CRITICAL SUCCESS FACTORS FOR EFFECTIVE IMPLEMENTATION OF LEAN ASSESSMENT TOOLS/ FRAMEWORK IN MANUFACTURING INDUSTRIES

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EXECUTIVE SUMMARY

Research Title: Critical success factors for effective implementation of lean assessment tools/framework in manufacturing industries.

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The base of this research is the concept of Lean Manufacturing which has been used over the years for increasing productivity by minimizing waste from the organization. Many companies have understood the importance of Lean and to make certain of the successful result from the lean system, they have supported the fact that it is necessary to assess the Lean progress continuously. This study examines the different Lean assessment frameworks and gives the critical success factors for effective implementation of these assessment frameworks in manufacturing industries. Research conducted for finding out the important success factors is by extensive use of literature review. However the hypothesis for proposed success factors finalized after literature review and these hypothesis have been proven by conducting survey among the lean experts in manufacturing industries. This study provides the basic understanding of lean concept which further helps in recognizing importance of lean assessment in the growth of organization. The objective of this study can be seen in two ways first is to ensure the successful implementation of lean assessment framework and second is the result from the first objective which ensures the successful use of lean system in the industry while giving boost to the economy, efficiency and productivity of the company.

Keywords: Lean manufacturing, Lean assessment, Lean assessment framework, Critical success factors, effective implementation.
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1 Introduction

1.1 Background

Womack et al. (1990) mentioned that Eiji Toyoda and Taiichi Ohno of Toyota, (Japan) developed the approach for lean manufacturing. If we traced the root to 1950s and 1960s they have developed a concept of quality enhancing system with continuous improvement, termed as a Toyota Production System (TPS) which is also known as a Lean production or Lean Manufacturing. This system has helped businesses to achieve higher quality, safety and increased morale of employees.

As reviewed by Randy Urbance The Machine that Changed the World (Womack, Jones & Roos, 1990) has mentioned that, earlier in 1950 during development of Toyota Production System “Taiichi realised that total system view of manufacturing process is key to maintaining efficiency, quality and flow through the system” thus the focus was on removing waste which is in terms of cost, time and effort and increased value.

Lean manufacturing is an organized way of eliminating waste, mainly focusing on cutting extra work from the production activities. It has been used and implemented successfully to production, administration and engineering functions. Therefore Lean implementation has a structured way of working based on five principles of specifying value, value stream mapping, value stream flow, pull and perfection. This can be explained as follows: (Shah & Ward, 2002)

- Specify value: Value is defined in terms of customer needs at specific prize and time.
- Map: Preparing a map of actions in current state of the system. Identify waste in current system and eliminate it.
- Flow: Develop value stream flow by eliminating any barriers.
- Pull: Customer can pull the products according to their need, while eliminating sale forecast.
- Perfection: Make continue effort of developing the process by always going to the 1st step and begin next lean transformation.

This five lean principle are commonly used while implementing Lean.

However in today’s competitive era many companies are struggling for survival. Wherein Lean manufacturing method assures them to provide system which helps to reduce cost, eliminate waste, elevate efficiency, escalate productivity with high level of quality and maintain a profitability (Womack, Jones & Roos, 1990). Implementation of lean manufacturing with its tools and principal is proven beneficial methodology for any organization. This system can be use not only in production areas but also in retail, healthcare and administrative areas (Womack, Jones & Roos, 1990).

The continue intensification of market competition and demand pressurizes the businesses to adopt innovative tools and techniques. Introducing new tool and technique will help businesses to increase its value adding activities. As described Lean manufacturing in businesses is one of the way for reducing waste and concentrating more on value adding activities, thus it is also necessary to constantly assess the present state of “leanness” of an organization and its willingness to change (Alaskari et al, 2012). For this purpose different lean assessment frameworks are available, like EFQM (European Foundation for Quality Management), LESAT (Lean Enterprise Self-Assessment Tool), VSM (Value Stream Mapping), BSC (Balanced Scorecard), and Lean Index Tool. Lean assessment framework mainly assesses the integration of strategies, leadership and commitment and lean transformation.
planning, execution and monitoring. Lean assessment tools are also useful in assessing change management and performance management within the organization (Nightingale, 2005).

However, identification of real critical success factors for implementing lean assessment framework can be a major step towards improving chances of effective Lean system.

1.2 Research Question
The study seeks to address the following question:

“What are the critical success factors for implementation of lean assessment tools/framework in manufacturing industries?”

Sub RQ: What are the different lean assessment framework generally used by manufacturing industries?

1.3 Unit of analysis
Consideration of unit of analysis in a research project is one of the important parameters. It is a major entity being analysed in the research. Unit of analysis in study can be 1) Individual 2) Groups 3) Organization 4) Geographical units 5) Societies (Bryman & Bell, 2003). In this research, data is collected from the people having background of lean manufacturing from level of supervisor to top management in manufacturing industries. Hence, main unit of analysis here considered is an Individual.

1.4 Research Scope
The scope of this study is limited by the following parameters.

1.4.1 In Scope
This study mainly includes literature review of Lean manufacturing, Lean assessment tools and frameworks and critical success factors for effective implementation of Lean assessment tools. Through literature review number of hypothesis being established for critical success factors. This is quantitative research, where data required for fulfilment of the thesis will be collected using survey. Data will be thoroughly measured by statistical analysis. The hypothesis will be validated by analysing the results.

1.4.2 Out of Scope
This study will focus specifically on manufacturing industries and will not consider Information technology, financial consultancies, and telecommunication industries etc. Survey will be restricted to respondent with the expert knowledge of lean manufacturing.

1.5 Research Purpose
The aim of the research is to get better understanding of lean manufacturing and its assessment in manufacturing industries and examine the critical success factors for effective implementation of lean assessment tools.

This research will investigate critical success factors (CSFs) necessary for successful implementation of lean assessment tools or framework in manufacturing industries which help to understand how CSFs in industries have changed over time with the coming new technologies and globalization and what CSFs have already been considered for previous researches. To fulfil this aim and identify direction for
selecting main critical success factors for this research, comprehensive review of published literature have conducted.

The findings of CSFs from literature review are considered as Hypothesis. The CSF’s hypothesis validation (accepted or rejected) for research is supported by analysis of detail survey from the lean experts of the manufacturing industries.

Proven critical success factors in this research can be used to achieve success in business. The targeted audiences will get benefit from this study are:

**Researcher:** Result of Analysis of this study can be shared for future work for academic purpose with the researcher.

**Company or Organization:** They can consider development in area which will give boost to this critical success factors so as to get success in business.

**General Audience:** Awareness regarding the importance of critical success factors in lean assessment.

### 1.6 Thesis Structure

This section explains the overall structure of the research.

Chapter 1 is an Introduction of the research study and explains further about the background of this research giving understanding of the concept of Lean manufacturing and lean assessment which is basis of this study. It also covers the main research question and sub research question, which decides the outcome of the study also the topic in scope and out scope are discussed. Further the aim of the study i. e. research purpose is explained in brief.

Chapter 2 is a Methodology consisting of the methods used for data collection necessary for carrying out this research. It explains the basis of this research involving research philosophy, approach and strategy. Data analysis is elaborated so that reader could understand how the analysis s carried out for the data received. Also here reliability and validity of the research is described in detailed.

Chapter 3 is a literature review, this gives a scientific base for this research and describes all the concepts required to understand the research area. Various scientific papers, journals, scientific data bases, literature books, websites are considered for reviewing all the concepts. Here also hypothesis is proposed for critical success factors upon thorough literature search.

Chapter 4 is a result and analysis, this research collects data from the responses received from the survey. This section presents the result using pie charts and bar charts and by combining all the survey data and predict the meaning of each result produced for each critical success factor. Thorough analysis is conducted on the result which provides easy understanding to reader. Further the result and analysis use for hypothesis testing.

Chapter 5 is a Discussion, which discusses the proven critical success factors (CSFs) for implementation of lean assessment framework. The discussion is based on general concept of CSFs and what study has revealed about these CSFs during result and analysis.

Chapter 6 is a Conclusion, which concludes this study and gives answer to the research questions followed by contribution of the research and limitation of the research. Last but not least it provides recommendation for future research in this area of study.
Research Methodology

This chapter describes the research methodology used in this study. Here firstly the basis of the research i.e. Research philosophy is discussed. Then research approach and strategy will be explained in brief. It also gives a detail description of main data collection method and finally describes the details of validity and reliability of this study.

2.1 Research Philosophy

According to Saunders (2009) research philosophy is “The basic belief system or world view that guides the investigation, not only in choices of method but in ontologically and epistemologically fundamental ways.”

Here ontology concerns with the researcher’s views about how things work out in surroundings and his commitment toward his opinion. In Ontology, objectivism and subjectivism these two aspects are considered. Where objectivism is mostly concerned with the position which suggests “how social entities exist independent of social actors.” Saunders (2009) on other hand Subjectivism is more concerned with “Understanding the meanings that individuals attach to social phenomena” Saunders (2009).

This research selects philosophy of Subjectivism. Subjectivism considers the fact that social phenomena is created due to the opinion and perception of a people. This is also further explained by Remenyi (1998) “the details of the situation to understand the reality or perhaps a reality working behind them” can also be known as Social constructionism.

However philosophy of Epistemology relates with the acceptable knowledge in a particular field of study. Saunders (2009). This research reflects one of the category of epistemology that is Positivism. Positivism focuses on recognizable social reality. The study follows the “Positivism” where social reality comes from the perception of group of people on the given study topic.

2.2 Research Approach

There are two types of research approaches so far, Deductive approach and Inductive approach.

In Deductive approach, researcher first develops a theory and finalises the hypothesis. To verify this hypothesis, research strategy will be developed. Deductive approach is a top-down approach where theory and hypothesis is developed using thorough literature review. Hypothesis is accepted or rejected using data analysis where data collected through research strategy (Saunders, 2009 PP 155).

In Inductive approach researcher collects a data and create a theory as outcome of a data analysis. (Saunders, 2009 PP 155). Inductive approach is bottom-up approach where research strategy is decided as either a group interview or survey or other methods of collecting data and theory is developed upon data analysis.

In this research deductive approach is followed. Six critical success factors are finalized after literature review which are taken as a hypothesis for this study. Survey has been conducted to get the data for verification of hypothesis.
2.3 Research Strategy

Business research strategy is divided into two categories, Qualitative and Quantitative.

As specified by Bryman and Bell (2003) qualitative methods are more concerned with the information coming through words rather than concerned with the numbers. Qualitative method doesn’t use the quantification in data collection and data analysis. As per Greener (2008) “Qualitative methods are governed by rules and offer a way of exploring issues which cannot be expressed by numbers.” General qualitative tool for data collection is case study and interviews.

As defined by Aliaga and Gunderson (2000) Quantitative analysis is “Explaining phenomena by collecting numerical data that are analyzed using mathematically base methods”. Quantitative method deals with the collecting sample of numerical data. The data analysis is carried out using statistics or mathematical based methods (Bryman & Bell, 2003). Quantitative tool for data collection is survey using questionnaire.

Quantitative method is used in this research for conducting study aligned with the deductive approach. Self-completion questionnaires are distributed to targeted audience to collect primary data through survey. Result is generated considering filled questionnaire from various respondents. Thus this study is able to generate valuable output.

According to Yin (2003), research strategy can be used for exploratory, descriptive and explanatory research. There are different strategies explained by Saunders (2009) which are as follows:

- Experiment
- Survey
- Case Study
• Action Research
• Grounded Theory
• Ethnography
• Archival research

For this study, Survey is used as a research strategy. According to Saunders (2009) for deductive approach, generally survey strategy is used. Survey is mostly used in business and management research which gives answers to the questions like how much, how many, who, what and where etc. Survey allows to get valuable data from a large group of people in a highly economical way. (Saunders, 2009). The data collected is usually by using questionnaire, this data can be effortlessly analyse by descriptive and inferential statistical methods which allows to produce valid results. As suggested by Saunders, “The survey strategy is perceived as authoritative by people in general and is both comparatively easy to explain and to understand”

2.4 Data collection Method

2.4.1 Self-completion questionnaire
This is primary data collection method. Self-completion questionnaires are also known as self-administered questions, where there is no need of presence of interviewer. This questions can be filled on forms, websites by targeted audience and can be distributed by using emails or social websites. Here self-completion questionnaires are formulated to get required data from the respondents. This questions are carefully designed to draw appropriate results from the various responses. This method proven to be very cost effective way of collecting data. For this study questionnaire plays a major role for evaluation of each critical success factor.

2.4.1.1 Respondents
Respondents are selected from lean network such as lean forums, lean manufacturing groups and social websites Linkedin, and personal connections. Responses are mainly accounted from the candidate who has experience in lean manufacturing and has previously worked or currently working in Lean company.

2.4.1.2 Questionnaire Design
There are total 25 no. of questions and divided into following sections:

1. General Background
2. Critical Success factors for effective implementation of Lean assessment framework
   • Commitment and support from top management
   • Organizational structure
   • Human resource empowerment and training
   • Communication
   • Technology
   • Culture
3. Rating of Critical Success Factors

The first section consists of general background of a respondent giving information about area of business, respondent’s total year of experience and his/her knowledge about Lean concept. Second
section is important for this study which shows the necessity of critical success factors in implementation of lean tools or frameworks. Third and fourth section will help to analyze the most important critical success factors amongst the chosen ones according to view of respondents.

2.4.2 Secondary data
For this study secondary data is collected through research papers, scientific journals, articles and conference papers from various data bases including:

- Science Direct
- Emerald Insight
- Google Scholar
- Elsevier
- Springer Link
- KTH university DIVA
- Libris

Further keywords for searching appropriate results are “Lean Manufacturing”, “Lean Assessment”, “Critical success factors”, “The Toyota way”, “Total Plant solution”, and “CSF for lean implementation” in addition to this knowledge has increased by reading a book of “Operations Management” by Lewis & slack (2003) and for following appropriate research methodology and understanding how to select references for the research work, the book of “Research Methods for business students” by Saunders et al (2009) was very useful. This book also provided a guidance on using authentic references for reliable and valid research writing (Saunders et al, 2009).

2.5 Data Analysis
As specified by Dr. Sue Greener (2008) there are two types of data analysis, univariate analysis and bivariate analysis. Univariate analysis deals with the one variable at a time whereas bivariate analysis focuses on relation between two variables. In Univariate analysis bar charts, Pie charts and histograms are used to present data (Greener, 2008). For this research study, Univariate data analysis is considered which will focus on individual variable at a time.

Survey questionnaires have been created using Google forms, which is easier and more reliable way of formulating any types of survey questions. The responses collected through the survey is recorded and collected in an excel sheet. This excel sheet can generate a small report for the data analysis. But for this study elaborative analysis was required so report generated from the Google forms has not been used. For Statistical analysis of Survey data a software DataCracker is used. Statistical analysis has been conducted, by calculating, Average, mean and standard deviation for the questions which can be answered by giving statistical points from 0 to 5 according to instruction. This result of the survey presented in a bar charts. Other questions give a answers in a percentile format presented in pie chart as a result.

2.6 Reliability
“Reliability is to design a research which is auditable” (Greener, 2008) which means research should be consistent and clear and if the research is given to any person for reading he or she must able to produce same results by following same methods in the research study or at least he or she should have a complete understanding of the research and built a trust and belief in the results which have been produced (Greener, 2008). In this study data collection method is explained thoroughly. Also For
this study respondents have been selected according to their work background, work experience and their industry. The participants who are particularly chosen mostly have over 5 to 10 years of experience in lean management and have thorough knowledge of lean assessment usage in manufacturing industries. Freedom of choice is given to respondents for answering the given questions and aim of the study is explained in advance as a purpose for “master’s thesis” so the reply received from them is honest and clear. Thus this study is producing reliable data and if reader try to produce same data by using a same method, it is able to regenerate the same result.

2.7 Validity
Dr. Sue Greener (2008) has explained face validity as, “if any non-researcher can relate the method to its researching question and agrees that it is a suitable method for the given study then research has a face validity” The test of validity is conducted by distributing initial set of survey questions to few people to check whether they could understand the meaning of questions and whether they can answer appropriately. During distribution basic aim of the study and subject of the research has been explained to participants. It seems that they can relate the survey questions to the research aim and can answer appropriately to the survey, which showed that they could understand the reason behind choosing this method for this study. Survey questions also checked and rechecked by giving it to proof reading.

Survey questions are statistically analyzed by the computer software program DataCracker, which is widely used software for quantitative analysis and provides an accurate prediction of the quantitative data. Results are presented in the form of bar charts and pie charts which able to read the data precisely. Thus this research study shows the validity.

2.8 Ethical Consideration
According to Alcser et al (2011), ethical guidelines for survey has to be think through which are as follows:

- Providing enough necessary information about the background of the study and encourage participation in the survey but always try not to harass candidates by continue push for participation, attempt of several contacts and frequent visits to the respondent.
- There is emphasize on using present available survey data received from participant rather than pursuing participants for gathering extra data.
- Show respect and give an honest opinion about the time required to fill the survey, no of questions in the survey, actual duration for interview and benefits offered for participation.

In this study ethical attributes are followed while conducting survey. While distributing Survey questions, there is an attachment of self-introduction, educational background, purpose of the study, short introduction of research area and thank you note for participation also provided. At the beginning of the questions, consent note providing information that “The results from this survey will be used only for the study purpose and identity of the participants will not be disclosed in any case” is written. If participated in the survey respondents had an option of selecting whether they want summary of the results from this study, if yes they need to fill their email address. Thus the short summary of the results of the survey will be sent to interested individual participants after the publication of the thesis report. Once they have filled the survey and submitted it, an email with the thank you not has been sent to the survey participants.
3 Literature Review

Research papers, scientific articles and practitioner work on lean assessment and on critical success factors are considered to sum up this section.

3.1 Lean assessment: Why it is necessary?

Nowadays more companies are facing difficulties in implementing lean manufacturing systems, however few cases are observed where denoting success have been achieved in this area. The reason behind lean system failure is debatably lack of understanding of lean performance and its measurement, where in other words it is very necessary to assess performances to manage lean (Behrouzi & Wong, 2011).

Lean assessment gives complete analysis of current level of leanness of the organization with process accuracy, stability and improvement and the degree of employee commitment towards these activities. Lean manufacturing has importantly 14 key areas namely scheduling, material handling, equipment, work process, quality, employees, layout, suppliers, customers, safety and ergonomics, product design, management and culture (Yu Cheng Wong et al, 2009).


3.2 Lean performance measures for assessment

Performing lean practices and establishing lean assessment framework is the part of organizations manufacturing strategy. While developing lean assessment framework for analysing level of lean implementation, well planned and strategic approach should be considered. (Doolen & Hacker, 2005). Understanding performance measures in organization is as important as developing a model to assess these performance measures. As suggested by Srinivasaraghavan & Allada (2005) lean assessment metrics should have some important properties such as:

- Realistic & updated
- Measurable
- Able to monitor, control and evaluate performance
- Helpful in understanding current situation and level
- Easily enable to identify improvement opportunities
- Aligned to strategic objective of the company and customer values

To measure the Lean system of an organization there are nine variables suggested by Karlsson & Åhlström (1996) which are Elimination of waste, Continuous Improvement, Zero defects, Just-In-Time Deliveries, Pull of materials, Multifunctional teams, Decentralization, integration of functions, and vertical information system. (Behrouzi & Wong, 2011). Accordingly this nine variables can quantified and compare with benchmarks from historical data and can identify the current leanness of the company.
3.3 Lean Assessment Tools/ Frameworks

As defined by Womack, Roos & Jones (1990) “A lean enterprise is an organization which uses lean concepts and practices not just in the manufacturing but in everything it does” so here are the lean assessment tools described considering area of Quality, Culture, Process Improvement and stability, employee satisfaction. Research papers, upcoming lean developments posted through authentic websites, recent studies are considered as a reference here. Lean assessment tools or frameworks are as follows:

- EFQM assessment (European Foundation for Quality Management)
- LESAT (Lean Enterprise Self-Assessment Tool)
- VSM (Value Stream Mapping) and opportunity assessment
- BSC (Balanced Scorecard)
- Lean Index Tool
- Key performance indicator Benchmarking tool
- Lean culture assessment model (LCAM)
- Shingo Model
- Strategos Lean Assessment tool

3.3.1 EFQM Assessment (European Foundation for Quality Management)

EFQM model or framework is a basis for Quality management which is standardised by European foundation. As per European foundation for Quality management, the criteria of assessment divided into two section of Enablers and Results. Where “Enabler” criteria gives overview of organization and “Results” shows the achievement of organization. It mainly focuses on “maintaining leadership, developing policy and strategy for achieving ultimate quality goal which further gives the result of customer satisfaction, economic benefits and positive social impact” (Camison, 1996).

![EFQM Model](image)

3.3.2 LESAT (Lean Enterprise Self-Assessment Tool)

According to LESAT Facilitator’s Guide by Massachusetts Institute of Technology, 2012 Lean Enterprise Self-Assessment Tool helps to assess and guide leadership during organizational transformation for achieving enterprise excellence. It also states that LESAT was developed with aerospace industries in US and UK and has significant impact and applicability for large kind of manufacturing industries.
As defined by Deborah Nightingale (2005) “LESAT is tool for executive self-assessment of the present state of “leanness” of an enterprise and its readiness to change”. This assessment is advisable to take during the planning phase of the organization transformation. It has been stated by LESAT Facilitator’s Guide (MIT, 2012) and Nightingle (2005) that LESAT can identify gaps in current performance and required improvement areas by assessing current and future state of the organization. LESAT also gives important information or required inputs while developing transformation plan and helps in monitoring improvements during implementation phase.

In assessment 54 lean enterprise practices have been considered and divided into three main sections where section 1 deals with Leadership and Transformation including 28 practices, Section 2 deals with Lifecycle processes in organization including 18 practices and Section 3 deals with Enabling Infrastructure including 8 lean practices. Each lean practice is assessed on 1 to 5 capability maturity scale (Nightingle, 2005).

### 3.3.3 VSM (Value Stream Mapping) and opportunity assessment

A value stream is combination of all value added and non-value added actions which is required to produce a final group of products from same resources. This main flow generally start with the raw materials followed by final product and end with the customer delivery (Abdulmalek & Rajgopal, 2007). The actions in this consists of processes, information and material handling. Value stream mapping is mainly helps in identifying wastes from value stream and eliminate those extra steps which are not needed (Rother & Shook, 1999). Value stream mapping considers the overall value processes and not focusing on any one single process thus providing more sorted way for identifying non-value added systems in value map.

The starting point of value stream mapping is by selecting any one of the target product or group of product which needs to improve (Rother & Shook, 1999). By observing processes required for delivering the final product, current state map of the all the actual processes is being drawn. The Current state map will help to clearly analyse and asses the system flow and identifying any flaws in current system. For suggesting further improvement, future state map is drawn by answering few questions regarding efficiency, lean tools implementation and technical expertise. Future state map is used as basis for making any changes in the system (Abdulmalek & Rajgopal, 2007).

### 3.3.4 Balanced Scorecard (BSC)

According to Procurement Executive Association’s Initiative (1996), the Balanced Scorecard is framework for conceptualising organization’s strategies, mission and objective in performance indicators through four perspective of “Finance, customer, internal business process and learning and growth”. It is also mentioned that performance indicators in Balanced scorecard helps in measuring organization’s advancements towards accomplishing it’s vision and monitoring financial growth while tracking progress in constructing organizational capability needed for organization’s future growth (Kaplan & Norton,1996).
3.3.5 The Lean Index

Lean Index assessment model used to denote leanness of each special operational areas of any organization, at any specific time during lean implementation (Ray et al, 2005). Factors affecting to each operational area is assigned a particular score and this score is considered from monthly or timely driven collected data from individual. Then Lean Index can be calculated using factor score as follows, (Ray et al, 2005)

\[
\text{Lean Index} = \exp (1.5 + \text{Factor score})
\]

"Higher the lean index, the more lean the company is" (Ray et al, 2005). The lean index can also be used to compare “leaniness” of one company to other successful lean company. (Ray et al, 2005).

3.3.6 Key performance indicator Benchmarking

"Benchmarking is an improvement technique that considers how others perform a similar activity, task, process or function." (Hanman, 1997). Key performance indicators are generally both financial and non-financial which track company’s progress towards its targeted goals and objective.
Above figure describes how Benchmarking process is essential component of the “Continuous improvement” of the organization. While performing benchmarking partner companies should consider the qualitative or process discussion to understand each other’s operations thoroughly. It is also important to check whether similar things and valid KPI’s have been compared (Hanman, 1997).

As specified by Hanman (1997) Benchmarking procedure need to consider following steps:

- **Defining company’s process which has to be benchmarked.** It consists of understanding the policy, procedures in area which is to be benchmarked.
- **Existed rules to be observed which is necessary for ensuring correct follow up of procedures.**
- **Monitor performance by understanding policy, procedures, rules and outcomes.**
- **Decide level of performance desired in a current activity.**
- **Identify how, what and when the improvement needed to able to gain goals.**

### 3.3.7 Strategos Lean Assessment tool (SLAT)

The Strategos Lean Assessment tool (SLAT) is created by Quaterman Lee from Strategos Inc. Quaterman Lee has developed SLAT assessment which helps in identifying, measuring and assessing nine important areas of lean manufacturing (Lee, Strategos Inc & Ihezie, Keith & Mitchell, 2009). This assessment also explores different problem areas and their probable solutions.

The nine key areas evaluated are, mainly “Inventory, Team Approach, Processes, Maintenance, Layout & Material Handling, Supplier, Setup, Quality and Production control & Scheduling.” (Lee, Strategos Inc & Ihezie, Keith & Mitchell, 2009). Excel template is used to record data from different response from the assessment studies in all nine key areas which results in to the various score. This final “Result” drawn into the “radar chart” which is visual representation of organization’s current lean state and gap between its decided target of achieving perfect “LEAN Company” (Ihezie, Keith & Mitchell, 2009).
3.4 Critical success factors overview (CSF)

Definition of success is varied in perspective of each individual. However Critical success Factor (CSF) is defined by Rockmart as “the limited number of arrears in which results, if they are satisfactory, will ensure successful competitive performance for the organization” (Rockart, 1979). CSF’s method has been used by many to understand important factors influencing the growth of the company. As explained further by Grunert & Ellegaard (1992) the critical success factors can be used in many ways, Like CSF’s are essential components of “management information system” thus can be seen as “unique characteristic of a company”. Whatsoever CSF’s help to improve critical thinking for managers and also they can be used as a depiction of a skills and resources necessary to get success in a particular market. (Grunert & Ellegaard, 1992)

As specified by Grunert & Ellegaard (1992) Critical success factors are those which can be both internal and external things affecting business in positive and negative ways. CSF’s are things which can be monitored, measured, analysed and controlled by the managers. (Grunert & Ellegaard, 1992) Understanding CSF’s allow organization to concentrate their energy onto the areas meeting the requirement of CSF. It also gives an opportunity to assess the necessary capability of any organization to meet CSF’s constraint (Alaskari et al, 2012)

According to Alaskari & Ahmad (2012) organizations have understood the importance of adopting lean tools for improving profitability. In this study Author has identified 83 critical success factors necessary for integration or implementation of lean tools. By observing and reviewing the citation trend for all the CSF’s, Alaskari et al (2012) has managed to sort out 18 CSF’s. These 18 CSF’s are “fundamentally critical for implementation of lean tools” (Alaskari & Ahmad et al, 2012).
Among this 18 CSF’s, it has been noted that over the years importance of three critical factors have immensely increased. They are “Commitment of the top management, Change in organizational culture and effective leadership” (Alaskari & Ahmad et al, 2012). These factors are considered to be most critical factors for successful implementation of lean tools in organization. (Alaskari & Ahmad et al, 2012).

In the following table, different critical success factors are mentioned by different authors which are compared with the CSF’s considered for this study.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Commitment and support from top management</td>
<td>Commitment of top management</td>
<td>Management commitment and leadership</td>
<td>Top management support, commitment</td>
<td>Involvement of top management</td>
</tr>
<tr>
<td>Organizational structure</td>
<td>Determining goals and objective</td>
<td>Feasible lean practices</td>
<td>Ensure mechanism for successful lean implementation</td>
<td>Aligning links between corporate strategy and objective and incentives</td>
</tr>
<tr>
<td>Human resource empowerment and training</td>
<td>Comprehensive education &amp; training</td>
<td>Empowerment of employee</td>
<td>Training and skill building</td>
<td>Employee empowerment</td>
</tr>
</tbody>
</table>
Table 3.1: Comparison of proposed CSF’s with literature

The table has shown that the proposed CSF’s structure is well suited and this set of CSF’s are used for the further analysis in this study. The author has proposed six distinct critical success factors for integrating and implementing lean assessment tools/framework in manufacturing industries. Final CSF’s proposed are as follows:

### Critical Success factor

<table>
<thead>
<tr>
<th>Commitment and support from top management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational structure</td>
</tr>
<tr>
<td>Human resource empowerment and training</td>
</tr>
<tr>
<td>Effective Communication</td>
</tr>
<tr>
<td>Technology</td>
</tr>
<tr>
<td>Organizational Culture</td>
</tr>
</tbody>
</table>

Table 3.2: Proposed final List of critical success factors (CSF)

The definition of six proposed critical success factors for lean assessment implementation are explained in next section.

### 3.5 Critical Success Factor Definition

#### 3.5.1 CSF 1: Commitment and support from top management

Commitment and support from top management can be defined as “Dedicating time to the program according to its value in terms of cost and potential, reviewing plans, following up on results and facilitating management problems” (Younga & Jordanb, 2008). Where top management consists of Director, Chief executive officer of the organization. Many studies have promoted the fact that support and involvement of top management is essential factor in lean implementation.

According to Anchanga et al (2006) an outstanding leadership and top management involvement is crucial factor which pushes ahead the implementation of lean practices. Moreover lean implementation success depended on the “evidence of management commitment” to Lean program (Scherrer Rathie et al, 2009, Kundu & Manohar, 2012).
3.5.2 CSF 2: Organizational structure

The organizational structure plays an important part in Lean implementation (Faron, 2012) and thus in lean assessment implementation. As stated by Pugh, Hickson, Hinings and Turner (1968) and mentioned by Siemerink (2014) organization structure consists of four basic dimensions: “Structuring activities, concentration of authority, line control of workflow and size of supportive component”.

According to Faron (2012) “the companies who transformed successfully, have observation that organization structure is one of the success factors of lean transformation”. Also, many research papers on lean management have confirmed that flexible organization structure and lean is a successful combination (Faron, 2012).

3.5.3 CSF 3: Human resource empowerment and training

“Human resource is an important asset of any organization” (Mohammad, Rashidi & Karimdoust, 2014) by training and empowering this resource, organization can explore its ability to succeed in lean implementation. Thus it is important to use human resource and trained them skillfully. (Mohammad, Rashidi & Karimdoust, 2014).

Training of skilled mind-sets in the organization consists of the both workers and managers. Empowering the key resources and changing attitude is crucial step in achieving success in implementation process (Jurado, Fuentes & Gomez, 2013).

According to Jurado, Fuentes & Gomez (2013) considering employees opinions, actively listening to their proposal and implementing those proposal will motivate them in a longer run, which eventually help in executing changes.

3.5.4 CSF 4: Effective Communication

Many publishers have considered effective communication as essential factor in success of lean manufacturing and executing lean tools. (Womack & Jones et al, 1990, Jurado, Fuentes & Gomez, 2013). Communication is necessary for flow of information from top-down management and understanding the need for change for executing any new tools like lean assessment. Continuous exchange of information regarding benefits of lean helps in reducing the resistance from the people in the organization (Jurado, Fuentes & Gomez, 2013).

Communication is one of the success factor, because many authors suggested that failing to understand and communicate urgency of lean transformation may lead to failure of implementation and change process (Womack & Jones et al, 1990, Jurado, Fuentes & Gomez, 2013).

3.5.5 CSF 5: Technology

As defined by Lewis & Slack (2003) in operations management, Information technology is the “capability offered by computers, software applications and telecommunications” IT is been continuously used in manufacturing industries for process modelling, information management system and product scheduling and controlling (Lewis & Slack 2003). Thus in Lean assessment, assessment data has stored and managed by company’s information management system. So IT has important role in implementation and integration of lean assessment tools. As stated by Lewis & Slack (2003) “IT is a more than useful tool in Business processes redesign”.

Technology comes handy for analyzing data received from lean assessment tools. This data can be easily interpreted and used in predicting current state of leanness of the company. It also helps in identifying gaps in current and required performance of the organization (Nightingle, 2005).
3.5.6 CSF 6: Organizational Culture

Organizational culture has been defined in many ways by many researchers. Whereas Schein & Edgar (1984) has elaborated culture in different aspects, they gave a formal definition of culture as, “The pattern of basic assumptions that a given group has invented, discovered or developed in learning to cope with its problems of external adaptation and internal integration.”

Importance of the role of organizational culture in lean management and in implementing lean tools in an organization has been debated over a lot, Thus researcher Bortolotti, Boscarin & Daneseb, (2015) has examined lean management plants to observe whether organizational culture plays a crucial part in lean management success or not.

This research conducted by them (Bortolotti, Boscarin & Daneseb, 2015) shows that the plant which are successful in lean management has put more emphasis on soft lean practices in organizational culture. These lean practices consists of more “concerned of people and relations involving of small group task solving, providing training for resolving various tasks, more customer involvement, continuous improvement and Supplier partnerships” (Bortolotti, Boscarin & Daneseb, 2015)

So researcher have supported the fact that organizational culture is one the most important factor when it comes to success of a lean management and lean implementation (Liker & Hoseus, 2012, Bortolotti, Boscarin & Daneseb, 2015).

3.6 Hypothesis Proposal

Based on the literature review following are the proposed hypothesis for this study. This hypothesis considered for successful lean assessment tools/framework implementation and integration in organization. These hypothesis will be proven further in result and analysis section, where results from survey report is taken into an account.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Commitment and support from top management is important factor for successful implementation and integration of Lean assessment tools/framework</td>
</tr>
<tr>
<td>H2</td>
<td>Organizational structure is important factor for successful implementation and integration of Lean assessment tools/framework</td>
</tr>
<tr>
<td>H3</td>
<td>Human resource empowerment and training is important factor for successful implementation and integration of Lean assessment tools/framework</td>
</tr>
<tr>
<td>H4</td>
<td>Effective Communication is important factor for successful implementation and integration of Lean assessment tools/framework</td>
</tr>
<tr>
<td>H5</td>
<td>Use of Technology is important factor for successful implementation and integration of Lean assessment tools/framework</td>
</tr>
<tr>
<td>H6</td>
<td>Organizational Culture is important factor for successful implementation and integration of Lean assessment tools/framework</td>
</tr>
</tbody>
</table>

*Table 3.3: Hypothesis of critical success factors (CSF)*
4 Result & Analysis
This section gives detail of the responses received from a research survey in a predictive form which is considered as a result. Results are presented in clustered columns and pie charts, which is easy way to analyze quantitative data accurately. This section also gives a complete analysis for results and is used to prove the proposed hypothesis of this study.

4.1 Response rate
Research survey has been developed using “Google forms”. The survey web link is distributed through, social website LinkedIn, Lean groups, Lean manufacturing forum, using personal connections and making personal visit to respondent. As this study has a requirement of people having valid experience in LEAN manufacturing, response rate is lower than the usual quantitative survey. Though response rate is low, the results shown here are reliable because they come from the opinion of the Lean experts.

<table>
<thead>
<tr>
<th></th>
<th>Sent</th>
<th>Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Personal Connections</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Social Websites</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Lean forum</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Personal Visit</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>93</strong></td>
<td><strong>20</strong></td>
</tr>
</tbody>
</table>

*Table 4.1: Survey Response rate*

Quantitative survey data is analyzed using “DataCracker” software which deduces the data into one logical form. Responses from each question statistically analyzed and this statistical data has been plotted using clustered columns and pie charts for accurate reading.

4.2 General Background
For taking samples for this study I have targeted different areas in manufacturing companies. Basically this study focuses on lean practises in manufacturing industries however considering various areas within this industry gives an acute edge to this study. As specified earlier DataCracker program has been utilized to formulate this result.

4.2.1 Survey Respondent Background
Firstly the pie chart shows the participation of respondents having varied experience in respective areas. Sectors included are Manufacturing of Automobile (40%), Chemical (10%), Equipment (10%), Machines (10%), Medical Components (10%), Plastics (10%) and Print packaging (10%). As detected automobile industry has 40 % of total participation, which is a major contribution for this study. During this survey, it’s been observed that majority of automobile industries are far ahead in following Lean practises including lean assessment framework. Automobile sector is advanced user of lean techniques and have understood the benefits of lean assessment. The responses from them are
valid as they have an understanding of important factors necessary for implementation of lean assessment framework.

From research survey, result shown here are of working areas of Lean experts which mainly consists of Technology management (20%), System management (50%) and People management (30%). In lean and particularly in implementation process is crucial to deal with system management and people management. Also in the survey, 70 % of people has more than 10 years of working experience in Lean manufacturing, 20 % of the people have 2 to 5 years and 10% of the people have 5 to 10 years of experience. Thus majority of the respondents are experts in lean and has vast experience in implementing lean systems. This shows the fact that people participated in survey has mixed working areas within various manufacturing sectors having more than 10 years of working experience in Lean will give a valid and reliable opinion about the critical success factors in lean assessment implementation.

**4.2.2 Lean Benefits observed**

Following is the result of benefits observed due to lean and lean assessment. Companies who have fully implemented and in the process of implementing lean systems have commented that they are able to see the various benefits. In the given plot average statistics point system is given to each benefits ranging from 0 to 5 according to the most observed as 5 and least observed as 0. Here 3.75 is set as the accepted level. According to which “Improved productivity with better profit and increase
in efficiency” has the highest point 4.2. Then “Improved system with fewer defects in product” with the point 4, “Improved lead time with fewer delays in business processes” with 3.9 and “More safe work environment” with 3.9 points. Overall improvement is observed in organization’s system, production and safety in working environment. This benefits are necessary in the growth of any company, and further if lean assessment is continuously carried out benefit of “total company involvement” also can be seen.

Figure 4.3: Lean Benefits observed.

4.2.3 Lean Assessment tools/ framework
Recent research during this study and interaction with the lean experts have shown that there are many lean assessment tools and frameworks are available in market. Also nowadays companies have realized that lean work is not completed until it has been continuously assessed and controlled.

Following pie chart shows what different type of lean assessment tools/framework is used by all the companies involved in this survey. It also shows that “key performance indicator benchmarking tool” with 22% voting is used by most of the companies followed by “Value stream mapping and opportunity assessment tool” with 17% voting. This two are traditional methods used by many companies, as for them it’s easier way to assess key performance indicator for deciding company’s success. Other than this, recently introduced frameworks are Lean self-Assessment tool (LESAT) with 13 %, Balanced scorecard (BSC) with 13 %, European Foundation for quality Management (EFQM) with 4 %, Strategos lean assessment tool with 9 %, Lean Index tool with 9 %, Lean cultural assessment tool with 4 % and Shingo model with 9 % of voting.
4.3 Critical Success factors for effective implementation of Lean assessment framework

This section is the important part of this study which gives the result and analysis providing useful information necessary for proving the hypothesis proposed. The responses of participants on six critical success factor viz. Commitment and support from top management, Organizational structure, Human resource empowerment and training, Communication, Technology and culture has been drawn into a statistical format. Further rating of each success factor according to its importance and ranking of all the six factors are shown in the result. These results are logically analysed for proving proposed hypothesis.

4.3.1 Commitment and support from top management

4.3.1.1 Authority and responsibility of top management

For observing commitment and support from top management, it is required to analyze their involvement in lean activities. For this purpose questions has been formulated for understanding if they are involved in the activity of establishing Lean assessment (LA) framework or not and whether they have any participation while maintaining the Lean assessment (LA) framework or not. The employee level in the organization is taken into account from top to bottom respectively, Board Committee, Executive management team, Chief Executive Officer (CEO), Plant manager, Supervisor and Staff. The response has been converted into the statistical form, where point from 0 to 5 is given for each role according to their involvement in the given task.

Upon asking who has the authority to establish lean assessment framework in the organization, the responses are, as per statistical points Board committee has 3.7, Executive management team has 4.1, CEO has 4.3, Plant manager has 4.2, supervisor and Staff has 3.4. This result shows that in establishing lean assessment framework, involvement of top management including CEO and Executive management team has acceptable level. They are involved in successful implementation of LA framework in current lean companies. The involvement includes timely support, commitment, providing required resources, formulating strategy to get a success in the particular activity.
Support of the top management checked by getting response of the question, who has the responsibility to maintain lean assessment framework. Generally maintenance of LA is the main responsibility of the plant manager but there is necessity of continuance support from top management. The result shows that though Plant manager is more responsible (4.3), the board committee (3.1), executive management team (3.4), Chief executive officer (3.3) all are somehow involved in the process by providing guidance and support.

**Figure 4.5: Authority and responsibility to establish and maintain Lean assessment framework**

### 4.3.1.2 Assuring successful integration of LA Framework

The top management should ensure that the Lean Assessment is integrated successfully in the organization to avoid any further complications or delays in accepting the new concept by the employees. Respondent has convey that for assurance of successful integration of LA framework top management involvement in the act is one of the success factor (3.8). Also arranging training sessions to understand lean concept and assessment framework (3.7), Allocating roles and responsibilities (3.6), Following change management steps (3.6), Setting up lean management team (3.5), and Providing necessary resources (3.3). These all factors are equally important as their statistical points does not differ much.
Long term policy establishment to support future maintenance of LA framework shows that the Top management is completely involved in this lean activity and has a plan to follow by formulating policy. Creating a policy helps in continue development in LA framework which also involves the updating, creating, maintaining the framework. 80% of the companies have policies for future maintenance of the LA Framework.

This shows, respondents have agree that the success in implementing and integrating lean assessment framework in organization is due to the consistent top management support and commitment.

4.3.2 Organization structure
An effective organization structure means the alignment of organization’s strategy, vision, mission to the organization’s goal and objective. For implementation of lean assessment framework aligning strategies of the companies to the company’s lean objective is important. According to results, shown in figure 4.8, respondent have specified that 70% of the organization have goals and objective aligned
to their strategy and also lean assessment fulfills the goal and objective of lean manufacturing in respective organization.

In organization structure, Lean assessment process gives out the scores for each department or individual employees depending on which LA tools they are using. In a figure 4.8, result shows that whether this scores are linked to bonuses or benefits, 50% said scores are linked to bonuses and 50% said scores have no connection with the bonuses. As seen 50% of the organization gives bonuses and benefits to respective department or individual if their lean assessment scores are good. This organization system certainly provide environment and motivation for better performance in implementation phase.

As shown in the figure 4.9, 60% of the participant’s organization have documented guidelines for understanding lean assessment framework. Also 60% have said that lean assessment framework is updated once in a year. This once in year schedule for updating LA framework is accurately followed by the organization as new changes and improvements are rapidly taking place. Intact and flexible organization structure is essential when LA framework getting updated every year. To understand updated version and getting acceptance from employees is a difficult task, in this case strong, communicative organization structure and proper documented guidelines for LA framework are effective factors for success.

4.3.3 Human resource empowerment and training
Human resource is important asset for every organization. When there is an introduction of new tool or concept in the organization it is necessary to provide training for employees for more productivity.
Implementation of lean assessment framework gets easier when thorough training on lean concept and lean assessment is provided. As seen in the result in fig 4.10, almost all the companies are providing training to the employees only the frequency of training is different. 56% of the companies provides training once in a year which seems to be logical. 11% twice in a year, 11% more than 2 times per year, 11% less than year and 11% companies never gives a training to their employees.

![Figure 4.10: Human resource empowerment and training](image)

To assure complete integration of lean assessment framework, as shown organization providing consistent training courses to their employees on lean and lean assessment. Whereas when new employee join the company it is a requirement to provide detail training to him. The usage of lean assessment and how it works in the organization and what will be the responsibility of new employees are few things which are considered while giving training. Here result in figure 4.10, denotes that 80% of the companies give training to new employees and assure the complete integration of lean assessment in the organization. Most of the lean organization have understood the requisite of human resource empowerment and their training to achieve goal of becoming a lean company.

### 4.3.4 Effective Communication

Figure 4.11 shows the most frequently used communication system in organization and overall percentage of awareness of lean assessment within the organization.

![Figure 4.11: Communication system and Lean assessment awareness in organization](image)
To maintain effective communication between the employees and within the organization the different modes of communications are used by the companies. In the research survey statistical point system is followed. To get a better idea of what is the general frequency of different communication system being used in organization, statistical points from 0 to 5 have been assigned by each participant to each communication tool according to its usages. As seen in the graph (Figure 4.11) majority of participants have given maximum point to Email, 4.5 which shows that it is most frequently used mode of communication. Email is fast and easier way to communicate and can reach maximum people in a short time. Lean manufacturing have emphasized more on human to human interaction, so Daily Meetings get a point of 3.8, Face to face conversation gets 3.8 and visual presentation gets a 3.8 points, which also shows that the frequency is quite higher and most companies prefer to use this mode. These are traditional ways of communicating and prove to be effective. Using telephone for conversation gets 3.7 and reaching out to employees by using monthly bulletin has received 3 points. Now a days using Note or fax consider as a slowest way of communication and gets a 1.8 point which shows that it is rarely used.

In implementation process of lean assessment framework, choosing effective, clear and fast mode of communication is essential. As seen from the result, the companies who have implemented lean assessment framework have suggested that Email, Daily meetings, Face to Face conversation and visual presentation are most used mode of effective communication.

The figure 4.11 also shows the result of general awareness about lean assessment and how it is used in organization, which gives the fact that 40 % of the time “more than 50 %” of the employees have understanding and awareness of lean concept and lean assessment. This figure implies that real use of lean assessment is understood by employees and they can use it efficiently. 30 % of the time “less than 10%” of the employees have awareness about lean assessment. This figure shows that company should emphasis more on communicating and spreading the knowledge of lean in employees. No awareness of the basic concepts of lean and its usage may lead to refusal for changes needed for implementation process. Thus here it can be say that effective communication is a required factor.

![Effective implementation using communication as a tool](image)

**Figure 4.12: Effective implementation of lean assessment using communication.**

As shown in the figure 4.12, communication is used for effective implementation of lean assessment framework in the company. The result for conducting trial sessions for using lean assessment tool is
3.2 point, maintaining clear communication between management and staff using earlier specified communication modes is 3 point, conducting informative seminars about lean concept is 2.5 point, providing easy access to all the employees when needed is 2.6, developing common understanding between management team and staff about the tasks carried out for implementation process is 3.1, distributing information booklets amongst the staff to increase awareness about the lean system.

4.3.5 Technology

With increasing use of technology in industries, it is becoming an important part of the daily working life of the organization. Thus this study gives out the few facts related to the technology. International standards are used to follow up procedures, no defect in production and to maintain quality work. In the implementation and integration of lean assessment framework using international standards can be a very significant step. As seen in the result of figure 4.13, among the companies involved in the survey 40% of the companies are using the international standards for implementing, maintaining and controlling the process of lean assessment.

![Figure 4.13: Use of Technology in lean assessment](image)

Lean assessment involves usage of tools and technology, where for analysing results coming from the post assessment, technological aide have been taken into an account by the companies. From figure 4.13, 70% of the companies have agreed that they are using tools for analysing assessment results however 30% companies are not using any tools for analysing assessment results. Results from the assessment should be accurately analysed and sometimes human observation or calculation are not enough that time computer software’s are designed particularly for this purpose.

Depending on the size of the organization and no of employees working for the organization, the data size from the assessment varies. This data generated will be stored and updated continuously using various methods. Here information technology is used for data management system. Thus as specified on the figure 4.13, 100% companies are trusting technology for analysing and maintaining the assessment data. This shows that organization are considering technology as one of the important factor in the implementation and integration of lean assessment framework.

4.3.6 Organization Culture

After noticing the results and discussing with lean experts, it is observed that role of organizational culture in the success of lean management is notable and important. Cultural factor comes with the different angles which can be used for the success of the company. Maintaining appropriate and balanced culture within the overall organizational structure is a key. So this study reveals the fact
about the importance of culture within the participated companies. The acceptance level for the statistical point is at 3.4 point for analysis purpose.
First analysis of the statements which are above accepted level of points, so “change in culture won’t be resisted by the employees if they are beneficial for organization” has a statistical point of 3.7, which predicts that employees are interested in organizations benefits and are ready to make few changes when necessary. It also shows the cooperation between the employees and the organization. “Organizational culture, its leadership and human resources are important aspect in organization’s success” has a 3.8 points, so participants have agreed that this aspects have to be considered and taken good care of while making any changes or implementing any new concepts in the organization. “Existing culture helps you to easily adapt to lean organization” has a 3.5 point, thus this statement gives the fact that organization may be started introducing new changes in culture long before it started to take a steps to become lean. Also it can also be said that current culture of the organization is suited for lean and implementing lean assessment. “Collaboration and common understanding comes from the strong culture” has a 3.8 points, which predicts that collaboration and understanding are two core values which are inbuilt and they usually comes when the strong cultural systems are present in the organization.
Now one statement which is below the acceptance level of 3.4 is “your organization does not hesitate to change the old culture for future development and adaption” has 3.3 points, this can be predicted while considering positively, participant have nearly disagrees to this statement and the statement implies that organization is obliging employees by changing culture and not considering views of employees while failing to communicate properly.
Thus participant’s companies are lean companies and the culture observed by the participant is supportive to lean management and lean assessment implementation.

![Importance of culture](image)

**Figure 4.14: Use of Technology in lean assessment**
4.4 Rating of critical Success factors

This section gives a result which summarises the analysis and rate and rank the six critical success factors according to their importance and critical level. The graph shown in the figure 4.14 denotes the statistical points according to the importance of these CSFs in the success of lean assessment implementation and integration in the organization. This survey has given the result as, for “commitment and support from top management” 4.3 points, for “organizational structure” 3.7 points, for “Human resource empowerment and training” 4.1 points, for “Effective communication” 4.2 points, for “Use of Technology” 4 points and for “Organizational culture 4.2 points. As per this rating CSF’ have been ranked as follows: 1) Commitment and support from top management 2) Organizational culture 3) Effective Communication 4) Human Resource empowerment and training 5) Use of Technology 6) Organizational structure.

![CSF Rating According to Importance](image1)

*Figure 4.15: Rating of the Critical success factors according to the importance*

![CSF Rating according to Most Challenging to least challenging](image2)

*Figure 4.16: Rating of the Critical success factors according to the most challenging to least challenging*
The figure 4.15 shows the rating of CSFs according to the challenges organization faces in using this CSF for successful implementation and integration of lean assessment tools/frameworks. The graph shows the rating as, for “commitment and support from top management” 4 points, for “organizational structure” 3.7 points, for “Human resource empowerment and training” 3.3 points, for “Effective communication” 3.3 points, for “Use of Technology” 3.5 points and for “Organizational culture” 4 points. As per this rating CSFs have been ranked as follows: 1) Commitment and support from top management 2) Organizational culture 3) Organizational structure 4) Use of Technology 5) Effective Communication 6) Human Resource empowerment and training.

The both the results of rating and ranking predicts that the proposed six critical success factors are important in the process of lean assessment framework implementation. Thus hypothesis considered in this study has proven.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Statement</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Commitment and support from top management is important factor for successful implementation and integration of Lean assessment tools/framework</td>
<td>Confirmed</td>
</tr>
<tr>
<td>H2</td>
<td>Organizational structure is important factor for successful implementation and integration of Lean assessment tools/framework</td>
<td>Confirmed</td>
</tr>
<tr>
<td>H3</td>
<td>Human resource empowerment and training is important factor for successful implementation and integration of Lean assessment tools/framework</td>
<td>Confirmed</td>
</tr>
<tr>
<td>H4</td>
<td>Effective Communication is important factor for successful implementation and integration of Lean assessment tools/framework</td>
<td>Confirmed</td>
</tr>
<tr>
<td>H5</td>
<td>Use of Technology is important factor for successful implementation and integration of Lean assessment tools/framework</td>
<td>Confirmed</td>
</tr>
<tr>
<td>H6</td>
<td>Organizational Culture is important factor for successful implementation and integration of Lean assessment tools/framework</td>
<td>Confirmed</td>
</tr>
</tbody>
</table>

*Table 4.2: Result of Hypothesis Test*
5 Discussion

The identified critical success factors are genuine in nature and can successfully use by any sector of the manufacturing companies. As shown in the results participants have selected from different sector within the manufacturing industry and they supported the selection of set of CSFs necessary for implementation of lean assessment framework. The participants are skilled officials working in lean companies and some companies involved in survey are top establishment of Lean manufacturing and they have been using lean assessment from a long time.

5.1 Commitment and support from top management

Many researchers have mentioned in their studies that Commitment and support from top management and active leadership is considered as a major success factor for the implementation process (Alaskari & Ahmad et al 2012, Rose, Deros & Rahman 2014, Kundu & Manohar, 2012). Continue involvement of top management in the process of implementation of lean assessment motivates the employees and increases the overall performance of the process. During the research respondents have accepted that in a change management due to implementation process, top management supports the employees by providing necessary resources. This involvement of top management leads to a higher performance and success, whereas in the given research, Top management commitment and support is the top ranked and most choice critical success factor selected by the survey respondent.

5.2 Organizational culture

The one response for the question “what assessment tools are used by the company”, was from the lean organization as “lean assessment is only a starting point and real goal is to establish lean culture within an organization”. This statement clearly shows the importance of a Lean culture in well-established lean companies and further it also suggests the fact that the process of becoming lean has to start with building a strong lean culture amongst the employees. Hence the results from this study states the same that organization culture is major part of a successful lean organization and it helps to effectively manage implementation process of lean assessment.

5.3 Effective Communication

Aforementioned communication is basic tool for connecting people working together, hence effective communication is most necessary and important factor of the lean system (Achanga et al,2006, Punnakitikashem, Buavarporn & Chen, 2013) Effective communication is one of the success factor for the implementation of lean tools including lean assessment framework (Alaskari & Ahmad et al 2012, Rose, Deros & Rahman 2014). This study has given the results showing effective communication as critical success factor for implementation of lean assessment tools/ framework. Participants have suggested that the organization maintaining the communication with the employees about the new updates in lean assessment framework. Also they are understanding the progress of the processes by performing daily meetings and having face to face conversation which is necessary to know the requirements of the employees.
5.4 Organizational Structure
Organizational structure assure the alignment of organizations objective to its strategy. It also make sure the role and responsibility of different levels in the organization is properly maintained and understood by everyone, which is mostly required when the process of lean assessment implementation starts. Hence the research also proves that the organization structure is a critical success factor in the implementation of lean assessment framework.

5.5 Technology
Also technology considered as one of the critical success factor of lean assessment implementation as lean assessment itself involves technological aid. Lean assessment involves, collecting data from different resources, analyzing the large no of data, analyzing it and making prediction out of this received data during each process various software, process technologies are used. Also for suggesting improvement after analyzing data one needs to be trained in handling this software. This large no. of data has to be stored for future references, then also technology comes handy like using data management system for storage and updates of the assessment data. This research also supported technology as a critical success factor.

5.6 Human resource empowerment and training
The factor human resource empowerment and training, suggested in researches has important contribution in the success of lean assessment implementation (Mohammad, Rashidi & Karimdoust, 2014, Jurado, Fuentes & Gomez, 2014, Alaskari & Ahmad et al 2012). Understanding human values and empowering them is a one way of assuring better performance, however this study reveals that the companies are spending lot of time and money on training the present and new employees, because they have understood the benefits achieved by trained employees. Different courses on lean concept and lean assessment has been provided in companies for easing the process of implementation. Thus survey shows that human empowerment and training is critical success factor for implementation of lean assessment framework in the manufacturing industries.
6 Conclusion

This section gives the summary of the research and concludes the study based on the research findings. In chapter 4, results and analysis are explained in detail which give the answer to the research question of this study. Hence response to the research questions mentioned in section 1.4 are elaborated here. Further the contribution from this research towards the lean assessment is mentioned briefly. Finally the recommendation for future research and few suggestions are discussed.

This research is based on finding of a critical success factors for lean assessment implementation from literature review to develop a suitable hypothesis and conduct a survey to prove the proposed hypothesis. Thus survey conducted amongst the lean experts have given a positive reply to the hypothesis considered, and this study could find out the main critical success factors necessary for implementation/integration of lean assessment framework in the manufacturing industries based on the proven hypothesis. So the conclusion of this research in terms of answer to the research question is drawn as follows.

**Research objective 1: Identify critical success factors**

This study is developed to find answer to the research question “What are the critical success factors for implementation of lean assessment tools/frameworks in manufacturing industries?” the particular set of critical success factors (CSF) are considered for this study. However this set of CSF is tested using survey and valid CSF’s have been finalized. As per the research findings the main critical success factors for implementation/integration of lean assessment framework are 1) Commitment and support from top management 2) Organization structure 3) Organizational Culture 4) Effective communication 5) Human resource empowerment and training 6) Technology

Research survey participants also provided much guidance on the rank of this set of critical success factors according to the importance and criticality. This set of CSF’s are truly useful for companies to achieve success in the process of implementation of lean assessment framework. While rank system provides more easy path in considering various CSFs. The rank of the CSFs according to its importance is shown as follows:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Critical Success Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Commitment and support from top management</td>
</tr>
<tr>
<td>2</td>
<td>Organizational culture</td>
</tr>
<tr>
<td>3</td>
<td>Effective Communication</td>
</tr>
<tr>
<td>4</td>
<td>Human Resource empowerment and training</td>
</tr>
<tr>
<td>5</td>
<td>Use of Technology</td>
</tr>
<tr>
<td>6</td>
<td>Organizational structure</td>
</tr>
</tbody>
</table>

*Table 6.1: Ranking of final critical success factors*

**Research objective 2: Identify type of most used lean assessment framework in industries**

This study also provides answer to the supportive research question which is one of the conclusion for this research and research question is “What are the lean assessment framework generally used by manufacturing industries?” During the conduction of this research it is observed that understanding
different types of framework in a manufacturing industry is a necessity. Nowadays there are different types of frameworks are available in the market and companies are using them according to their purposes which are useful for organization’s cultural assessment, lean assessment, quality management and process mapping. So the companies are using them according to their requirements. As we have seen that there are six critical factors for lean assessment framework, we also get the response from the participants about what different types of lean assessment frameworks are being used in manufacturing industries. The survey responses showed that most used lean assessment frameworks in the manufacturing industries are Key Performance Indicator (KPI) benchmarking, value stream mapping and opportunity assessment, Lean Enterprise Self-assessment tool (LESAT), balanced scorecard (BSC), Lean Cultural Assessment Model (LCAM) among the many other frameworks available in the market.

6.1 Contribution of the research
Most of the studies have focused on Lean management and finding critical success factors for lean implementation (Achanga et al 2006, Rathje, Boyle & Deflorin 2009, Bortolotta, Boscarib & Daneseb, 2015) Many researchers have discussed about the Lean manufacturing over the years. Few researches conducted studies of finding critical success factors for implementation of lean tools. However this study mainly comprises of the topic which particularly focuses on Lean assessment.

Lean assessment plays a major role in analyzing state of leanness of the organization, so identifying critical success factors for effective implementation of lean assessment in manufacturing industries provides a key to the success for companies. Identification of set of critical success factor is the major contribution of this research. Also it gives understanding of various lean assessment frameworks used in the industry which can be used for identifying particular applications in respective industries.

6.2 Limitation of the research
This research has few limitations, as mentioned the subject of this research is “Critical success factors for implementation/integration of lean assessment tools/frameworks” shows that this study concentrated on only lean assessment tools and does not consider overall “lean tools”.

- It does not give complete elaboration of Lean concept or lean manufacturing in the study. The research considered a thesis topic as a constraint to discuss more on “Lean concept”.
- This study focuses on singular application while restricting to one area of industry that is manufacturing.
- Survey responses and quantitative data are limited due to the time constraint for the master thesis.

6.3 Recommendation for further research
In this research lean assessment considered in manufacturing industries, further research can be conducted with following same method in a different industries like Construction, IT, Finance, Hospitality etc.

General background of respondents in this study is restricted to the lean expert, different survey can be carried out using participants from varied background by adjusting survey questions according to general understanding of the topic.

Here critical success factors are researched for Lean assessment tool/framework, same research can be done for various important tools in Lean manufacturing.
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• http://www.efqm.org/efqm-model/model-criteria (Accessed on 06-06-15 at 00:15)
• http://www.sae.org/manufacturing/lean/column/leanju01.htm (Accessed on 25-06-15 at 16:00)
• https://www.datacracker.com/ (Accessed on 04-07-15 at 00:09)
APPENDIX A

I. TEMPLATE OF SURVEY QUESTIONNAIRE

Introduction:
Hello,

My name is Pradnya Baviskar. I am Master's student of Project Management and operational development at KTH Stockholm and currently working on my master's thesis.

Aim of the thesis is to find "Critical success factors for effective implementation/integration of lean assessment tools/frameworks in manufacturing industries"

Please can you fill this survey which will be used only for academic purpose? It will not take more than 10 minutes of your time.

Thank you for your valuable contribution.

Warm Regards,

Pradnya Baviskar

Note: If you have any queries regarding the survey please approach me via my email id pradnyaxxxx@gmail.com. I will be happy to answer.

Aim: Finding critical success factors for integrating Lean assessment frameworks in manufacturing industries

General Background

1. Company works in manufacturing and production of:
   • Automobile
   • Chemicals
   • Equipment
   • Foods
   • Machines
   • Textiles
2. You are working in area of:
   • Technology Management
   • People management
   • System management
3. Your total years of work experience in this industry:
   • Less than 1 year
   • 1-2
   • 3-5
   • 5-10
4. Your total years of work experience in Lean:
   - Less than 1 year
   - 1-2
   - 3-5
   - 5-10
   - More than 10 years

5. What benefit/s do you observe the most in your company due to lean manufacturing? (you may choose more than one)
   - Improved productivity with better profit and increase in efficiency
   - Improved system with fewer defects in product
   - Improved lead time with fewer delays in business processes
   - Improved communication with customers and stakeholders
   - Total company involvement
   - More safe work environment
   - Reduction in manpower

6. For assessing leanness of the company, what lean assessment framework/s your organization uses?
   - EFQM assessment (European Foundation for Quality Management)
   - LESAT (Lean Enterprise Self-Assessment Tool)
   - VSM (Value Stream Mapping) and opportunity assessment
   - BSC (Balanced Scorecard)
   - Lean Index Tool
   - key performance indicator Benchmarking tool
   - Lean culture assessment model (LCAM)
   - Other (Please specify)

<table>
<thead>
<tr>
<th>Critical Success factors for effective implementation of Lean assessment framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Management support</td>
</tr>
</tbody>
</table>

7. Who has the authority to establish lean assessment framework in your company?
   - Board committee
   - Executive management team
   - Chief executive officer
   - Line Manager and supervisor
   - Staff

8. Who has the authority to maintain lean assessment framework in your company?
   - Board committee
   - Executive management team
   - Chief executive officer
   - Plant manager
   - Supervisor
   - Staff

9. How does your organization assure successful integration of lean assessment framework?
• Setting up lean management team
• Providing necessary resources
• Allocating responsibilities
• Arranging training session on concept of lean and lean assessment framework
• Following change management steps
• Other (please specify)

10. Does your organization have a policy to support future maintenance of lean assessment framework?
   • Yes
   • No

11. Do you think that lean assessment framework fulfil the goals and objective of lean manufacturing in your company?
   • Yes
   • No

12. Does score of the assessment linked to bonuses and other benefits?
   • Yes
   • No

13. Do you observe result of assessment have helped in improving operational performance?
   • Yes
   • No

14. Does your organization have documented guidelines for lean assessment framework?
   • Yes
   • No

15. How often lean assessment framework getting updated or improvised?
   • Once per year
   • Once per 2 years
   • Once in more than 2 years
   • Never
   • Other (please specify)

16. What type of communication system used in your organization?
   (According to frequency)
   • Email
   • Telephone
   • Daily meetings
   • Visual presentations
   • Face to face conversation
   • Bulletin board
   • Note/fax
17. Is everyone in your team aware of how to use lean assessment framework?
   - Yes
   - No

18. How does your organization assure the effective implementation and use of lean assessment framework within the company using communication as a tool?
   - Conducting trial assessment sessions
   - Maintaining clear communication between management and staff
   - Conducting informative seminars
   - Providing easy access to all necessary information when needed
   - Developing common understanding between management team and staff
   - Other (Please specify)

19. Does your organization timely inform all employees about the updates and changes in system or framework?
   - Yes
   - No

20. Does your organization use any international standards or methods to protect assessment data?
   - Yes
   - No

21. Does your organization use any tools and techniques for analysing assessment result?
   - Yes
   - No

22. Does your organization use the tools, methods and technology for improving performance after the assessment result?
   - Yes
   - No

23. Does your organization provide training courses on lean and lean assessment?
   - More than 2 times per year
   - Twice in a year
   - Once in a year
   - Less than once in a year
   - Never

24. Does your organization provide training for new employees?
   - Yes
   - No

---

**Technology**

Give points from 1 to 5 for each statement.

Strongly disagree = 1 to strongly agree = 5
Collaboration and common understanding within the organization comes from strong culture. 
Existing culture helps you to easily adapt to your lean organization.
Your organization does not hesitate to change the old culture for future development and adaptation.
Organizational culture, its leadership and human resources are most important thing in any organization’s success.
Change in culture won’t be resisted if they are beneficial for organization.

<table>
<thead>
<tr>
<th>Rating of Critical Success Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please give points accordingly from 1 to 6 score.</td>
</tr>
<tr>
<td>According to Importance</td>
</tr>
<tr>
<td>Commitment and support from top management</td>
</tr>
<tr>
<td>Organizational structure</td>
</tr>
<tr>
<td>Human resource empowerment and training</td>
</tr>
<tr>
<td>Communication</td>
</tr>
<tr>
<td>Technology</td>
</tr>
<tr>
<td>Culture</td>
</tr>
<tr>
<td>According to most challenging to least challenging</td>
</tr>
<tr>
<td>Commitment and support from top management</td>
</tr>
<tr>
<td>Organizational structure</td>
</tr>
<tr>
<td>Human resource empowerment and training</td>
</tr>
<tr>
<td>Communication</td>
</tr>
<tr>
<td>Technology</td>
</tr>
<tr>
<td>Culture</td>
</tr>
</tbody>
</table>

Thank you for your participation! The survey result can be shared if interested. Please leave your email ids and mail will be sent to you with short summary and result of this research study.

Email id:
II. **BRIEF COMPARISON OF ASSESSMENT TOOLS**

<table>
<thead>
<tr>
<th>Assessment Mode</th>
<th>LESAT</th>
<th>Baldrige Prize</th>
<th>Good to Great</th>
<th>Shingo Prize</th>
<th>ISO 9000</th>
<th>EFQM</th>
<th>CMMI</th>
</tr>
</thead>
</table>
| Source: Nightingale (2005), LESAT: The Lean Enterprise Self Assessment Tool

<table>
<thead>
<tr>
<th>Assessment Stakeholders</th>
<th>Enterprise leadership</th>
<th>Flexible</th>
<th>Top leadership</th>
<th>Flexible</th>
<th>Management</th>
<th>Management</th>
<th>Management</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Criteria or Information Addressed</th>
<th>Enterprise practices</th>
<th>Quality and customer commitment</th>
<th>Best principles identified in Good to Great book</th>
<th>Toyota Production System and lean manufacturing</th>
<th>Quality management systems</th>
<th>Compliance of management systems with the EFQM excellence model</th>
<th>Best practices in process improvement</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Information Gleaned</th>
<th>Gaps and prioritized improvement areas</th>
<th>Areas for improvement and key principles</th>
<th>Trends in implementation of concepts</th>
<th>Successful adoption pyramid guides transformation</th>
<th>List of problems and improvement plans</th>
<th>Gaps and improvement areas</th>
<th>Gaps and improvement areas</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Designed for enterprises who design, manufacture and support products; recently applied to healthcare and services</th>
<th>Manufacturing, service, small business, health, education, non-profit</th>
<th>Broad</th>
<th>Designed for manufacturing; recently expanded to Operational Excellence</th>
<th>Broad</th>
<th>Broad</th>
<th>Designed for software development processes; adapted to wide range of business processes</th>
</tr>
</thead>
</table>

Source: Nightingale (2005), LESAT: The Lean Enterprise Self Assessment Tool