

# Analysis of Factors Influencing the Implementation of Lean Manufacturing in Small and Medium Enterprises

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Date of Submission: 25-11-2022

Date of Acceptance: 06-12-2022

**ABSTRACT:** Lean manufacturing is mainly waste elimination philosophy which can be done in several ways. This paper investigates whether these wastes affect, Small, and Medium enterprises (SMEs). SMEs are important manufacturing firms who contribute much in country's growth. Small and Medium-Sized Enterprises (SMEs) are among the most important economic units in the world. They contribute more than larger organizations economically, in terms of providing employment, added value and contribution to GDP of the country. For all this, it has become important to think about the ways that will contribute to the improvement of the SME. Lean's approach as a model, based on the elimination of waste, can play a vital role in the competitive trend to help manufacturers by saving their resources with higher productivity. The recent philosophy facilitates the opportunity to design and direct SMEs to survive in a dynamic market environment. Hence, it is suggested that Lean be applied to SMEs. However, SMEs are suffering from certain deficiencies, which make it difficult for them to implement the Lean concept comfortably. This situation necessitates the need for developing a well-structured investigation from the various SMEs that can identify and overcome the deficiencies existing in SMEs and enable implementation of the Lean concept for achieving prosperity, which was concluded from the extensive literature review. Considering these situations, the project is proposed in a way to collect the data from the selected industries (SMES from Kozhikode and Malappuram, Kerala) and to analyze the enablers and the barrier factor for the Lean manufacturing implementation of SMEs. Suitable analyses are carried out to find out the relations between the factors of considerations. Multiple Regression analysis was performed in order to realize the relationship between the lean

implementation levels with the eight independent variables.

**Key words:** Critical success factors, lean, SMEs, Questionnaire survey, multiple regression analysis.

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## **I. INTRODUCTION**

The small and medium scale industry plays an important role in bringing wealth and prosperity to the society. This is due to the most of larger companies are outsourcing their activities to small and medium scale industries (SMEs). Because of this kind of activities, SMEs are required to implement the competitive strategy adopted by large size companies. Lean approach is widely used to eliminate wastes from the systems in manufacturing areas; lean concept is well-known for its profound improvements and on the other hand it is not easy to implement. In order to achieve impressive results in cost, quality and time, lean principles and tools need to be applied to enhance the process performance. These principles enabling a company to differentiate value from waste and facilitate to maximize customer value while minimize waste. This research studies provide the application of lean principles in manufacturing sectors, and to create awareness of how lean can fetch important changes in the improvement of certain process, but what must be done to implement it. Several literatures were reviewed to get the knowledge of lean, its implementation in different areas of business, and these reveal that lean is a philosophy and a way of

thinking, not just a different production tool. Implementation of lean is a long-term approach and in order to see big improvements companies need to put efforts continuously, but it also depends on the nature of the process that is under consideration.

## II. LITERATURE REVIEW

There are many factors affecting Lean Manufacturing However only a very few studies have been conducted with respect to Indian context. Arvind Kumar Shrimali and V. K. Soni [1], have to captured the barriers in implementation of Lean Manufacturing and improve understanding with the Lean philosophy in small and medium enterprises in India. The work has two steps. The first step attempts to document the barriers in lean implementation based upon literature review. In the second step the methodology includes surveying a large number of Indian small and medium enterprises (SMEs) having implemented lean to crystallize the major barriers in lean implementation. T. Ramadas, K.P. Satish and K. Aibel Mathew [2], did structural equation modelling. The aim of the research paper is to present the factors associated with supplier communication and financial availability that constitute a successful implementation of lean manufacturing within the small and medium scale enterprises. Structural equation modelling (SEM) was employed to test the model drawing on a sample of 124 small and medium scale enterprises (SMEs) Kerala India. Specification search in Amos 20 was employed to find out the best theoretical model given an initial model using the following fit function criteria, Chi-square, Chi-square-df (C-df), Akaike information criteria (AIC), Browne-Cudeck criterion (BCC), Bayes information criterion (BIC), chi-square divided by the degrees of freedom and significance level. I.S. Mohammed and Oduoza [3], did three case studies approach. This study investigates a contextual relationship among lean enablers in SMEs in the Kurdistan Region of Iraq (KRI-SMEs) by applying Interpretive Structural Modelling (ISM) techniques. The enablers derived from previous studies formed a basis for semi-structured interviews conducted with nine business managers in KRI-SMEs. In conclusion, the study provides a structural model of lean enablers that should support business practices within SMEs.

## III. RESEARCH METHODOLOGY

The research phase starts with literature review and objective formulation. The Objectives

of this study are to identify the various enablers of the implementation of lean manufacturing in SMEs, to develop an instrument to assess how far these factors are prevalent and influence the implementation of lean manufacturing in SMEs and to investigate the relationship between various success factors of lean manufacturing Implementation in SMEs (Hypothesis Testing). To address these issues an extensive and systematic literature review has been conducted and it was understood that only limited research had been carried out in this area with respect to the Indian context and nine relevant factors have been sorted out. A questionnaire survey has been done for 47 small and medium different enterprises in the Malabar side of Kerala state, India. A questionnaire was formulated with 104 items to measure the factors of lean in a 5-point Likert scale and was administered to the respondents. After the data collection, reliability analysis was conducted in order to check the reliability of the instrument, Factor analysis and multiple regression analysis were conducted to understand the relationship between these factors and lean implementation success. The factor analysis was performed to validate it thus establishing the reliability and validity of the research instrument.

## IV. ANALYSIS AND FINDINGS

### 1.1. Reliability test

Reliability analysis was conducted by examining the value of Cronbach's alpha to test instruments reliability. The internal consistency of measures used in this study is verified by considering Cronbach alpha. The rule of thumb for Cronbach's alpha is that a value greater than 0.7 is generally considered acceptable (Cortina, J.M. (1993)). The Cronbach's alpha of all constructs was calculated to test the reliability of the scale used in the study. The Cronbach's alpha values for each factor are tabulated in Table 5.1 are consistent with the required conditions, hence proving that the questionnaire is reliable and consistent.

**Table -1:** Reliability analysis of factors

FACTORS	CRONBACH'S ALPHA	No of items
Leadership and Top Management Involvement	0.861	14
Equipment Maintenance	0.855	8
Working Arrangements	0.848	12
Organization Culture	0.830	14
Workforce Training	0.811	12
Customer Communication	0.704	6
Lean Implementation Level	0.693	17
Technological Update	0.672	9
Involvement of Supplier	0.668	12

#### 4.2 Factor Analysis

Factor Analysis (FA) is usually employed to categorize a given number of constructs into factors based on their factor loadings. It is used to test whether a group of preformed factor constructs are consistent with their factor loadings. In this research, factor analysis was performed to check whether the preformed nine factors show factor loading consistency. Constructs with factor loadings greater than or equal to 0.5 have been accepted.

Kaiser-Meyer-Olkin test was used to check the adequacy of the sample. It indicates the

proportion of variance in the sample taken. High values (greater than 0.6) indicates that the factor analysis might be useful with the data (Truong & McColl 2011; Hulland, 1999). In addition, Bartlett's test of sphericity was used to investigate whether the variables are related or not. A small value (less than 0.05) indicates that the factor analysis might be useful.

FACTORS	KMO Value	Bartlett's test of Sphericity Value
LEADERSHIP AND TOP MANAGEMENT INVOLMENT	0.739	.000
WORK FORCE TRAINING	0.751	.000
WORKING ARRANGEMENTS	0.689	.000
TECHNOLOGICAL UPDATE	0.616	.000
SUPPLIER INVOLVEMENT	0.654	.000
EQUIPMENTS MAINTENANCE	0.727	.000
CUSTOMERS COMMUNICATION	0.650	.000
ORGANISATION CULTURE	0.673	.000
LEAN IMPLEMENTATION LEVEL	0.623	.000

### 4.3 Multiple Regression Analysis

Multiple Regression Analysis (MRA) is usually used to assess the interaction or relationship of a dependent variable with two or more independent variables. It is more commonly done as a part of hypothesis testing. In this particular research, the independent variables are the eight factors and the dependent variable is Lean implementation level. MRA checks for the relationship and quantifies the extent to which the variables are related to the help of significance values and coefficient. The relationship between critical success factors and lean implementation level were analyzed by using multiple regression analysis. Multiple linear regression analysis makes several key assumptions:

The Linearity of a relationship between the dependent and the independent variables represents that; the effect of independent variables on the dependent variables should be linear. The Linearity of a relationship is examined through

residual plots, and any curvilinear pattern indicates corrective actions are necessary to increase the accuracy and validity.

The Homoscedasticity is ensured to determine whether the variance around the regression line is constant across all the values of independent variables. The assumptions are violated if unequal variances indicating heteroscedasticity are present. The presence of homoscedasticity is determined through residual plots or simple statistical tests.

Normality: MRA assumes that the residuals are normally distributed.

No Multi collinearity: MRA assumes that the independent variables are not highly correlated with each other. This multi collinearity assumption is tested using Variance Inflation Factor (VIF) values. The VIF values of all factors lied in between the acceptable range of 1-10.

All the above conditions were satisfied and multiple regression analysis can be performed.

Table 3: Multiple regression analysis summaries1

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.926 <sup>a</sup>	0.857	0.827	0.17350

a. Predictors : ( constant), OC, SI, CC, TU, WT, EM, WA, LTMI

b. Dependent Variable: LI

Table -2: Multiple Regression Analysis Summaries2

FACTORS	Sig value
LEADERSHIP AND TOP MANAGEMENT INVOLMENT	0.016
WORK FORCE TRAINING	0.072
WORKING ARRANGEMENTS	0.147
TECHNOLOGICAL UPDATE	0.016
SUPPLIER INVOLVEMENT	0.003
EQUIPMENTS MAINTENANCE	0.005
CUSTOMER COMMUNICATION	0.853
ORGANISATION CULTURE	0.054

The value of simple correlation is represented by the notation 'R' and the obtained value of R is 0.926. Generally, a value greater than 0.5 represents

good correlation and the value nearing 1 shows strong correlation within the data set. According to Cohen (1988), R<sup>2</sup> value between 1.0 and 5.9 percent is

considered as small, between 5.9 and 13.8 percent is medium and above 13.8 percent is large. It can be observed that the coefficient of determination ( $R^2$ ) is 0.857, which represents that 85.7 per cent of performance can be explained by the eight independent variables.

From the analysis it can be noted that factors that the significance level for each of the factors leadership and top management, technological update, supplier involvement, and equipment and maintenance are lesser than 0.05 and other factors working arrangements, work force training, organization culture and customer communication are greater than 0.05. Hence here the null hypothesis is rejected. These shows the result of the multiple regressions of all eight critical success factors regressed on the dependent variable lean implementation success. Results demonstrated that leadership and top management involvement, supplier involvement, Equipment and maintenance and Technological update have significant relationship with the success of lean implementation level. Interestingly, there was no significantly relationship between workforce training, organization culture, Customer communication and Working arrangements expertise to the success of lean implementation. Here, all the significance values except customer satisfaction, workforce training, organization culture and working arrangement were lesser than 0.05 and hence acceptable. Among these eight factors, results suggested that Involvement of supplier strongly contributed to the success of lean implementation level. It was followed Equipment and maintenance, leadership and Top management involvement, and Technological update respectively.

It also interprets that manufacturing firm's operations, suppliers and top management, equipment and maintenance, technological updates strongly supporting the implementation of lean in these type of SMEs and business operation activities, level scheduling, involvement of workers to take ups new tasks due to language and literacy problems are the main obstacles to the implementation of lean in these type of SMEs in Kozhikode and Malappuram districts of Kerala.

## V. CONCLUSIONS

This study identifies eight factors that influences the implementation of lean manufacturing in small and medium enterprises. The eight factors taken are Organizational culture, Leadership and top management involvement, workforce training, working arrangements, supplier involvement, technological update, customer communication and

equipment and maintenance. A questionnaire survey was conducted among 47 industries out of which 29 were from small scale manufacturing firms and 18 medium scale manufacturing firms across Kozhikode and Malappuram districts of Kerala. Based on the objectives of the research and the collected data, a series of analysis techniques were employed to reach a conclusion on the effect of these identified factors. In this particular research, the independent variables are the eight factors and the dependent variable is Lean implementation level. The result obtained from the multiple regression analysis suggests that there is significant influence of the independent variables for the implementation of lean manufacturing in SMEs except the workforce training, organization culture, customer communication and working arrangements since the level of significance obtained is greater than 0.05 for all the factors.

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