium and small scale industries especially electrical and electronics industry in India are facing global competition within Indian manufacturing market place. The traditional manufacturing approach of making product available for customer has been replaced by new manufacturing style of meeting the customer specific requirements. Lean Manufacturing is a strategy adopted to achieve manufacturing excellence with continual process improvement. When small and medium scale industries faced grave challenges such as rising customer's expectation, fluctuating demands and intense competition, Lean Manufacturing is introduced. Lean Manufacturing provides flexibility requirements to satisfy the rapidly changing demands of customer[12,13]. Lean Production is an integrated socio technical system which consists of social aspects (people and society) and technical aspects[14,15]. Some of the barriers preventing the improvement in productivity are lack of top management's awareness of lean tools and its implementation, financial constraints, dependence in traditional system of operation and conventional machinery, lack of technical skill of the worker, lack of supervision. In this article, a thorough study has been made to find how far the workers are aware of lean philosophy, how far the awareness would influence the effective implementation of lean tool, how far lean implementation influenced the productivity and quality factor of the product and examined the remedial measures taken and their effect on productivity. Total Effective Equipment Productivity (TEEP) and Overall Equipment Efficiency (OEE) were the tools applied on selected manufacturing sections.

2. Data Collection and Analysis

Lean is a philosophy which requires technical and social aspects. Lean tools implemented to Small and Medium Enterprises (SMEs) especially electronics and electrical industry in India could not produce immediate and sustainable improvement. At this case study, we made a thorough study to design a model for effective implementation of lean methodology to SME. This study chose a leading connector manufacturing company and their the employees mainly to explore:

- Awareness of employees regarding the Lean tools and their implementation.
- Problems in the manufacturing sector (Plating, Moulding, Stamping and Assembly sections).
- Reasons for non improvement of the productivity and finding out solutions to rectify them.

In order to implement lean technology in system, it was found that the six step processes were suitable like identify the problem, analyze the problem, find out the exact cause of non increase of productivity of stamping and assembly divisions, remedial measures like seminars and workshops were conducted to rectify the exact cause. After the remedial classes, lean tools were implemented and results were evaluated. The productivity and quality factor of products showed a remarkable rise and hence it was accepted that the above procedure being a corrective measure.

Strength of the Manufacturing unit being 770 workers with an average turnover of 400 crores with a profit margin of 240 crores after tax deduction. As per company records, it was obvious that until 2003, supply of the connectors was less than demand. Hence in global competition, profit margin got slightly reduced and this was as per financial highlights of the company from 2005 to 2008 and it is given in Table 1.

Table 1. Financial statement of the company from 2005-2008(Rupees in Crores)

Parameters	2005	2006	2007	2008
Turnover	1990	2010	2062.35	2008
Material Cost	1340	1380	1420.38	1630.99
Personal Cost	102.12	108.35	115.38	159.98
Profit Before Tax	460.03	511.25	565.33	359.59
Profit After Tax	341.24	344.42	399.46	242.76

Financial statement of the company from 2005 to 2008 showed that for surviving the global competition, the performance of the company had to tone up. Accordingly the company started steps for implementation of lean tools. Hence the company had inducted training to the workers regarding awareness of lean tools and method of its implementation. By study classes and conducting workshops, workers were made aware of lean technology. Then lean

tools were implemented by reducing wastes in transportation, inventory, unwanted movement, waiting period, excess processing, excess production and defects elimination. As a result, it reduced the cost per unit. Quality of product is improved without rise of cost per unit and products were manufactured and sold as per requirement of the customer. Besides manufactured goods with high quality and enough diversity were satisfy the needs of the customer. Lean tools were applied in four sections of manufacturing department namely Moulding, Stamping, Plating and Assembly. Lean tools were applied to quality control section. The intention of lean tool was to reduce the number of accidents and to eliminate the number of quality complaints[16]. Then lean tools were applied to supply and purchasing sections and finally to financial section also. The effect of lean tool implementation on performance of company was studied by measuring the key performance indicators[17,18]. The financial statement of the company from 2009 to 2013 is shown in Table 2, there was an initial improvement of performance of the company by the implementation of lean tool and the company could not sustain the improvement in performance. Owing to inflation and other factor, there was fluctuation in the turnover and profit of the company.

Table 2. Financial statement of the company from 2009-2013(Rupees in Crores)

Parameters	2009	2010	2011	2012	2013
Turnover	2522.82	3688.04	3596.52	2056.26	2628.17
Material Cost	1689.50	2638.68	2525.71	1620.17	2078.35
Personal Cost	186.63	33.41	384.01	234.26	275.81
Profit Before Tax	378.95	107.44	282.9	56.03	155.41
Profit After Tax	258.40	48.89	248.76	38.49	101.60

The performance of the company did not show continual improvement from 2011, 2012 and 2013. To design remedial measures for improvement, a questionnaire survey was conducted among the employees. This was mainly to explore awareness among employees regarding lean tools and its implementation, problems in the production sector and the basic reasons for non improvement of the productivity and solutions to rectify them. During the study, Employees were classified into four grades:

Grade 1 - One to two years of experience
Grade 2 - Two to five years of experience
Grade 3 - Five to eight years of experience
Grade 4 - above eight years of experience

The answers of fifteen questions were collected from all the employees. In the study, rating was made in accordance with the extent of their awareness in lean technology. Employees were categorized in accordance with the extent of their awareness in LM. They were classified into four types like little awareness regarding LM, partial awareness, average awareness and full awareness. They were given marks as 0.25, 0.50, 0.75 and 1. A sample of 100 employees was chosen from all the section of manufacturing division (Assembly, Stamping, Moulding and Plating).

3. Results after the Training Programme on Lean Tools

Study classes were conducted to improve the knowledge of workers regarding lean tools and its implementation throughout 2013 July to 2014 June is given in Table 3 and thereafter the survey was repeated. The survey conducted in 2013 indicated that 60% of workers in grade 4, 40% workers in grade 3, 30% of workers in grade 2 and only 20% in grade 1 having lean awareness. In accordance with this, the company conducted study classes and weekly meetings to improve the knowledge of workers regarding lean tools. This is continued for months and meanwhile Lean tools were implemented in all the four sections of manufacturing department. The key performance indicators were observed regularly[19]. TEEP and OEE of all the four sections of manufacturing departments were studied and the readings were recorded and plotted graphically. Also Lean awareness of workers was noted category wise.

Table 3. Percentage of lean awareness in 2013 and 2014

Grade Category	Percentage of Lean Awareness in 2013	Percentage of Lean Awareness in 2014
Grade 4	60	95
Grade 3	40	80
Grade 2	30	65
Grade 1	20	50

The study based on the survey showed that lean awareness of workers was improved sharply during first half of 2014 as a result of remedial measures like study classes on lean awareness and its implementation[20,21]. The details of TEEP and OEE input data collections are given in Table 4 and Table 5.

The key performance indicators like TEEP and OEE of the workers showed that there was a sharp increase in productivity of plating and moulding section by the implementation of lean tools after educating the workers regarding lean tools[22,23]. The graphical representation of TEEP and OEE of stamping section hasn't shown appreciable increase and the productivity of assembly section hasn't shown any observable rise. One of the reasons for this non increase might be that workers were not having sufficient technical skill regarding the operation of the machine. In this context, a root cause analysis was made in stamping section. Main reason found out was that change over time during this observation was enormously large. Hoshin workshops were conducted in all departments.

Performance indicator measures like TEEP and OEE were determined every month during 2014 and 2015, results were analysed and measures were taken for continuous improvement in every department. These measurements were made in all the four departments of plating, moulding, assembly and stamping. Also we measured quality factor in terms of accidents or number of quality complaints in every month. These measures, especially details of OEE and TEEP stamping lean production were given in Table 6.

The measurement of performance measures of stamping section showed that there is appreciable increase in productivity, TEEP and OEE and these increase could be sustained by the corrective measures taken. But the performance measures of assembly section showed that even after the remedial measures taken, there were marginal increase in productivity. To increase the TEEP, OEE and hence productivity of Assembly section, a thorough analysis is needed. The measured value of DL Productivity, DL Efficiency, TEEP and OEE in the months of 2014 showed that Assembly section did not show

Table 4. Details of TEEP input data collection in percentage

Index	KPI's TEEP Operations	Average OEE for the Month from the Lean Production											
		Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	July-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
L1	Assembly	40	38	34	41	41	41	38	30	34	41	42	30
L1	Molding	60	54	55	51	55	51	51	46	53.50	51.30	53.80	38.30
L1	Plating	55	50	48	41	51	54	47	45	55	52	47.20	35
L1	Stamping	48	41	42	41	42	40	33	40	47	46	39	26

Table 5. Details of OEE input data collection in percentage

Index	KPI's OEE Operations	Average OEE for the Month from the Lean Production											
		Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	July-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
L1	Assembly	62	64	60	66	61	65	67	62	63	58	62	57
L1	Molding	65	61	66	65	67	56	58	72	70	69.80	70.90	68
L1	Plating	72	70	70	69	70	71	67	74	77	76	75	72
L1	Stamping	60	53	55	54	54	55	53	55	55	55	54	52

Table 6. Details of OEE and TEEP stamping lean production in percentage

Index	KPI's	KPI-Input Data Collection	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
L1	OEE-Stamping	Average OEE-Stamping for the Month from The Lean Production	53	55	55	55	54	55
L2	TEEP-Stamping	Average TEEP-Stamping for the Month from the Lean Production	33	40	47	45	47	47

appreciable and sustained growth. To improve TEEP, OEE, Productivity and DL Efficiency following remedial measures were taken. The details of OEE and TEEP stamping lean production are given in Table 7. As a corrective measure of non improvement of performance of Assembly section, several workshops were conducted. One of the root causes was nest damage. The reason was found that ribs of the nest damaged. It was due to continuous use of nest and there was no timely replacement because of high cost incurred for replacement and nest was machined in a single piece. The above problem is defined. It was inspected that rib damage occur in insulating feeding section and assembly inspector had detected the problem and this occurred in every shift and occurred 5761 Parts Per Million (PPM) and it was detected by visual inspection. When 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 was conducted to reduce the large cycle time from 54.50 sec to 24.5 sec. Because of the large cycle time, productivity was very low as 192 connectors/man hour. The salient features of balancing workshop were everyone was doing the same amount of work, amount of work to the customer requirement and variation was smoothened.

3.1 TAKT Time Calculation

Total available time	= 2 Shifts/ Day (6 Days in a Week)
Customer demand	= 50000 Pieces/ day
Available working time per shift	= 480 minutes
Available time per day	= 835 minutes
Available time per day	= 50100 seconds
No. of work centres	= 7
Total Available Time/day	= 350700 seconds
Required TAKT time	= Total available time/ Customer demand
	= 7.014 seconds

Another remedial measure adopted was Hoshin planning workshop for toning up the performance of assembly section. The company used seven steps Hoshin planning process.

- To establish organizational vision. The relevant question under study is to explore the policies and procedures already existing to create and deploy the objectives.
- To develop break through objectives which could be achieved in three to five years.
- To 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.
- To deploy annual objectives- Steps were sought out to turn the break through objectives into workable targets. So we develop top level improvement priorities and apply metric to them. Next was created the business specific to second and third level targets to improve then directly to the top level priorities.
- To implement annual objectives- this was where improvements were executed using most problem solving approach.
- To conduct monthly review- The organizational meeting was conducted so as to review the progress of implementation of the Lean tools.
- Annual review- At the end of every year, the organizational meeting is arranged to review the progress of our operation to know how far ahead or behind is our organization regarding the stated objective.

Table 7. Details of OEE and TEEP of assembly lean production in percentage

Index	KPI'S	KPI-Input Data Collection	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
L1	OEE-Assembly	Average OEE-Assembly for the Month from the Lean Production	67	62	63	58	62	57
L2	TEEP-Assembly	Average TEEP-Assembly for the Month from The Lean Production	38	30	34	41	42	30

After the implementation of the above mentioned remedial measures, OEE and TEEP of assembly section for the months of January, February, March, April, May and June 2015 were measured and given in Table 8.

This research revealed, there were certain potential barriers blocking the success in lean implementation of SME. The barriers identified were:

- Lack of Lean understanding and its implementation know how among the workers.
- Lack of management focus and management support.
- Lack of innovative ideas.
- Resistance offered by workers for the change.
- Lack of team spirit and involvement in problem solving.
- Lack of technical skill.
- Lack of modern equipment.

4. Conclusions

In the light of above observations, the following essential steps were necessary for the effective implementation of lean technology in SMEs.

- There should be regular study classes, seminars by experts, interaction with workers and management, weekly meetings and evaluation of the performance by senior managers, discussion of relevant remedial measures, eliciting innovations and new ideas.
- Formation of multi-disciplinary team of chosen members among the workers. Every worker was instructed and trained to do every type of work. Workers are to be made to feel that they were the integral part of company and everyone should have collective involvement in the governance of the firm.
- Provide visual work place and visual control.
- Form various teams, each under inspiring leaders. They have to study and analyse existing processes and practices. Wastes are to be identified if any; innovative ideas were developed to eliminate waste.
- Use of efficient tools and techniques of Lean manufacturing to make goods of high quality.
- Use of five WHY techniques to find solutions for the existing problems and implement them. So cost of production was reduced without compromising quality for precise implementation of Lean technology. Priority was given for financial condition of the firm. By waste elimination, cost of production is reduced, profit margin was increased and financial condition of company got improved.
- Lean concept been used at customer end by providing systematic and easily understandable instruction to the customer regarding the minimization of waste at customer end. The customer satisfaction and retention had been increased by providing qualitative reliable product to customer with fast delivery and quick response.
- After sale service was provided to the customer through chain of material and shop floor management.
- Kaizen methodology could be incorporated to the working condition of the employees. Based on study and work one piece flow has to be implemented. Pull production system can be accepted with uniform loading of operators, reduction in movement by modifying layout and it will increase productivity. In Kaizen, we start the work, complete manufacture and make the product a standard one. Identify waste; minimize it, do it again. If successful, choose this as the corrected way.
- A carefully planned lay out had to be used. By carefully designing the plant layout and performance of the firm, cycle time can be reduced. Customer satisfaction was increased. Rearrange machine equipment, storage place of material and provide adequate space for working objective of maximum utilization of place and minimum movement and optimum utilization of machines.

Table 8. Details of OEE and TEEP of assembly 2015 in percentage

Index	KPI'S	KPI- Input Data Collection	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15
L1	TEEP Assembly	Average TEEP- Assembly for the Month from the Lean Production (%)	41	40	31	39	42	42
L2	OEE-Assembly	Average OEE- Assembly for the Month from the Lean Production (%)	57	61	57	58	61	61

- Total quality management methodology was an essential requisite of lean mode of performance of SMEs. This method reduces the defect of products by the involvement of management. Six sigma methodologies being an improvement of total quality management methodology. It aims at zero defects.
- Lean manufacturing has to be developed as an operating style or culture.
- For effective lean tool implementation, employee empowerment has to be ensured, commitment and involvement among workers, reduce reuse, remanufacture and recycle.
- Another factor for effective implementation of lean manufacturing to SME being visible and robust infrastructure. Visible and robust infrastructure network facility, improved distribution system, working capital reduction, fixed capital efficiency, inventory control, forecast based on customer, signal effective planning, effective feedback management, improved design, priority on customer needs, facilitating workers, motivation given to the workers being few factors leading to successful lean tool implementation.

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