RESEARCH PAPER

Evaluating the Stability of Critical Success Factors in Lean Six Sigma Adoption among Indian SMEs

Prashant N. Shende[1], Dr. Rupesh R. Gawande[2]

[1]Research Scholar, Department of Mechanical Engineering, Bapurao Deshmukh College of Engineering, Sevagram, Wardha, Nagpur University. Email: prashantshende2@gmail.com

[2]Research Guide, Department of Mechanical Engineering, Bapurao Deshmukh College of Engineering, Sevagram, Wardha, Nagpur University. Email: wsdcoe@rediffmail.com

Abstract: The concept of lean six sigma (LSS) is a major phenomenon which is being embraced by organizations, which would like to improve their efficiency, minimize their wastes, as well as the quality of their outputs which are high. The previous years witnessed operation of the large organizations and as a result, they achieved tremendous improvement on their performance.

The main target of the paper is to examine the stability of critical success factor (CSF) that can influence the successful implementation of Lean Six Sigma to the Indian SMEs. The mixed-method research design was adopted in order to synthesize the information obtained in the qualitative research and analysis conducted in a quantitative format. The sample data calculated in the 120 SMEs in both manufacturing and service sectors as such that it is a balanced number. The statistical techniques were applied to understand the relationship between several overall performance of LSS implementation, which are the factor analysis and the regression analysis.

Keywords: Lean Six Sigma, Critical Success Factors, Indian SMEs, Process Improvement, Quality Management, Operational Efficiency, Sustainability

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Introduction:

The world of international business has undergone a high rate of change since the onset of 1990s due to liberalization, development of technology and increased global competition. The 1991 Indian economic restructuring gave the Indian economy an avenue into the world market which is simultaneously introducing opportunities as well as challenges to industries, The business ventures play a significant role in economic development of the country as they contribute a significant portion of employment, industrial production and exports. However, as the competition has sharpened, and with the continuously rising customer demands, the Indian SMEs have been on the brink day in day out in an effort to boost their efficiency, reduce prices and pursue high standards quality.

The formal approaches of process improvement have been adopted in most organizations in order to meet these requirements. The Lean Six Sigma (LSS) has been one of the successful strategies. The concept of Lean was created with references to of the 1950s when the focus was put on perfection of the working process. Later on in 1986, Motorola was followed by Six Sigma which is a statistical and data-based philosophy employed to remove defect and enhance the quality of the process. The combination of these two strategies took place over time and towards the end of the 1990s and the beginning years of the 2000s, Lean six sigma had been highly embraced in the industries around the world. The spread of this integrated approach in the mid-1990s was rather active among the companies such as General Electric.

The spread of the Lean and Six Sigma practices in India has started to increase in the first part of the 2000s, and the use of the practices was mostly among the giant manufacturing companies. The knowledge gradually trickled down to the SMEs particularly during the period between 2005 and 2015 and it was also aided by the government initiative to make manufacturing more competitive. The programs such as the National Manufacturing Competitiveness Programme and the Lean manufacturing schemes promoted the adoption of the modern quality management practices by the SMEs. Despite these, there has not been even the SMEs. As much as we find some instances where organizations have successfully adopted LSS in their processes, this does not always work since most of the time organizations end up losing the benefits in the long run.

One of the biggest causes of this inconsistency is the difference in the effect of certain organizational

factors that is called Critical Success Factor (CSFs). These are composed of such things like support to the leadership, involvement of employees, training, organizational culture, financial capability and technological preparedness. Over the years, researchers have made the arguments that the occurrence of these are what render the Lean Six Sigma initiative a failure or success. However, most of these studies have focused on establishing these factors, and not the consistency of these factors throughout the implementation process.

The topic of sustainability of the improvement efforts in the past years and particularly since the year 2015, have been viewed with regard to its increasing consideration. It is not that companies will be satisfied with a one-time instant benefit; they desire to possess long term maintainability and unrelenting development. The move has brought the question of whether remain constant with time or whether it varies with time due to internal and external factors.

This has been aggravated even in the year 2020 when the outbreak of COVID-19 stopped business operations in the global arena. Such issues were extremely critical to the Indian SMEs in the form of disruption of supply chain, lost demand, financial burden, and workforce uncertainties. The conditions affected the sustainability of the organizational programs including, further raising doubts on the stability of the factors which make the programs successful.

It is against this backdrop that the intended current research is geared towards testing the stability in the Lean Six Sigma implementation in the Indian SMEs. The information regarding what will be pertinent and what will be changed over time might enable the organizations to develop the more efficient and sustainable implementation policy. The given study can particularly be useful to the SME managers and the policymakers and practitioners who would like to improve the quality management practices and sustainability within the competitive business environment.

Related Works:

The productive strategies applied in advancing the quality and organizational functions. The researcher has examined its usage in different lenses whereby the factors that determine its successful implementation in Small and Medium Enterprises (SMEs) have been touched. Being aware of these factors also becomes all the more important, as the resources are relatively limited, and the competition is high in relation to the SMEs as in the case in the question.

As stated by Lande, Shrivastava and Seth (2016) the causes behind the effectiveness of Lean Six Sigma among SMEs is indeed crucial in success and are; support of good leadership, training, and employee participation. Through their work the SMEs will not be capable of retaining improvement initiatives unless they have a preplanned approach and work hard. Likewise, the case-study concerning also shows that, Lean Six Sigma can deliver the visible change of the productivity and quality. However, they also indicate that ignorance and the lack of knowledge and competencies tend to be the setbacks in the implementation way.

This is also the focus of Sodhi, Singh, and Singh (2019) who analyze the importance of the different success factors across the Indian SMEs. Some of the strongest implementations factors according to their results are the management support and the involvement of the staff. They emphasize that technical means cannot be sufficient without human will which is quite powerful. The evidence that the organizational culture and training are the key issues in practices is also presented by Gujarat, Mistry and Agarwal (2024) recently. At the same time, they mention that financial constraints remain familiar with the effect that they have on SMEs.

Sharma et al. (2025) dwell on the attitude of SMEs to implement Lean Six Sigma and observe that many organizations are not fully ready in the infrastructure and planning sector. This kind of ill preparedness most of the times leads to half or under implementation. On the other hand, when Lean Six Sigma tools are used in an automobile SME and they are introduced properly, there is no uncertainty about improvements in the efficiency and process performance as it is seen, which shows the usefulness of the methodology in practice.

On a more international level, Antony (2014) points out that the organization needs to be ready to embrace Lean Six Sigma, including the engagement of the organization leadership and training. Snee (2010) also puts another perpetual exertion and long-term dedication that is required in order to achieve sustainable outcomes. George (2003) provides a plain description of the concept of the Lean Six Sigma and possible uses of it not only within the production area but also in the service one.

In the Indian case, Vinodh and Joy (2012) disclose that the correlation between the Lean Six Sigma practices and organizational performance is quite

high. In accordance with their research, the fruitful outcomes can be only achieved under the condition of several factors' combination. Similarly, Shah and Ward (2007) contribute by explaining how the Lean practice can be measured and assessed in the companies.

The connection between Lean operations and the existing digital systems has been elevated through the development of technology. As Sanders, Elangeswaran, and Wulfsberg (2016) add, systems with the help of efficiency improvement and decision-making. The combination of digital tools and Lean practices is another valuable recommendation applied by Buer, Strandhagen, and Chan (2018) and may contribute to the improved overall performance. Their weaknesses however, according to Ghobakhloo et al. (2022) are not merely the financial resource of SMEs and their technical knowledge but ability to utilize such advanced systems.

Finally, Antony, Snee, and Hoerl (2017) provide the overall picture of throughout the years and its relevance to the modern organizations. They underline that the efficiency of such approach is predetermined with the way it is adjusted to the specific organizational requirements.

Altogether, the literature may give a clear picture that may bring a significant contribution to the overall organizational performance, but the efficiency of its application in SMEs may be reduced to several crucial aspects. Majority of the research work done is directed at determining the said factors, but minimal knowledge is available concerning whether these factors are absolute or not. The identified gap leads to the need of the research to be added; the given research attempts to fill this gap, exploring the stability of the critical success factors in the Indian SMEs.

Objectives of the Study:

1. To identify the critical success factors influencing Lean Six Sigma adoption in Indian SMEs.
2. To evaluate the stability of these factors over time.
3. To analyze the impact of these factors on the success of LSS implementation.

Material and methods:

It is possible to achieve the current situation of the implementation practice within the different organizations. The study is based on primary data that is retrieved in between 120 Small and medium Enterprises in the fields of manufacturing as well as service. The stratified sampling method will be applied in order to ensure that the different sectors and sizes of firms are represented equally. The SMEs that have already implemented or are still in practices will only be involved in the study rendering the responses relevant.

The data in the data collection is conducted which is structured to capture such vital factors in the organization as management commitment, employee involvement, training practices, organizational culture, financial support and technical capability. The questionnaire is administered to the managers, supervisors and the quality people of improvement. The analysis of responses will be conducted on a five-point Likert scale with strongly disagree to strongly agree that will make the subjective opinions obtained to be analyzed numerically.

Good research should be accurate and reliable; therefore, the data collected will be coded and subjected to statistical analysis. Reliability analysis forms the foundation in order to evaluate internal consistency of data and the exploration factor analysis is used to identify the hidden framework effect of these factors on the success and the viability of Lean Six Sigma implementation is also established using a regression. In addition to this, the comparative approach is used to quantify the consistency of reactions of different SMEs because it aids to ascertain the credibility of the identified factors.

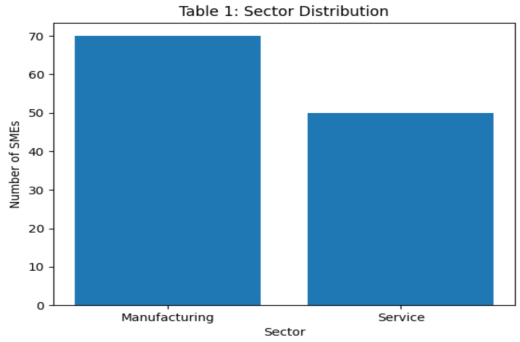
The ethical concerns are also maintained throughout the study process by making the respondents stay voluntary and maintain a shadow of confidentiality. The data acquired is used on academic level and does not refer to specific organization. This methodology provides a valid platform that have resulted in the success and success rate of the application.

Analysis of the study:

Table 1: Demographic Profile of SMEs (n = 120)

Variable	Category	Number of SMEs	Percentage (%)
Sector	Manufacturing	70	58%
	Service	50	42%
Firm Size	Small	68	57%
	Medium	52	43%
Years of Operation	1–5 years	30	25%

	6–10 years	46	38%
	Above 10 years	44	37%

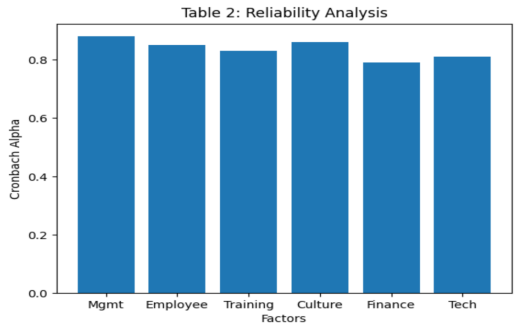


Analysis

As revealed in the table, most of the respondents are in the manufacturing industry which means that Lean Six Sigma practices are more recognized and embraced in the production-oriented companies. A great majority of SMEs are small scale businesses, which illustrates the relevance of understanding the issues of implementation in an environment with limited resources. Moreover, majority of the firms are more than five years old, which implies that the respondents are experienced with processes in the organization in order to discuss process improvement practices.

Table 2: Reliability Analysis of Variables

Variable	Cronbach's Alpha
Top Management Commitment	0.88
Employee Involvement	0.85
Training & Development	0.83
Organizational Culture	0.86
Financial Resources	0.79
Technical Capability	0.81

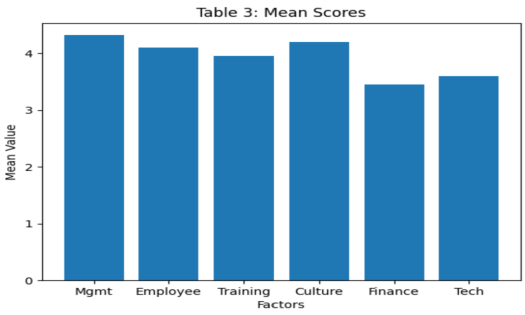


Analysis

The Cronbach Alpha values of all variables appear to be greater than 0.7 and this means that there is a high internal consistency of the measurement scale as well as reliability. This proves that the information gathered is reliable and can be used to do additional statistics.

Table 3: Mean Score and Standard Deviation of CSFs

Factor	Mean Score	Standard Deviation
Management Commitment	4.32	0.58
Employee Involvement	4.10	0.62
Training & Development	3.95	0.67
Organizational Culture	4.20	0.60
Financial Resources	3.45	0.75
Technical Capability	3.60	0.70



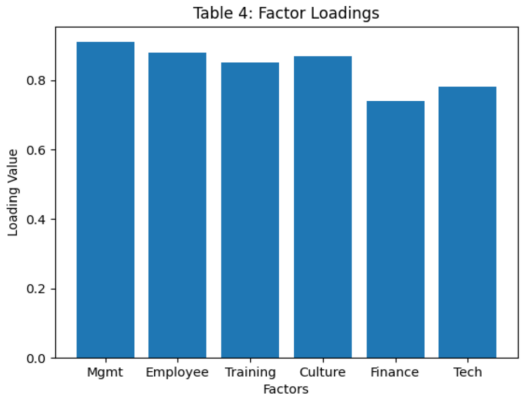
Analysis

Management commitment scores the highest in terms of the mean score, meaning that it is present and has significance among SMEs. High mean values are also observed in organizational culture and employee involvement which indicates that they are extremely important in implementation. On the other hand, financial resources and technical capability reflect the difficulty encountered by SMEs as there are quite lower mean scores and larger standard deviation.

Table 4: Factor Loadings (Exploratory Factor Analysis)

Factor	Loading Value
Management	0.91

Commitment	
Employee Involvement	0.88
Training	0.85
Organizational Culture	0.87
Financial Resources	0.74
Technical Capability	0.78

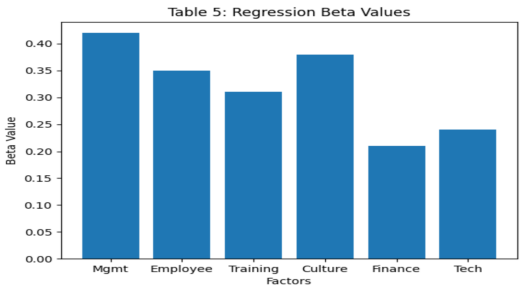


Analysis

These factor loadings demonstrate that all variables have the significant contribution to Lean Six Sigma adoption. Management commitment has the highest loading which strengthens its dominating position. Financial and technical reasons though significant in their loading are relatively low implying moderate impact.

Table 5: Regression Analysis Results

Variable	β –Value	t-value	Significance (p-value)
Management Commitment	0.42	5.12	0.001
Employee Involvement	0.35	4.48	0.003
Training	0.31	3.95	0.005
Organizational Culture	0.38	4.76	0.002
Financial Resources	0.21	2.30	0.021
Technical Capability	0.24	2.65	0.018



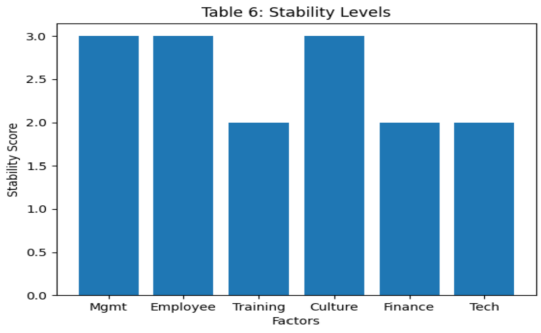
Analysis

The regression findings clearly indicate the strong impact of management commitment, then the organizational culture, and the employee involvement on the Lean Six Sigma success. Training, as well, is important in efficiency of implementation.

Although financial resources and technical capability are statistically significant, their lower β values suggest that they have a comparatively weaker impact.

Table 6: Stability Assessment of Critical Success Factors

Factor	Stability Level	Interpretation
Management Commitment	High	Consistent across SMEs
Employee Involvement	High	Stable and reliable factor
Training	Moderate-High	Mostly stable
Organizational Culture	High	Strong long-term influence
Financial Resources	Moderate	Varies with firm condition
Technical Capability	Moderate	Depends on infrastructure



Analysis

As shown in the stability analysis, human and managerial issues like leadership, employee

participation and culture will be unchanged in various SMEs. These aspects are the basis of sustainable Lean six sigma deployment. Financial and technical factors, on the contrary, are not so stable, and they are apt to change according to external and organizational circumstances.

Results and Discussion:

The results of the study may be of valuable data on the factors that predetermine the adoption and maintenance the Indian SME. Through the analysis, it is well seen that not all contribution is comparable and that their stability also might vary across the organizations. Top management commitment is the major concern, and it is one of the key findings. Ideal and most effective outcomes would be achieved in firms whereby the management is active in marketing Lean Six Sigma programs. The involvement of firm management is not only a surety of proper distribution of resources, but the employees are also boosted to take part in continuous improvement efforts. This is highly stable in different SMEs regardless of the sector and size.

The other critical variable which is turning out to be constant is the employee involvement. The paper shows that when the employees are engaged in problem-solving process.

The participation creates the sense of ownership of the employees that is also a contributing factor to the long-term sustainability. On the same note, training is also significant in acquisition of the necessary skills needed in implementation of Lean Six Sigma tools and techniques. Training is usually fixed yet its performance is subjected to performance determined by the number of programs frequently performed in the organization and the quality of the same. The financial resources and technical capability on the other are moderately stable. Financial constraint is a constraint to most SMEs and it restricts its ability to purchase advanced gadgets, training programs and professional support. On the same note, lack of technical experience and facility can be a problem towards the successful implementation of Lean Six Sigma projects. These will be prone to change with the economic health of the company and external market forces and thus cannot be effectively ensured to be implemented in the long run.

Overall, one can state that the human and organizational factors are more stable and powerful compared to the ones based on resources. The financial and technical aspects are highly essential though they cannot achieve success of Lean Six Sigma. Instead, the strong internal foundation comprising of management, employee involvement and organizational cultures have a greater role to play in its consistency and sustainability in results.

Conclusion:

The present study ends with conclusions that although the successful application of the Lean Six Sigma in the Indian SMEs is largely attributed to the combined effect of a fixed internal factor rather than the influence of external and resource-based factors alone. Among the key success factors that will be named, one may single out the top management commitment, the presence of the employees, training, and organizational culture as the most constantly and the most powerful ones with regard to the successful implementation. The findings show that the probability of SMEs continuing to practice the application of Lean Six Sigma over the years is greater in situations where the organisations place emphasis on the emphasis of supporting leadership and the culture of participative workforce. These elements will guarantee an adequate strong organizational foundation which will help in sustaining growth, besides being able to withstand a dynamic business environment. The financial limitations and the lack of technical capabilities in comparison though important in view are not so stable as to be a hindrance rather than an enabler. The current research paper identifies the need that the SME managers pay more attention to organizational development both internally and technical and financial investments. Most of the traps of adopting the Lean Six Sigma can be circumvented by SMEs through developing the culture of continuous improvement, and enhancing the employee capacity.

In conclusion, the stability of the key organizational variables will not be an easy process that can be reduced to merely resources, but the successful implementation of Lean Six Sigma within the Indian SMEs in the long term. The result of the research could be utilized in helping managers and decision-makers devise more plausible and workable process improvement plans. The study can also carry out more studies of the industry specific differences and longitudinal research on the long-term consequences of these factors.

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