

Critical Success Factors for the effective implementation of Lean Sigma: results from an empirical study and agenda for future research

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Critical Success Factors for Lean Six Sigma implementation

Abstract

Purpose

Identification of Critical Success Factors (CSFs) for any continuous improvement initiative is important as it allows organisations to focus their efforts on these factors to ensure a success. The purpose of the paper is to present the Critical Success Factors (CSFs) for the effective implementation of Lean Six Sigma.

To analyze the implementation of Lean Six Sigma, focusing on the Critical Success Factors identified in the literature, through a survey of companies, geographically disperse, from both the manufacturing and service industry.

Design/methodology/approach

The approach taken by authors in this study has two fundamental parts. The first part was to analyse the current literature on CSFs for all continuous improvement initiatives such as TQM, Lean, Six Sigma and Lean Six Sigma. The second part was to design a survey questionnaire based on the literature. The questionnaire was sent to 600 companies (both manufacturing and service) and the response rate is approximately 17%.

Findings

Analysis of key findings highlighted that the most important factors are: management commitment, cultural change, linking Lean Six Sigma to business strategy and Leadership styles. The results also revealed that the least important factors are Linking Six Sigma to HR rewards and Extending Lean Six Sigma to Supply Chain.

Research limitations/implications

A sample size of 101 companies is not sufficient to generalise our key findings. This will be rectified by carrying out further surveys in the forthcoming months and making this investigation a longitudinal study. Moreover the authors have to execute semi-structured interviews to obtain a better understanding of the current practice of Lean Six Sigma in participating organisations. An online survey was administered for this study; however future semi-structured interviews with employees in those companies would enable to have a better understanding of their practice of Lean Six Sigma programmes.

Originality/value

Although there are a number of papers published on CSFs of Lean and Six Sigma, it was found that there is a dearth of literature on CSFs of Lean Six Sigma implementation. The authors will also compare and contrast the CSFs in both manufacturing and service organisations. The results showed what the most and least important factors are for a successful implementation of Lean Six Sigma, providing valuable insights for organizations which will be embarking on this journey.

Keywords: Lean, Six Sigma, Critical Success Factors, Implementation.

Introduction

This paper presents the results of a research focused on the implementation of Lean Six Sigma, with the objective of analyzing what the critical success factors are.

After an introduction to Lean Six Sigma and its origin, followed by a review of the literature highlighting the Critical Success Factors identified, the results of a survey among practitioners are discussed, to show what Critical Success Factors are deemed more important from the practitioners that answered the survey.

Consistencies and discrepancies between survey's results and literature review are then discussed. It is hoped this study may bring out important considerations for both Companies that are currently implementing Lean Six Sigma and want to improve, and for Companies thinking to implement Lean Six Sigma: reviewing the Critical Success Factors for deployment may point out areas for improvement.

Finally, in the conclusion section, further opportunities for research are identified, particularly in the areas deemed important in the research, but under-developed in the current Lean Six Sigma literature.

Lean Six Sigma

Lean Six Sigma is a business improvement methodology that aims to maximize shareholder value by improving quality, speed, customer satisfaction, and costs: it achieves this by merging tools and principles from both Lean and Six Sigma. It has been widely adopted in manufacturing and service industries and its success in some famous organizations (e.g. GE, and Motorola) has created a copycat phenomenon with many organizations across the world willing to replicate the success.

Lean and six sigma have followed independent paths since the 1980s, when the terms were first hard coded and defined: the first applications of lean were recorded in the Michigan plants of Ford in 1913, and were then developed to mastery in Japan (within the Toyota Production System), while six sigma saw the light in the United States (within the Motorola Research Centre). *Lean* is a process improvement methodology used to deliver products and services better, faster, and at a lower cost. Womack and Jones (1996) defined it as:

a way to specify value, line up value-creating actions in the best sequence, conduct those activities without interruption whenever someone requests them, and perform them more and more effectively. In short, lean thinking is lean because it provides a way to do more and more with less and less—less human effort, less human equipment, less time, and less space—while coming closer and closer to providing customers with exactly what they want.

Six Sigma is a data driven process improvement methodology used to achieve stable and predictable process results, reducing process variation and defects. Snee (1999) defined it as:

'a business strategy that seeks to identify and eliminate causes of errors or defects or failures in business processes by focusing on outputs that are critical to customers'.

While both lean and six sigma have been used for many years, they were not integrated until the late 1990s and early 2000s (George, 2002; George, 2003), and today lean six sigma is recognized as: 'a business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom line results' (Snee, 2010). Lean Six Sigma uses tools from both toolboxes, in order to get the best from the two methodologies, increasing speed while also increasing accuracy.

Overview of critical success factors for Lean Six Sigma identified in the literature

Rockart (1979) illustrated the concept of Critical Success Factor (CSF) and how they can be used to determine the information needs for managers: according to Rungasamy et al (2002), CSFs are those factors essential to the success of any program or technique, in the sense that, if objectives associated with the factors are not achieved, the application of the technique will perhaps fail catastrophically. CSFs include vital issues to an organization's current activities and future success (Boynlon and Zmud, 1984).

In the vast Lean Six Sigma literature, we have identified 31 sources discussing Critical Success Factors for its implementation: 22 articles and 9 books, from whom the resulting list of nineteen CSFs is summarized in Table I.

Anthony and Banuelas (2002) analyzed the "key ingredients for the effective implementation of a Six Sigma program" UK companies, with Coronado and Anthony (2002) further refining them as:

- Management commitment and involvement.
- Understanding of six sigma methodology, tools, and techniques.
- Linking six sigma to business strategy.
- Linking six sigma to customers.
- Project selection, reviews and tracking.
- Organizational infrastructure.
- Cultural change.
- Project management skills.
- Linking six sigma to suppliers.
- Training.

The importance of organizational infrastructure and culture was highlighted from Zu and Fredendall (2010), while Pande et al. (2000) included leadership commitment as one the CSFs. Johnson and Swisher (2003) identified CSFs in:

- Sustained and visible management commitment
- Continuing education and training of managers and participants
- Setting clear expectations and selecting projects leaders carefully for leadership skills
- Picking and selecting strategically important projects

while Kwaki and Anbari (2006) summarized the CSFs in four main areas: management involvement and organizational commitment; project selection, management and control skills; encouraging and accepting cultural change; continuous education and training. Similarly, Achanga et al. (2006) identified four CSFs: leadership and management, finance, skills and expertise, and organizational culture; while Kumar (2007) identified thirteen CSFs for Six Sigma implementation

in SMEs. The importance of organizational culture as CSF was identified from Erwin (2000), while Dale (2000) highlighted the importance of linking Lean Six Sigma to the overall business strategy.

The need of a process management system, particularly the tracking and review of projects, was highlighted from Martens (2001), while Ingle and Roe (2008) went deeper in the subject, identifying the prioritization of projects as a CSF. Antony (2006) add other CSFs to the literature, identifying selection of team members, understanding of the tools, linking Six Sigma to customers and accountability to the existing list of CSFs.

Goldstein (2001) identified thirteen CSFs:

1. Deployment plan.
2. Active participation of the senior executives.
3. Project reviews.
4. Technical support (Master Black Belts).
5. Full-time vs. part-time resources.
6. Training.
7. Communications.
8. Project selection.
9. Project tracking.
10. Incentive program.
11. Safe environment.
12. Supplier plan.
13. Customer “WOWS.”

while Halliday (2001) put his focus on the training of Six Sigma resources. Henderson and Evans (2000) identified the following CSFs for Six Sigma: management support, organizational infrastructure, training, tools, and linking Six Sigma to human resources based actions (promotions, bonuses, etc...); while, in an appeal to statisticians, Hahn et al. (1999) identified leadership, training and projects involvement as CSFs. Antony et al. (2007) identified thirteen CSFs:

- management commitment and involvement;
- company-wide commitment;
- cultural change;
- linking six sigma to business strategy;
- integrating six sigma with the financial infrastructure;
- organisational infrastructure;

- training and education;
- incentive program;
- customer focus;
- understanding the DMAIC methodology;
- project management skills;
- project prioritization and selection;
- project tracking and reviews.

CSF (R...)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Cultural Change				X	X				X		X	X		X	X		X		X						X	X		X		X		
Leadership Style										X	X										X								X			
Management commitment	X		X	X					X		X	X	X	X	X	X	X	X	X						X		X	X	X	X	X	
LSS Training		X		X			X		X		X		X	X	X	X			X		X		X	X	X		X	X	X		X	
Organization infrastructure						X			X		X	X	X		X										X		X					
Communication	X											X																X				
Linking LSS to business strategy			X	X		X						X	X	X	X		X											X				
Linking LSS to customer												X		X	X		X											X				
Linking LSS to HR rewards	X										X	X		X										X			X	X				
Extending LSS to supply chain			X									X		X														X	X			
LSS projects prioritization				X				X	X		X	X	X	X	X	X				X	X				X			X	X		X	
LSS projects tracking and review													X	X			X		X	X	X	X							X			
Project Management Skills				X								X	X	X	X			X		X								X				
Tools and techniques				X					X		X			X	X									X				X				
LSS financial accountability													X	X	X																	
Data Based approach									X															X								
Communication and awareness																	X	X	X									X				
Selection of staff for LSS																				X	X										X	
Resources to LSS team																							X	X			X			X		

Table I: summary of CSFs from the literature

Notes:

- R1:** Henderson & Evans (2000)
- R2:** Halliday (2001)
- R3:** Pande, Neuman, & Cavanagh (2000)
- R4:** Eckes (2000)
- R5:** Erwin (2000)
- R6:** Dale (2000)
- R7:** Hendricks & Kelbaugh (1998)
- R8:** Ingle & Roe (2001)
- R9:** Harry & Schroeder (2000)
- R10:** Pande (2007)
- R11:** Snee & Hoerl (2002)
- R12:** Coronado & Antony (2002)
- R13:** Antony et. al. (2007)
- R14:** Antony & Banuelas (2002)
- R15:** Antony (2006)
- R16:** Breyfogle et al. (2001)
- R17:** Burton & Sams (2005)
- R18:** Hayes (2002)
- R19:** Sivakumar & Muthusamy (2011)
- R20:** Revere, Kadipasaoglu & Zalila (2006)
- R21:** Hahn et al. (1999)
- R22:** Martens (2001)
- R23:** Keller (2001)
- R24:** Brue (2002)
- R25:** Kwak et al. (2006)
- R26:** Zu et al. (2010)
- R27:** Kumar (2007)
- R28:** Brun (2011)
- R29:** Goldstein (2001)
- R30:** Achanga et al. (2006)
- R31:** Johnson & Swisher (2003)

Research methodology and data collection

The study's purpose was to verify whether companies that implemented Lean Six Sigma still recognize the same set of critical success factors individuated in the literature and which ones they would consider as more important.

To answer this question, a structure questionnaire was developed, which was structured as:

- Background of respondent and the organization
- Criteria for successful implementation of Lean Six Sigma in the organization
- Critical success factors for Lean Six Sigma implementation

The questionnaire was distributed electronically to 600 Lean Six Sigma professionals, from various industries and Countries: the list of companies was obtained from the database of the Department of Design, Manufacturing and Engineering Management of Strathclyde University, plus a network of professional contacts of the research team. The response rate was 17%, with 101 responses received.

The questionnaire was targeted to those organizations, irrespective of industry's sector, that have already implemented either Lean or Six Sigma, or Lean Six Sigma.

In the last part of the questionnaire, related to CSFs, the 19 CSFs from the literature were operationalized on a five-point Likert scale (1=Not Very Important; 2=Not Important; 3=Important; 4=Very Important; 5=Critical), and the respondents were also asked to rank each factor from 1 to 19 (1=most important, 2=second most important, etc...), in order to identify the importance of the 19 CSFs.

The data collected was then analyzed using Microsoft Excel data analysis tool-pack and JMP software.

Analysis of survey results

Demographics

The analysis of the first part of the questionnaire provided a better understanding and context of the key findings of the study.

Number of employees and position of respondents

The majority of the respondents were either Master Black Belts (24%), Black Belts (21%) or Function Lead / Manager (15%), with mostly Companies with more than 1,000 employees (63%) responding to the survey.

Areas of industry

Of the twenty areas of industry selected for this survey, Industrial Goods & Services, Financial Services and Automotive accounted for a third of total responses

Reasons for using Lean Six Sigma

Almost half (46%) of the companies have implemented Lean Six Sigma for Cost Savings or Cost Avoidance (e.g. less waste, inventory levels): this was by far the more mentioned reason for implementation, followed at a distance from Customers' satisfaction (11%) and Profit/Bottom-line (11%).

Status of Lean Six Sigma implementation

A third of respondents' Companies applied Lean Six Sigma to all their business units, with half applying it to more than one business unit. More than half of the companies use Lean and Six Sigma together in tandem, a quarter of them use Lean on its own, and only 9% of the companies use Six Sigma on its own.

Reliability Test

In order to measure the consistency of the survey, a reliability test was conducted, being reliability "an indication of consistency between two measure of the same thing" (Black, 1999). According to Cramer (1998), "reliability is particular important in connection with multiple item scales", and he indicates three main types of tests for assessing data reliability: Cohen's kappa coefficient, Ebel's intraclass correlation and Cronbach's alpha coefficient.

Being the Cronbach's alpha coefficient the most widely used (Black, 1999), it was calculated using JMP software: an alpha coefficient of 0.6 or higher is considered an acceptable level of internal consistency.

The results indicate the reliability coefficients vary from 0.76 to 0.80, with an overall Cronbach's coefficient for the entire data set of 0.79. Hence, we can infer the data collected is reliable for analysis.

Performance of Lean Six Sigma

Two thirds (66%) of the respondents consider the implementation of Lean Six Sigma either successful or extremely successful; about 31% consider it either unsuccessful or extremely unsuccessful, with the reaming 3% thinks it didn't have a significant impact, either way.

Analysis of critical success factors

The respondents to the survey were asked to score on a Likert scale their perceived importance of each CSF, with 1=Not Very Important; 2=Not Important; 3=Important; 4=Very Important; 5=Critical: analyzing the responses, a factor with the highest mean score is considered as the most important factor.

The results are showed in Table 2 and Figure 1, where the CSFs have been ranked accordingly to their assessed importance: "Management Commitment" is considered the most important, followed by "Cultural Change", "Linking Lean Six Sigma to Business Strategy" and "Leadership Style".

Furthermore, respondents don't consider "Organization Infrastructure", "Extending Lean Six Sigma to Supply Chain" and "Linking Lean Six Sigma to HR Rewards" as important for a successful implementation of Lean Six Sigma.

CSFs	Average Score
Management Commitment	4.63
Organizational Culture	4.35
Linking LSS to Business Strategy	4.26
Leadership Styles	4.14
Communication	4.11
Linking LSS to Customers	4.07
Awareness	4.03
Selection of LSS staff	3.93
Data Based Approach	3.88
LSS Projects Selection/Prioritization	3.88
LSS Projects Tracking and Review	3.80
Resources for LSS staff	3.77
LSS Training	3.71
LSS Tools & Techniques	3.65
Project Management Skills	3.54
LSS Financial Accountability	3.51
Organization Infrastructure	3.24
Extending LSS to Supply Chain	3.19
Linking LSS to HR Rewards	3.04
Others	1.99

Table 2: Average importance scores for CSFs

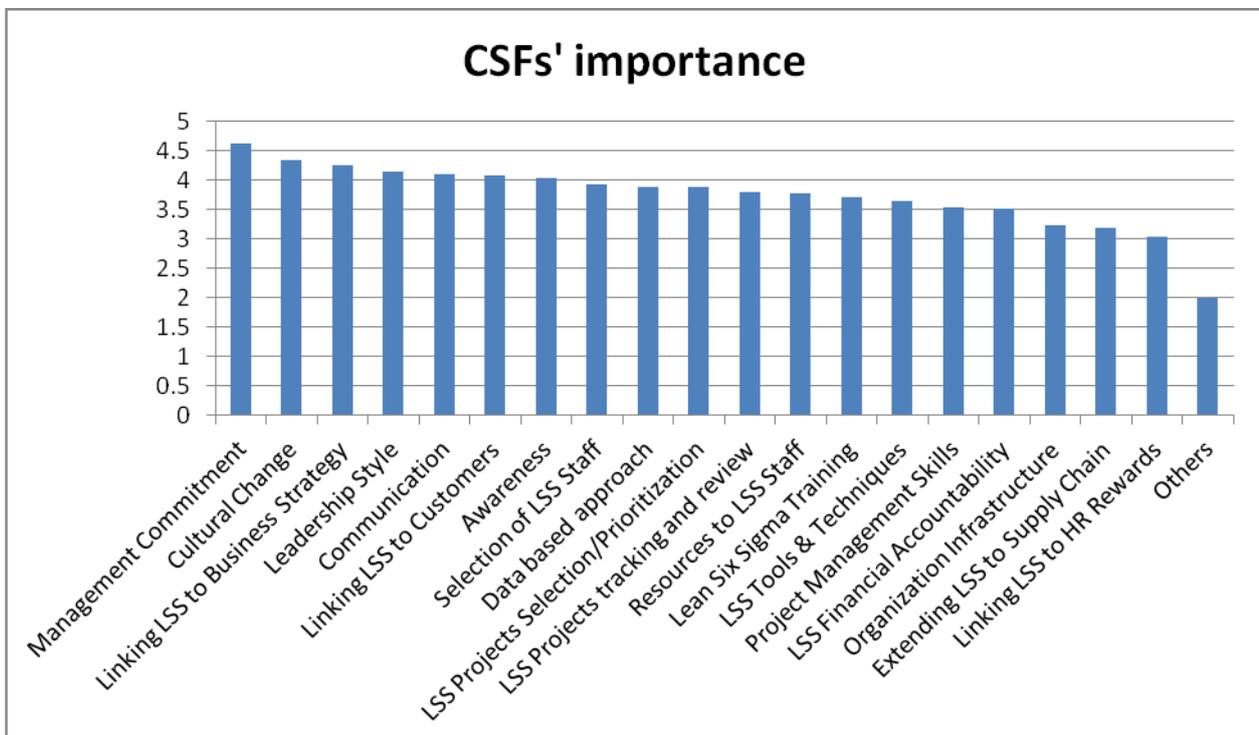


Figure 1: Average importance scores for CSFs

Discussion and key findings

Management commitment is crucial for the introduction of Lean Six Sigma in organization, and the results of the survey confirm the thinking process of many Lean Six Sigma experts and researchers behind this, with most of the literature review highlighting its criticality (see Table 1).

Organizational Culture and Linking Lean Six Sigma to Business strategy have also been widely identified as critical success factors in the literature (Antony and Banuelas, 2002), while the role of Leadership Styles in relation to Lean Six Sigma deployment appears to be more important to practitioners in the field than it was in the literature, where a relatively small number of sources identified it (see Table 1).

It's not a surprise the low score of "Extending Lean Six Sigma to Supply Chain": one company should first master the methodology before attempting to transfer it to suppliers.

However, it is surprising to see the low score of "Organization Infrastructure", as this was often mentioned in the literature as a key differentiator of Lean Six Sigma from previous quality initiatives (Snee, 2004; Pande et al. 2000; Harry & Schroeder, 2000).

Conclusions and directions for future research

Out of the critical success factors for Lean Six Sigma implementation that were identified in the literature, "Management Commitment", "Organizational Culture", "Linking Lean Six Sigma to Business Strategy" and "Leadership Styles" were deemed the most important from the respondents to the survey.

The identification of Leadership styles as one of the more important CSFs for the implementation of Lean Six Sigma, and its relatively smaller coverage in the Lean Six Sigma literature, leaves the field open to further research on which leadership styles are more conducive to a successful implementation.

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