PRODUCTIVITY ENHANCEMENT IN AN INDIAN SME BY INTEGRATION OF LEAN AND SIX SIGMA METHODOLOGIES - A CASE STUDY

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Abstract: A Small and Medium Enterprise is one in which the number of personnel employed are well below certain limits. Any enterprise with an investment between Rs.25 lakhs and Rs.10 crores is considered an SME.SMEs in India are considered as the backbone of the economy. It contributes to 45% of the industrial output and creates 1.4 million jobs every year. Despite this, India ranks quite low in World Bank's list of "Ease of Doing Business". A few reasons for this issue are low productivity, lack of skilled labour and inability to match the global manufacturing standards. This paper aims at resolving these issues. Lean Six Sigma coupled with the seven new tools of quality was implemented by the authors in an SME.A six-month research study was conducted. Data collected was analyzed and compared with the older data of the company. A productivity increase by 20% was recorded. The following paper establishes how the seven wastes of lean manufacturing were dealt with and how the DMAIC process helped achieve near perfection levels of manufacturing.

Keywords: Small and Medium Enterprises, Lean Manufacturing, Six Sigma, Enterprise Productivity, Kaizen, Manufacturing Enterprises.

Introduction: "Lean" literally means efficiency and without wastage. Lean manufacturing or lean production, often simply is a systematic method for waste minimization within a manufacturing system without sacrificing productivity. Six Sigma is a set of techniques and tools for process improvement. It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in the manufacturing and business process. Industries have found that lean six sigma is the most effective way to eliminate the flaws that lead to rework and scrap and thus enable Kaizen. (Smith, 2003). Lean is biased towards waste elimination whereas Six Sigma quantifies and solves problems through statistical tools and techniques. Synergizing the two approaches would have a greater positive impact on an industry. (Pepper, Matthew PJ, and Trevor A. Spedding, 2010) .All industries begin the approach by the implementation of current state map, 5S methodology and standardization. These tools lead to the elimination of a few wastes but the real chronic problems are solved once the six sigma techniques are actualized. (Kumar, Mike, et al, 2006). The benefits which a company implementing lean six sigma gets over a company not following suit are as follows: -

Boosting profits: streamlined processes result in products or services that are completed faster and more efficiently at no cost to quality. (Psychogios, Alexandros G., and Loukas K. Tsironis, 2012). Decrease costs: removing waste from a process. (Näslund, Dag, 2008). Improve efficiency: Maximizing your organization's efforts toward delivering satisfactory product or service to your customers (Fairbanks, Catharine, 2007). Develops effective people and teams: Involving employees in the improvement process. This promotes active participation and results in an engaged, accountable team. Improved customer loyalty: Surveys suggest, the reasons given by most customers for not returning to the business are dissatisfaction with the experience with the product and employee attitude. Implementation of lean six sigma shall give higher preference to the VOC, thus eventually satisfying and earning their trust and loyalty. (Arnheiter, Edward D., and John Maleyeff, 2005).

This research paper is a case study conducted to enhance the overall productivity of the SME. The case study is based on the data and values collected, analyzed and approached with the lean six sigma methodologies. The duration of the research study was 6 months. The main goal of the industry was to reduce the defects in the product, aim for inventory-less manufacturing, achieve customer satisfaction and thus enhance the productivity.

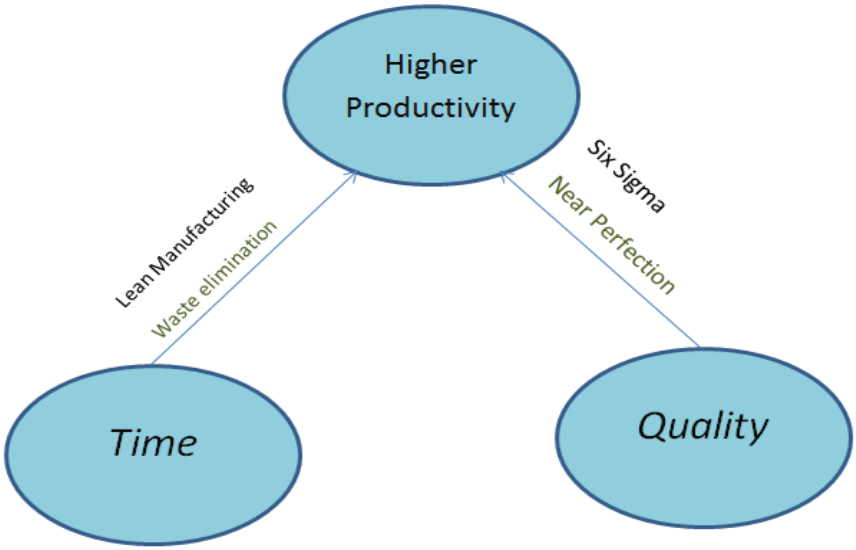


Figure 2

The rest of the paper is arranged in the following way. The next section gives an insight of the company, the problem it faces and the possible reasons for decreased productivity. The third section defines the integration of lean six sigma and the tools used in this research paper. The fourth section uses the DMAIC process for solving the problem and the fifth section implies how JIT helps in inventory-less manufacturing. (Bielecki, T., and P. R. Kumar, 1988). Finally, the productivity enhancement is calculated.

Company Background: The industry in this study is a manufacturing industry with 100 employees. It was established in the year 1993 and is involved in manufacturing radiators and coolers. It mainly focuses on the replacement market. The main problems faced by the company were as follows: -

- Sub-standard productivity
- excessive inventory
- inability to compete with the other competitors
- poor customer satisfaction

The Possible reasons for it were:

- absence of quality techniques
- excessive waste generation
- improper supply chain
- improper maintenance of machinery

Lean Six Sigma Integration: Lean speed necessitates six sigma qualities. Six sigma qualities enables lean speed (fewer defects means less time spent on rework (Salah, Souraj, Abdur Rahim, and Juan A. Carretero, 2010).

The problem solving approaches in lean six sigma are as follows:

- DMAIC
- PokaYoke
- JIT

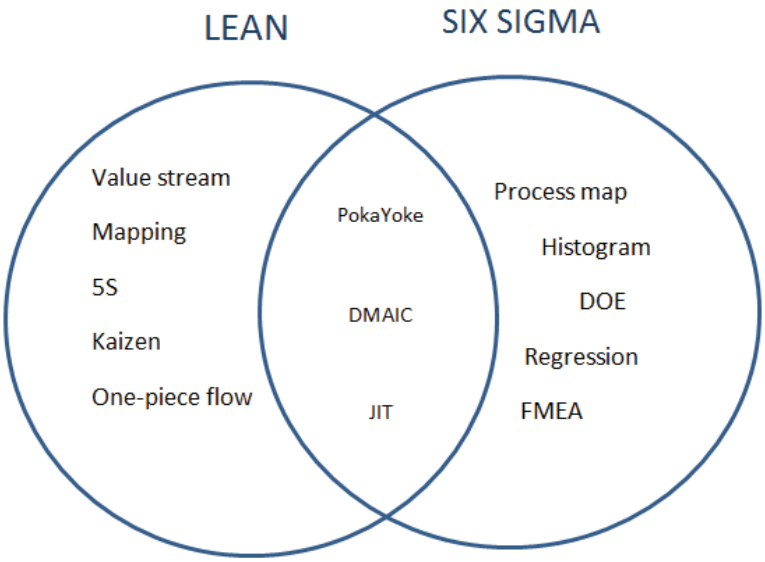


Figure 2

DMAIC: Define a Project: The improvement opportunity and the compelling need of the project are to be established (Salah, Souraj, Abdur Rahim, and Juan A. Carretero, 2010). The Improvement opportunity has been defined in table 1.

Measure: Control Chart is a tool used to measure the stability and to identify the special causes involved in the process. It is referred to as "Voice of Process". (Hsieh, Chang-Tseh, Binshan Lin, and Bill Manduca, 2010). The control charts in Figure 3 shows the instability in production.

Table 1

	Threats	**Opportunity**
Short Term	• Failure to match immediate goals • Additional expenses incurred due to increased lead time	• Possibility of matching immediate goals • Systematic functioning of the SME
Long Term	• Loss of customer base • Decline in market share	• Stronger market share and increased profits. • Leads to better opportunities of growth of the company

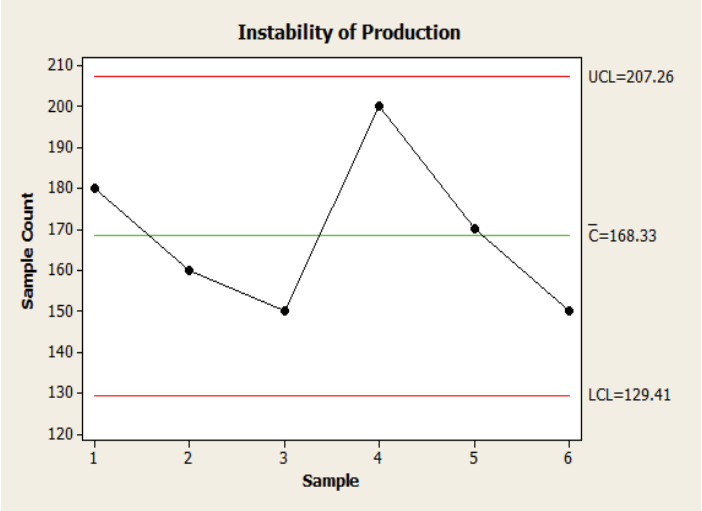


Figure 3

Analyze: It is carried out to determine the root cause and to validate the same (Furterer, Sandra, and Ahmad K. Elshennawy, 2005). The Pareto Analysis was conducted to determine the root cause. (Fig 4). The root cause was found to be excessive scrap generation.

Improve Performance: Once the root cause was analyzed, the next step was to improve the performance by eliminating the root cause. It can be done by shifting the mean in line with the CCR and CBR or it can also be done by reducing the variation. From the fig 4, the root causes are clearly defined in the order of their occurrence.

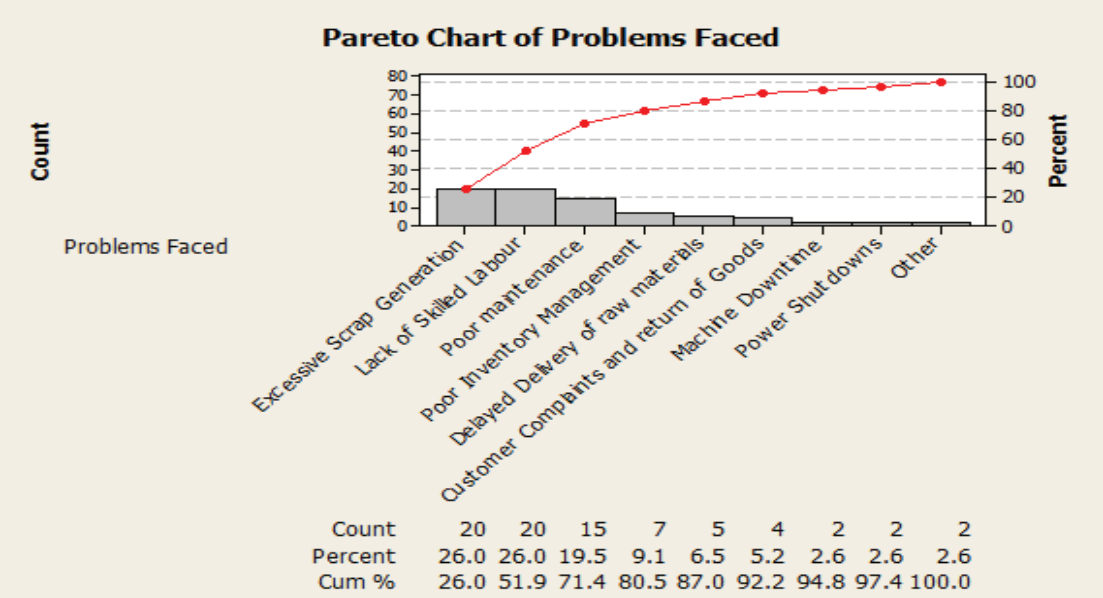


Figure 4

In this case, the concept selection for performance improvement was done in the following ways: Brainstorming and affinity diagrams to understand the exact issue and organize and prioritize ideas.

- The suggestions for scrap reduction were recommended to the top-level managers of the SME.
- From the PUGH evaluation matrix (fig5) it was understood that JIT would be the best viable option to be implemented at this stage followed by Industrial Symbiosis.
- Pugh matrix was used to select the solution (Tenera, Alexandra, and Luis Carneiro Pinto, 2014).

1	PUGH MATRIX EVALUATION CONCEPT - SCRAP REDUCTION					
2	Criterias	Imp ratings	AS IS process	Industrial Symbiosis	Just In Time Production	High Skilled Labour
9	Expenditure	5		+	+	+
10	Time to implement	4	Cutting	-	-	-
11	Impact time	3	Edge	-	-	-
12	Resources	4	Technology	-	+	+
13	Percentage of scrap reduction	5		+	+	-
14						
15						
16	SUM of Positives			2	3	2
17	SUM OF Negatives			3	2	3
18	SUM of Sames			-	-	-
19	Weighted Sum of Positives			10	14	9
20	Weighted Sum of Negatives			-11	-7	-12
21						
22	Final Result			-1	7	-3

Figure 5

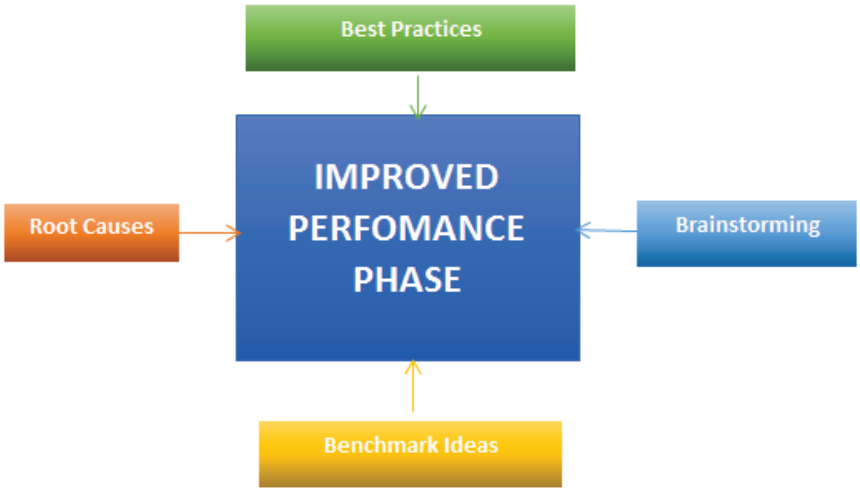


Figure 6

Control: Implementing solutions is a major milestone of a project. This was basically the final phase of the DMAIC process. From the previous phases it was understood that Just In Time production would be the perfect solution to the excessive scrap generation problem. (Flynn, Barbara B., Sadao Sakakibara, and Roger G. Schroeder, 1995). The following is a list of proposals suggested and the proposals accepted and implemented by the SME.

Table 2

S.No.	Proposals	Implemented	Stalled
1.	Compact plant layout		✓
2.	5S	✓	
3.	Setup Reduction	✓	
4.	Skill diversification		✓
5.	Kanban		✓
6.	Preventive maintenance	✓	
7.	Error proofing	✓	

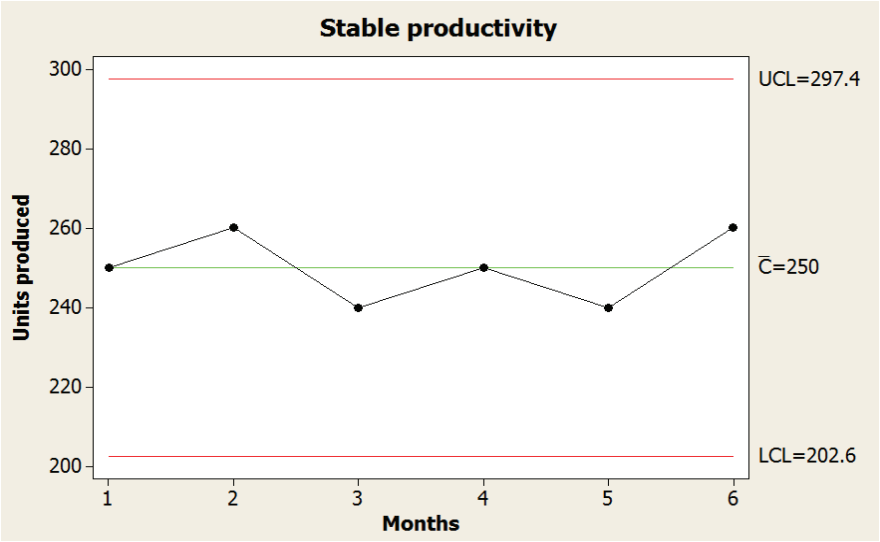
Calculation - $Takt\ time(before\ implementation) = \frac{400}{20} = 20\ minutes\ per\ unit$

$$Takt\ time(after\ implementation) = \frac{400}{24} = 16.6\ minutes\ per\ unit$$

Thus, the productivity of the SME, which is measured in JPH in this research paper, is improved from 20 minutes per unit to 16.6 minutes per unit and hence a total of 3.4 minutes per unit is saved. This results in the overall increased productivity of the company.

Conclusion: The following conclusions can be obtained from the paper:

- The implementation of lean six sigma provided the SME with an opportunity to achieve high standards while improving quality and productivity.
- The DMAIC process has led to the systematic identification of the problem and has provided solutions to address the same.
- Implementation of JIT leads to waste reduction and at the same time the layout change and inventory-less management leads to enhanced productivity i.e. by an increase of 20%.



- The figure 8 shows to which the productivity has stabilized after the implementation of Lean Six Sigma.
- Though profitability and productivity for an SME implementing Lean Six Sigma keeps improving, many companies ignore it as they think it to be time consuming and unnecessary. Apart from this, there is an absence of a defined set of tools and techniques within the Lean Six Sigma framework. This is a potential area of future research for the researchers.

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