

# Lean six sigma - critical success factors for implementation in small and medium enterprises

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**Abstract**—Small and Medium sector are the real backbone of the manufacturing sector of any country. This work is basically aimed at finding the factors influencing the implementation of Lean Six Sigma (LSS) in small and medium sector organizations within Kerala. The main beneficiaries of this work would be the manufacturing SMEs (small medium enterprises) sector in Kerala. In the initial part a detailed literature review was conducted to identify the factors that contribute to the successful implementation of LSS in SME sector. From this analysis 31 factors were identified and a structured questionnaire was prepared to test each of those variables. The survey was conducted mainly in the districts of Palakkad and Thrissur. The survey consisted of 142 organizations of which 80% belonged to small scale sector and around 20% belonged to medium scale sector. The data collected was analyzed using SPSS (statistical package for social sciences) software. Exploratory factor analysis was used as a tool to arrange the question in the questionnaire into required heading, thereby 6 main topics were extracted and the correlation between each of those factors were identified using SPSS software. The result obtained showed the lack of awareness about about the concept of LSS. As a result the implementation of LSS is almost non-existent. In such a circumstance this study will throw light upon the fundamentals which need to be strengthened so that this concept is applicable within the SME sector, thereby improving the overall quality of manufacturing industries within Kerala.

**Index Terms**—Lean six sigma, SMEs, Exploratory factor analysis, SPSS

## I. INTRODUCTION

The concept of lean and six sigma has gained vast popularity in manufacturing organizations worldwide, but very few organizations in India are using this concept. lean has become widely recognised as an effective tool to reduce waste and is in practice in most of the large and medium sector organizations, either applied in its real sense or done without realising it is lean. Six sigma on the other hand is mainly confined to those large organizations that has a strong motive to produce quality goods. The combined effect of lean and six sigma can work magic for the organization by complimenting one another. Six sigma focuses on the reduction and removal of variation by the application of a set of statistical tools and supporting software, where as lean thinking focuses on the reduction and removal of waste by process and value analysis. The reluctance of small and medium organizations to implement lean six sigma is the motivation factor behind this work. Combining these two methods gives the organization a comprehensive tool set to increase the speed and effectiveness of any process within the organization – resulting in increased revenue, reduced costs and improved collaboration. There are a lot of documented evidence for the successful implementation of LSS in large scale organizations but this is not the case with SME sector. This research is primarily intended to find the factors that contribute to the successful implementation of LSS in SMEs sector in Kerala. Objectives of the research include

- Study the critical success factors and their effects on LSS implementation
- Assessing support provided by government for LSS

## II. LITERATURE REVIEW

The Lean manufacturing can be a group of practices to eliminate waste. There are 3Ms in lean manufacturing - Muda, Mura and Muri. It is a “system for the absolute elimination of waste” [1]. Lean manufacturing represents a multifaceted concept that may be grouped together as distinct bundles of organizational practices [2]. Six sigma is another method which improve company performance by reducing the defect percentage. Six Sigma is a process which gives more value to customers and stakeholders with focus on improving product quality and company productivity [3]. In statistical word, sigma is a measure of process variability referred to as the standard deviation and 'six si gma" generally implies occurrence of defects at a rate of 3.4 defects per million opportunities (DPMO) for defects to arise [4]. Lean and six sigma essentially aim at removal of waste. Lean considers unproductive work as waste where as six sigma considers variation from a process as waste. There is now a substantial body of research on lean, most of which focuses on highly automated, repetitive production environments [5]. Fig 1 explains main steps of six sigma methodology.

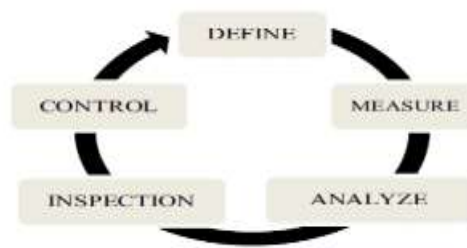


Fig 1 Main steps of six sigma methodology

Combining both lean and six sigma methodologies for improved performance has led to a new concept called lean six sigma (LSS). The integration of the two methodologies attempts to provide empowerment even at the higher-level process analysis stages, so that employees have true ownership of the process [6].

**III. METHODOLOGY OF RESEARCH**

The basic motive behind this research is to find those factors that influence the implementation of LSS in SME sector in Kerala. Initially a detailed literature review was conducted to identify the factors behind the successful implementation of lean, six sigma and combined lean six sigma methodologies. From this a set of 31 independent variables were identified and a questionnaire was prepared to test each of these variables. Exploratory factor analysis (EFA) was used as the key to categorise these independent variables into 6 factors. The variable which measure each of those factors are studied and relative importance of each of those factors are identified. SPSS software is used as the tool to carry out this research. In addition to this the awareness and use of LSS tools were studied. The purpose of EFA is for finding the variables having maximum influence on the research area with the greatest reliability. Studies have revealed that adequate sample size is partly determined by the nature of the data [7]. SPSS (statistical package for social sciences) software was used for the analysis. Figure 2 explains the methodology of LSS.



Fig 2 methodology of LSS

**IV. ANALYSIS**

The first step was to find out the value of Cronbach’s alpha. Cronbach’s alpha is a measure of internal consistency, that is, how closely related are a set of items as a group. Figure 4 explains the reliability analysis.

**Scale: ALL VARIABLES**

**Case Processing Summary**

		N	%
Cases	Valid	142	100.0
	Excluded <sup>a</sup>	0	0
	Total	142	100.0

a. Listwise deletion based on all variables in the procedure.

**Reliability Statistics**

Cronbach's Alpha	N of Items
.803	31

Fig 3 Reliability analysis

Reliability score of 0.70 or above is considered as a good value for a psychometric instrument. The alpha value obtained in this research is 0.803. The KMO statistic is a summary of how small the partial correlations are, with respect to the original (zero-order) correlations. KMO values greater than 0.8 can be considered good, KMO values less than 0.5 require corrective measures. The value of KMO obtained in the research is 0.621 which is satisfactory and no deletion of items were necessary to make the value significant. After finding the KMO value scree plot was drawn to analyse the number of factors to be extracted. Figure 4 and 5 represent KMO Bartlett’s test and scree plot respectively.

**KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.621
Bartlett's Test of Sphericity	Approx. Chi-Square	2212.815
	df	465
	Sig.	.000

Fig 4 KMO and Bartlett's test

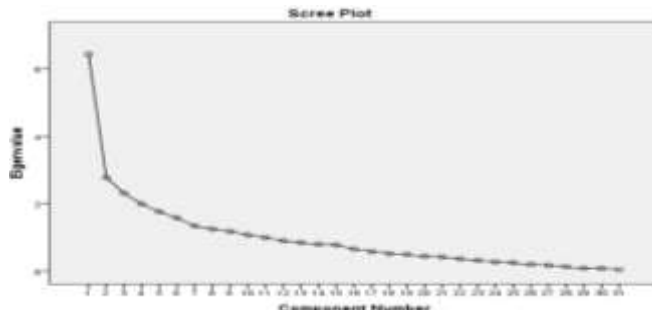


Fig 5 scree plot

From the above scree plot 6 factors were found to have significant influence on the collected data, so while calculating rotated factor matrix in the options command of SPSS the number of factors were fixed manually to 6 and values below 0.3 were suppressed in order to avoid clutter of information in rotated factor matrix (RFM), that does not have significant influence on LSS in SME sector of Kerala. Figure 6 represents rotated factor matrix.

	Component					
	1	2	3	4	5	6
VAR00001					.448	
VAR00002	.869					
VAR00003	.521					
VAR00004	.693				-.310	
VAR00005					-.628	
VAR00006	.720					
VAR00007	.685	-.315			.310	
VAR00008	.748					
VAR00009			.860			
VAR00010	.690			.318		.363
VAR00011	.486		.389	.481		
VAR00012	.771					
VAR00013					.538	
VAR00014		.623		.432		
VAR00015		.359		.310		
VAR00016				.384	.368	
VAR00017		-.325	.721			
VAR00018						.675
VAR00019						.554
VAR00020					.325	.654
VAR00021		.661				
VAR00022		.562	.456			
VAR00023		-.441				
VAR00024			.638	.452		
VAR00025				.841		
VAR00026						
VAR00027		.679				
VAR00028		.311			.393	
VAR00029				.378	.343	.315
VAR00030			.406			
VAR00031	.560					

Extraction Method: Principal Component Analysis.  
 Rotation Method: Varimax with Kaiser Normalization.  
 a. Rotation converged in 13 iterations.

Fig 6 Rotated factor matrix

## V. RESULTS

The Six critical factors contributing to LSS implementation in SME sector were identified as - management commitment, employee motivation, education and training, financial capability, organizational culture and infrastructure and customer satisfaction. Management commitment has the largest number of factors contributing to it (10 variables) while financial capability and customer satisfaction has the least number of factors (3each). The support provided by the government was found not to affect the LSS implementation in SME sector. The support provided by the top management to its employees

(0.829), special schemes to improve the overall quality of life of employees (0.679), the effect of internal politics (0.860), plans for expansion and improvement (0.841), capability to eliminate waste (0.628), after sales service (0.675) were found to be the key variables which are having substantial influence on the 6 factors identified.

## VI. LIMITATIONS

The survey basically was done in a few districts in Kerala, even though the results obtained in this study is believed to reflect the general trend through Kerala. There might be minor differences in industrial climates across various districts within the state. Variables such as support provided by the government, effect of internal politics etc. could not be accessed to the required level. Majority of the workers in SME sector were from north India and they showed very less cooperation with the research. Another major limitation is that very often people in industries tend to give biased information. Although all the companies regarded quality and customer focus as their main objectives but are practically were focusing on quantity rather than quality.

## VII. CONCLUSIONS

- LSS implementation in SME sector in Kerala could be made possible if all the six critical success factors of management commitment, employee motivation, education and training, organizational culture and infrastructure, customer satisfaction and financial capability are taken care off.
- Management involvement is found to have an influence on LSS implementation in order to successfully implement the concept of lean manufacturing successfully within SMEs. The companies also should have strong leadership capable of excellent project management.
- Management involvement emerged as the factor with largest number of variables (10 variables) and customer satisfaction and financial capability had the least number of variables (3each). which shows that in order to improve customer satisfaction and financial capability organizations need to rectify less number of variables where as it is much tedious in case of management involvement

## VIII. FUTURE WORKS

- LSS could be practically implemented in an organization within SME sector and its success could be used as a motivating tool to encourage more organizations to implement this methodology
- Models can be prepared with respect to implementation of LSS in SME sector useful to organizations in Kerala
- Product wise categorization of organizations could be done and the influence of products on LSS implementation could be studied

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