

# Lean Management and Six Sigma Practices within Small and Medium Manufacturing Industries

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**Abstract**— In today's world Lean and Six Sigma techniques are used in quality management sectors because it gives an opportunity to identify the defects and removing these defects using process capability and variability studies in business process. The objective of the study is to assess analysis of lean management and Six Sigma practices within small and medium sized manufacturing industries (SMEs). It was found from studies that management involvement, employee commitment, proper education and training are essential to bring a culture of Lean and Six Sigma with in SMEs. The major firms who believes in Six Sigma practices realized a improvements in the performance of daily operations (such as reduction in lead time, overall customer satisfaction, reduction in inventory level and cycle time after implementing Lean methodologies as compared to non-Six Sigma industries. The paper argues that there are major differences in management practices of SMEs, which leads to affecting their business performance level.

**Keywords**— Six Sigma, Lean, SMEs, ISO, Organizational Performance

## I. INTRODUCTION

Lean Management is an integrated system of continuous quality improvement aimed at meeting internal and external customers. The use of Lean Management as an overall quality program is still prevalent in advanced industry, but many industries are extending these principles to solve financial and strategic issues. The SMEs constitute the bulk of industries, with a major contribution to private sector output and employment in all economies. They also play a vital role in improving the competitiveness of larger companies by being an essential element of their supply chain and thereby providing high quality level.

Six Sigma is a business strategy that seeks a statistical approach to identify and eliminate causes of errors or defects, defined as anything which could lead to customer dissatisfaction or failures in business processes by focusing on outputs that are critical to customers; it uses various distributions and a strong relationship between product Non-Conformities, defects and product yield, inventory, schedule, etc. The activities of Six Sigma are not limited to process or operation levels, but extended to all levels of an organization to reduce cost and produce high quality products/services. Motorola and General Electric are the two most well-known success cases of Six Sigma implementation. Moreover, the Six Sigma tools is also gaining acceptance in healthcare, financial, marketing, legal service companies, in addition to achieving major benefits in respect to the manufacturing sector.

In the quest of process improvement, organizations have pursued quality initiatives such as total quality management (TQM) and continuous improvement methodologies such as Kaizen and more recently Six Sigma.

In spite of a number of success Six Sigma stories in large organizations, many SMEs are yet to be convinced of the benefits from the introduction, development, implementation, and deployment of Six Sigma. In order to explore the practicality of Six Sigma implementation within India SMEs, this research attempts to compare the quality management practices within small and medium SMEs through case study analysis.

The next section discusses the research methodology adopted to explore the quality management practices in Indian SMEs.

## II. RESEARCH METHODOLOGY

The objective of the study is to assess the status of Lean Management and Six Sigma practices in Indian manufacturing SMEs and compare the quality management practices with major companies. Given the nature of research, a case-study based approach seemed appropriate. Case study research is one of the most powerful research methods in operational management, especially in developing a new theory. Voss [9] defines a case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident. It focuses on understanding the dynamics present within single settings [1]. It is argued to be a favorable strategy for attaining a broad understanding of the research context, and the procedures being announced [3]. In addition, multiple sources of confirmation are emphasized and are viewed as critical in terms of securing data [10].

In the first part of research, the authors identified a list of SMEs implementing quality initiatives such as Lean, Six Sigma, total quality management (TQM), and Kaizen and certifications such as ISO 9000, by conducting surveys in 500 SMEs across the UK. For more information about the findings, see reference [11]. SMEs that participated in the survey were randomly selected for conducting in-depth interviews with respect to their quality management practices and their impact on organizational performance. This strategy further helped in checking for bias in selecting the case-study companies.

After the identification of SMEs implementing Six Sigma/Lean and ISO, multilevel case studies were conducted in the five SMEs. Selection criteria were based on size, type of industry, location and type of quality practices in the SMEs. Interviews were conducted for data samples, targeted at three levels in the organizations, i.e. senior managers, middle managers and shop-floor employees, with each interview lasting for about one hour, to get more information on the quality management practices. The questionnaire was designed by reviewing the

past literature on quality management practices in SMEs [2], [4], [6], [7] and [8].

The interview covered: geographic location of the firms, type of quality initiatives in the firms, success factors and linking the quality initiative to organizational performance. Some questions were added and deleted, but the theme of the study remained the same. The next section discusses the findings from case studies of five SMEs.

### III. CASE STUDY ANALYSIS

#### A. Details of Company A

Company A was formed in 2002, specializing in the design and manufacture of electronic connectors for data communications hardware. It employs 24 people, with an annual turnover of 28, 00,000 INR in 2015. The company has won several awards in the last two decades on account of its success manufacturing capability that embraces Lean and Six Sigma.

#### B. Details of Company B

Company B was formed in 2008, specializing in the design and manufacture of high temperature metal seals, CNC machine components, products for aerospace and industrial sectors. It employs 16 people, with an annual turnover of 53, 00,800 INR in 2015.

#### C. Details of Company C

Company C was formed in 1996. It employs 28 people, with an annual turnover of 63, 25,100 INR in 2015. The company manufactures products that range from different types of paper, thermal tags, tickets and labels for airlines and packaging industries.

#### D. Details of Company D

Company D was formed in 2006, specializing in the design and manufacture of single and multi-core cables. It employs 33 people, with an annual turnover of 48, 12,789 INR in 2015. The company supplies cables to different industrial applications all over India.

#### E. Details of Company E

Company E was formed in 1995, specializing in the design and manufacture of automotive parts. It employs 87 people,

with an annual turnover of 1 crore INR in 2015. The company has implemented projects related to Lean and Six Sigma such as quick changeover and process mapping for better business performance.

Other details of the companies are provided in Table 1.

### IV. PROPOSED METHOD

#### A. Quality initiatives in SMEs

Company A got ISO 9001:2000 certification in its effort to standardize the process and improve its revenue. Extending its continuous improvement, the company started Lean implementation in 2008. The company failed to implement Lean successfully in its first attempt in 2008 owing to poor communication and no involvement of employees at the shop-floor level. The lessons learned from this mistake helped the company successfully to implement Lean in 2010 by introducing it at shop-floor level. Company B acquired ISO 9001:2000 certification in 2011, followed by Lean implementation in 2010. At the time of interview, the company had already started applying Lean and Six Sigma principles in the administrative and finance processes. Companies C and E had gone through the route of ISO 9001:2000 accreditations in order to sustain their business in the market. Both these companies have witnessed several changes in management in the last 20 years. Company D had recently started applying Lean principles to minimize waste at the shop-floor level. Company D acquired ISO 9001:2000 certification recently in 2014 in order to implement Lean principles at every level in the organization. All the employees in the company attended a one-day workshop on the basics of Lean and its impact on business performance at both strategic and operational levels. Once the employees realized the benefits of Lean implementation and started believing in the principles of continuous improvement, the management decided to embark on Six Sigma to tackle the variation problems existing in their business processes.

Table 2 summarizes the quality initiatives undertaken in the case-study companies to date.

Company	Manufacturing Activity	Company Type	Annual Turnover	Location	Number of employees
A	Electronic components	Independent	28, 00,000 INR	Bangalore	24
B	Mechanical parts	Independent	53, 00,800 INR	Bangalore	16
C	Paper, packaging	Independent	63, 25,100 INR	Bangalore	28
D	Electrical components	Independent	48, 12,789 INR	Chennai	33
E	Mechanical parts	Independent	1 Crore INR	Chennai	87

Table 1: Company details

	Company A	Company B	Company C	Company D	Company E
Quality Program, certification achieved in the year	Lean (2008)	ISO 9001:2000 (2011)	ISO 9000 (1997)	ISO 9001:2000 Lean (2014)	ISO 9000 (1999)
Existing Quality Program	Six Sigma, Lean	Six Sigma, Lean	ISO 9001:2000	ISO 9001:2000, Lean	ISO 9001:2000 Lean & Six Sigma

Table 2: Quality initiatives taken by the company

#### B. Motivation behind embarking on Lean initiatives

Table 3 provides information on the motivation behind implementation of CI initiatives such as Lean and Six Sigma

or certification systems such as ISO 9001:2000 in the case-study companies. The Managing Director in all companies were committed to keeping the business sustainable on a long-term basis, resulting in the implementation of

continuous improvement initiatives and allocating resources to drive improvements in quality, performance, and customer satisfaction. For companies C and D, the main objective behind achieving ISO certification was to improve their market share and retain existing customers. However, interviewees in all four firms believed that accreditation also facilitated documentation and standardization of the procedures in place. If the procedures are not formalized, employees do the same things in different ways, creating confusion and chaos in the organization. It is almost impossible to implement Lean or any kind of strategic improvement initiatives without having established processes and procedures in place. It also depends on the maturity and existence of the firm: if it is a new business with 10–20 employees, ISO may help to establish the procedures. After documenting the procedures, the company is in a position to define their process, understand the input/output, and start measuring their process by collecting data. This is the time when the company is ready to embark on Six Sigma. Other senior and middle management executives expressed their view that ISO helped the company in establishing the structure and implementing procedures and worked as a foundation to get started with Lean and Six Sigma. Similar findings were reported during the interview with executives in companies B, C, and E.

V. RESULTS

Interviewees in the case-study companies were asked to rate, on a scale of 1 to 5, the benefits their organizations have experienced following the implementation of quality

initiatives. Table 4 shows the degree of improvement realized on a 1 to 5 scale after the implementation of quality initiatives. The score across each of the performance indicators reflects the improvement made by the SME after implementing the program. The table 4 gives information on the performance metrics existing in the company and the improvement realized after implementation of the program. It can be seen from Table 4 that company A has realized significant improvements in operational measures (including reduction in scrap, cycle time, and delivery time, and increase in productivity) and strategic measures (including increase in sales and profit and reduction in costs) of organizational performance from the implementation of Six Sigma. Since company B implemented Six Sigma in 2007, they have started to realize improvements in the established performance metrics. The improvement in the performance of company C is not the result of ISO certification, but of the use of tools and techniques of continuous improvement, as cited by the interviewees. The company has managed to reduce customer complaints by working close with the customer and through the nature of their personal business. The improvement can be attributed to the company’s reaction to changing market forces and stiff competition. However, ISO has helped in developing process thinking, working closely with customers, and improving delivery performance.

Similarly, in company D, improvement is the result of using tools and techniques, implementing the ERP system, and adhering to the basic concept of Lean manufacturing, i.e 5S practice.

	Company A	Company B	Company C	Company D	Company E
Motivation for Lean Initiatives	<ul style="list-style-type: none"> <li>- Lean</li> <li>- To improve work flow</li> <li>- Six Sigma</li> </ul>	<ul style="list-style-type: none"> <li>- Lean</li> <li>- Minimize waste</li> <li>- Customer focus using Six Sigma</li> </ul>	<ul style="list-style-type: none"> <li>- ISO 9001:2000</li> <li>- Preferred supplier status</li> <li>- Standard work instructions</li> </ul>	<ul style="list-style-type: none"> <li>- ISO 9001:2000</li> <li>- Reduction in customer complaints</li> <li>- Lean and 5S in the Shop floor</li> </ul>	<ul style="list-style-type: none"> <li>- Lean</li> <li>- To solve bottlenecks</li> <li>- Customer focused</li> <li>- Good control over inventory</li> </ul>

Table 3: Quality initiatives taken by the company

Performance Indicators	Performance evaluation of companies on 1 to 5 scale				
	A	B	C	D	E
Reduction in cycle time	4	4	3	4	3
Reduction in delivery time	3	3	4	4	4
Increase in productivity	4	4	3	3	4
Increase in profits	4	4	5	4	4
Reduction in customer complaints	4	3	4	3	3
Reduction in employee complaints	3	3	6	4	3

\*1 = negative benefit/improvement; 2 = no benefit/improvement; 3 = some benefit/improvement; 4 = significant benefit/improvement; 5 = crucial; 6 = measure not used.

Table 4: Quality initiatives taken by the company

Projects	Hard savings	Soft savings
Reduction in changeover time	30%	Increased employee efficiency
Reduction in rework	50%	Cleaner and safe work environment
Reduction in scrap rate	76%	High employee satisfaction
Reduction in floor space utilization	250000 – 750000 INR/year	High job retention
Reduction in raw material & inventory	35%	Improved support process
Reduction in customer complaints	15%	Improvement in problem solving

Table 5: Lean implementation benefits

Typical improvements that can be achieved through Lean and Six Sigma are shown in Table 5. The table is based on improvements witnessed in company E. Since

the company started Lean, all core processes, from receipt of order to dispatching, have been mapped, resulting in improvements in throughput and overall equipment

effectiveness (OEE). The implementation of 5S resulted in reorganization of the manufacturing line, which in turn brought savings 250000 – 750000 INR/year. Some of the other improvements through the Lean initiative are listed in table 5. Since the implementation of Six Sigma, company A has executed five projects that have had a significant impact on customer satisfaction and bottom-line savings of over 275000. Similarly, company E has finished Six Sigma projects, resulting in savings of over 1252000 INR.

## VI. CONCLUSION

The research demystifies the fact that Six Sigma can be implemented only in large organizations. The findings clearly indicates that Six Sigma can be implemented successfully in any organization, irrespective of the size of the company, as observed in the companies A, B, C. The observations made with SMEs following Lean and Six Sigma, as identified by the case – study analysis, are stated below:

- 1) SMEs selected their most talented, experienced people across the organization for training related to Six Sigma and projects execution. Process improvement was the main goal of the manufacturing department in the firms.
- 2) The decision making power in the SMEs was given to middle level managers or supervisors on the shop floor. They were ultimately responsible to make decisions for their own processes.
- 3) Like other big companies, SMEs were more focused on making cost savings either in the process or products.
- 4) Significant differences in performance were observed in the firms as discussed in section 5.

It is imperative for SMEs to have a strong management commitment and good leadership skills before embarking on Six Sigma program. If Six Sigma is only considered as the implementation of statistical tools and techniques to solve complex problems in the organization, it is doomed to fail owing to its very weak linkage to strategic business objectives. Six Sigma is about overall business strategy, culture, and change, and the small companies embarking on the Six Sigma initiative need to build all of this into a sound corporate strategy plan [9].

The next phase of the study will aim to construct a framework for SMEs to get started with Six Sigma implementation. The framework will be based on the findings from a systematic literature review survey, multiple case studies conducted related to manufacturing SMEs. The framework will be further tested in 2-3 case study companies to check its validity and robustness in different environments. Future research should attempt to establish the organizational infrastructure for Six Sigma implementation in SMEs.

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